INTRODUCTION

We all get into with no consideration. It's one in every of those natural resources that almost all individuals don't place tons of thought into, however so as to continue enjoying that free offer of water for several additional years, changes should be created.

Harvesting harvest is that the method of assortment of rain from surfaces on that rain falls, filtering it and storing it for multiple uses. Rain harvest puts the provision of hot-water tank to normal levels. It's the gathering and storage of water from surfaces that rain has fallen upon. For businesses, additional therefore hospitality institutions that accommodate a giant range of guests in an exceedingly single location need tons of water to satisfy customers. Rain harvest can merely facilitate to fill this gap.

Rainwater harvest is an innovative technique utilized to reap rain from roofs and different on top of surfaces to be keep for later use. Rain harvested water may be used for garden and crop irrigation, watering livestock, laundry, and flushing bathrooms. However, you can't use harvested rain for showering, rest room sink or room use as a result of it’s not really appropriate consumption.

Rain harvest could be a technique of assortment and storage of rain into natural reservoirs or tanks. One methodology of rain harvest is upper side harvest. With upper side harvest, most any surface — tiles, metal sheets, plastic, however not grass or palm leaf — may be accustomed the flow of rain and supply a family with high quality water and year-round storage. Different uses embody water for gardens, livestock, irrigation, etc.

Urban population in India has grown nearly 5 times in 5 decades from 1951 to 2011. Shortly past, most of our cities were self-sufficient in meeting their water desires from the in depth urban water bodies to produce water to citizens. These days these water bodies have utterly disappeared. Rain harvest is sensible only the amount and frequency of rain and size of the structure surface will generate decent water for the supposed purpose.

Rainwater harvesting technologies are simple to install and operate. Local people can be easily trained to implement such technologies, and construction materials are also readily available. Rainwater harvesting is convenient in the sense that it provides water at the point of consumption, and family members have full control of their own systems, which greatly reduces operation and maintenance problems. Running costs, also, are almost negligible. Water collected from roof catchments usually is of acceptable quality for domestic purposes. As it is collected using existing structures not specially constructed for the purpose, rainwater harvesting has few negative environmental impacts compared to other water supply project technologies. Although regional or other local factors can modify the local climatic conditions, rainwater can be a continuous source of water supply for both the rural and poor. Depending upon household capacity and needs, both the water collection and storage capacity may be increased as needed within the available catchment area. From the vast advantages of rain water harvesting following three can be listed.

1. Harnessing the Rain: Rain harvest

Rainwater harvest, in its several forms, has immense potential for domestic and multiple uses in rural areas round the world. rain harvest will be done from the home, roof water assortment level to active watershed management for higher soil and conservation. Rain harvest could be a well-tried thanks to improve the resilience of households and communities against climate variability, and doubtless a crucial a part of global climate changes adaptation. Aim by 2030 (end of SDG period): That rain harvest is employed additional wide and at a spread scales as a part of universal access to safe water and bigger global climate change resilience.

1.1 Need of rain Harvesting:-

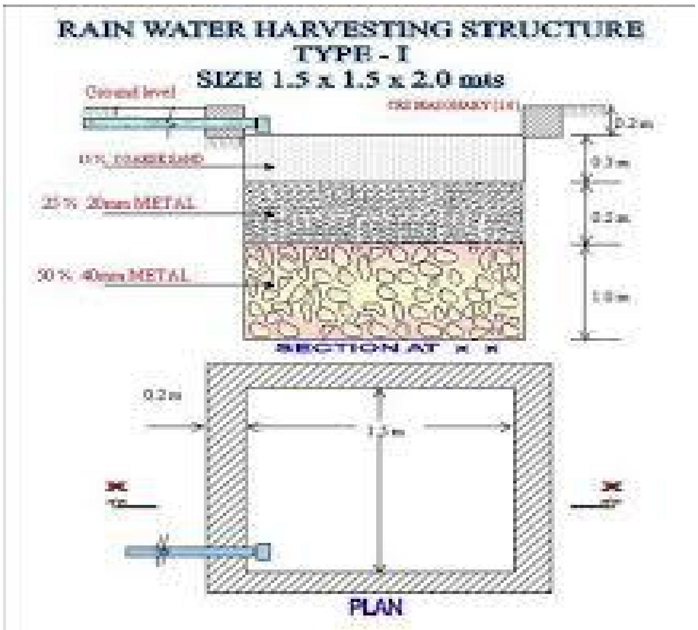
- As water is turning into scarce, it's the requirement of the day to realize autonomy to fulfil the water desires.
- As urban water system system is below tremendous pressure fir activity water to ever increasing population.
- Groundwater is obtaining depleted and contaminated.
- Soil erosion ensuing from the uncurbed runoff.
- Health hazards thanks to consumption of contaminated water.

1.2 Blessings of Rain Water Harvesting:-

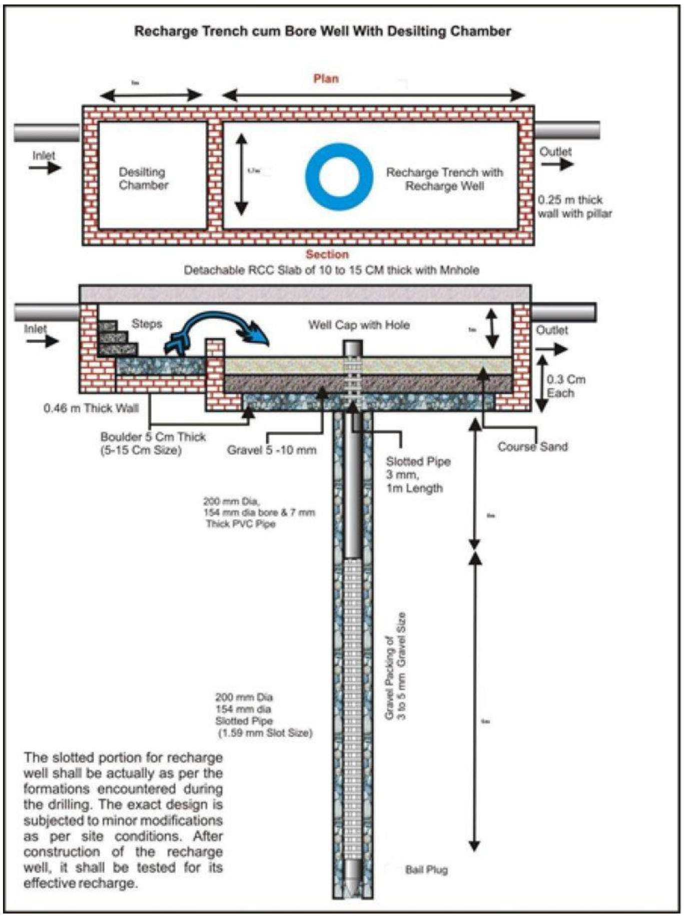
• Provision of supplemental water.
• Increasing soil wet level for urban greenery.
• Increase H2O table (by artificial recharge well).
• Mitigating urban flooding.
• Rainwater could be a relatively clean and completely frees thus urge of water.
• It will supplement alternative sources of water system like groundwater or municipal water connections.
• It lowers the water system price.
• It will give a superb keep a copy supply of water for emergencies.
• It is socially acceptable and environmental accountable.
• It uses straightforward technologies that are cheap and simple to take care of.
• It is employed in those areas that face skimpy water resources.

1.3 Disadvantages of rain water harvest:-

• Unpredictable downfall- downfall is tough to predict and generally very little or no rainfall will limit the provision of rain.
• Initial price of rain harvest system is simply too a lot of high.
• Regular maintenance - rain harvest systems need regular maintenance as they will get liable to rodents, mosquitoes, protoctist growth, insects and lizards.
• Certain kinds of roots could run chemicals, insects, dirt or animals faecal matter which will hurt plants if it's used for watering the plants.
• Storage limits. During the serious rain, the gathering systems might not be ready to carry all rain that ends in reaching to drains and rivers.



RAIN WATER HARVESTING STRUCTURE
TYPE - I
SIZE 1.5 x 1.5 x 2.0 mts
Ground level
25 % 20mm METAL
50 % 40mm METAL
0.2 m
SECTION AT
0.2 m
PLAN



Recharge Trench cum Bore Well With Desilting Chamber
Plan
Inlet
Desilting Chamber
Recharge Trench with Recharge Well
Outlet
0.25 m thick wall with pillar
Section
Detachable RCC Slab of 10 to 15 CM thick with Mnhole
Inlet
Steps
Well Cap with Hole
Outlet
0.3 Cm Each
0.46 m Thick Wall
Boulder 5 Cm Thick (5-15 Cm Size)
Gravel 5 -10 mm
Slotted Pipe 3 mm, 1m Length
Course Sand
200 mm Dia, 154 mm dia bore & 7 mm Thick PVC Pipe
Gravel Packing of 3 to 5 mm Gravel Size
200 mm Dia 154 mm dia Slotted Pipe (1.59 mm Slot Size)
The slotted portion for recharge well shall be actually as per the formations encountered during the drilling. The exact design is subjected to minor modifications as per site conditions. After construction of the recharge well, it shall be tested for its effective recharge.
Bail Plug

REVIEW OF LITERATURE

2. Cases from different States of India:-

2.1 Tamil Nadu, Chennai:-

Tamil Nadu is the first state in India to form rain harvest obligatory. Rain harvest was made obligatory for each building in Tamil Nadu to avoid groundwater depletion. The scheme was launched in 2001 and has been enforced in all rural areas of Tamil Nadu. Today, in keeping with the state government website, out of the 23.92 lakh buildings in town Panchayats (government, residential, commercial and industrial), 22.94 lakh have rain harvest facilities. On may might 2014, the government declared that it'll set up 50,000 rain harvest structures at varied parts of the capital town of city. Around 4,000 temples in Tamil Nadu state historically had water tanks that were used for varied rituals. The tanks additionally served as natural aquifers and helped recharge groundwater. Over the years, however, several of those tanks have gone out of use. Overflowing mounds of silt and garbage have replaced the water in them.

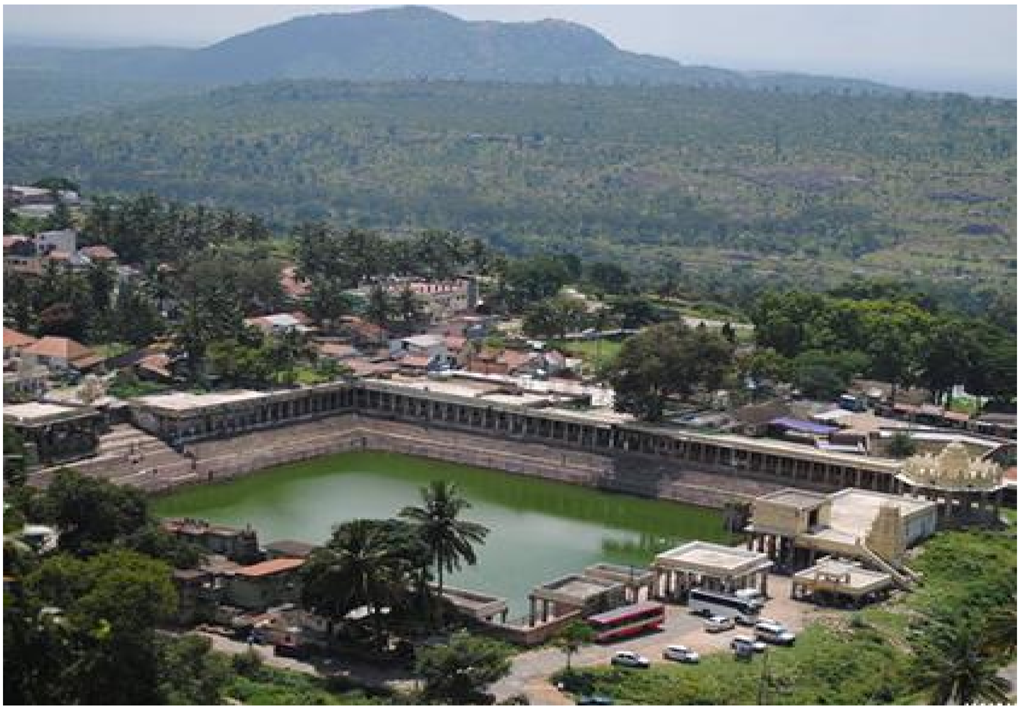
In 2016, Madras witnessed the worst drought within the last 140 years. The drought triggered a series of measures to stop such a crisis. It had been to revive the water bodies. Last year, district collectors were directed to analyse historical knowledge to spot blocks and villages that face potable crisis within the event of precipitation deficit. Water bodies and provide channels were cleansed. Little check dams were got wind of to store water close to streams and bore wells with potable. Defunct bore wells were reborn into water recharging ones through rain harvesting. In April 2017, the TN Industrial Department announced a plan to de-slit tanks and reservoirs across the State. In 2017, about six crore cubic meters of slits were removed from nearby 43,000 tanks. Work is going on in another 24,000 tanks this year. Authorities in Chennai also decided to restore around 40 major temple tanks in the city. The aim is to convert the tanks into catchments for rain water harvesting. De-silting had helped flood-prone regions cope better.

The Rain Water Harvesting movement launched in 2001 was the brainchild of the Honourable Chief Minister. It has had a tremendous impact in recharging the groundwater table all over Tamil Nadu. Amendments made to Section 215 (a) of the Tamil Nadu District Municipalities Act, 1920 and Building Rules 1973, have made it mandatory to provide RWH structures in all new buildings.To consolidate the gains, various measures have been taken up for rejuvenation of RWH structures created already in both public and private buildings, besides creating new ones. IEC activities will be continued in the Town Panchayats to sensitize all the stake holders to sustain the momentum. During 2011-12, in order to give a fillip to this laudable programme, the Town Panchayats have undertaken the construction of new RWH structures and renovation of old RWH structures. IEC activities are being carried out in Town Panchayat areas to sustain the momentum of the programme.

There are 1821 water bodies maintained by Town Panchayats with an extent of 6286.84 acres. In order to restore the 243 water bodies Rs. 55.52 crore has been allocated for the years 2011-12 and 2012-2013 under IUDM and NABARD. Similarly, during 2013-2014, 561 improvement works such as de-silting and strengthening of bunds and sluice works have been taken up at a cost of Rs.18.40 crore under General fund. Proposed to taken up 88 water body improvement works in 68 Town Panchayats at an estimated cost of Rs.28.15 crore.

Total number of buildings in Town Panchayats is 23,92,457 out of which 22,94,342 buildings are provided with Rain Water Harvesting facilities as mentioned in the following table.

Type of Buildings	No. of Buildings	No. of Buildings providing RWH structures so far	Balance
Government Buildings	**24116**	**23190**	**926**
Residential Buildings	**2208377**	**2114294**	**94083**
Commercial Buildings	**148170**	**145064**	**3106**
Industrial Buildings	**11794**	**17794**	**0**
Total	**2392457**	**2294342**	**98115**



2.2 Gandhinagar, Gujarat.

Amba Township is located at distance of 10kms from Gandhinagar, state-Gujarat (India).It lies between latitude 23°11’17” N and longitude 72° 34’32” E. Amba Township is simply on the outskirts of Gandhinagar. The population of township is around 1000. Entire Amba Township contains 100 acres. Entire Township is split in 5 sectors. But, presently we tend to are study solely sector-3 (A, B). This sector holds varied sorts of buildings 1RK, 1BHK, 2BHK, 3BHK, gym, library etc.

Total Terrace space of Sector-3(A, B) = 22011 Sq.m
Total Road space of Sector-3(A, B) = 8000 Sq.m
Total Landscape space of Sector-3(A, B) = 14011Sq.m
Total space of Sector-3(A, B) = 44022 Sq.m

The total space of roof high of all buildings in Amba territorial division is 22011 Sq.m and average annual downfall in Gandhinagar is 740.3mm. Amba territorial division is 10kms far from the Gandhinagar, thus there's no any water system from Municipal of Gandhinagar. There’s no any reliable supply of water in Amba territorial division. Thus there's got to mammary gland a non-public bore wells in Amba territorial division. However day by day buildings area unit made and population of town area unit increasing as quicker approach. Thanks to this, water demand is additionally increase.

2.2.1 Population: -

So, in last five year the population of Amba territorial division is increase during this manner.

Table No. 1:- Population Data

Sr.No	Year	Population
1	2009	150
2	2010	250
3	2011	450
4	2012	700
5	2013	1000

So, in future the town can face varied water issues .Because well water is depleted an excessive amount of thanks to increase in water demand. So, to resolve this downside Rain Water harvest is a solely low price harvest technique to resolve this downside.

2.2.2 Downfall and Climate:-

Gandhinagar includes a tropical wet and dry climate with 3 main seasons: summer, monsoon, winter. The climate is mostly dry and hot outside of the monsoon season. The weather is hot to severely hot from March to June once most temperature is 45°C and minimum temperature is 10°C.

The rain fall information of last five years is:-

Table No. 2:- Monthly Average downfall information of Gandhinagar:-

Sr No.	1	2	3	4	5
Year	2009	2010	2011	2014	2013
January	0.0	0.0	0.0	1.0	0.0
February	0.0	0.0	0.0	0.0	5.7
March	0.0	0.0	0.0	0.0	0.0
April	0.0	0.0	0.0	0.4	0.9
May	0.0	0.0	0.0	0.0	0.0
June	1.5	81.8	9.3	40.5	93.8
July	381.8	341.6	217.0	65.4	412.4
August	115.6	307.5	346.0	233.1	252.3
September	3.3	168.8	52.7	257.0	206.1
October	8.6	0.0	0.0	0.0	75.6
November	0.0	20.9	0.0	0.0	0.8
December	0.0	0.6	0.0	0.0	0.0

Total average annual rainfall of Gandhinagar = 740.3mm.

2.2.3. Water Demand:-

As per IS Specification (IS 1172: 1993), Total water demand for one person = 135 lit/day

Total water demand = 135*1000

Annually total water demand = 365*135*1000

Annually total water demand = 4, 92, 75, 000 lit

2.2.4. Rain water harvesting system:-

1. Catchment area.
2. Coarse mesh / leaf screen.
3. Conduit.
4. Drainage network (Road network).
5. Percolation well.

Catchment area is the surface on which the rain Water falls .In this study all building's roof and all roads are taken as catchment area. This water can be used for recharging ground aquifers after proper filtration.

Coarse mesh/leaf screen is used to prevent the entry of leaves and other delbris in the system. Conduits can be of any material like PVC, GI or cast iron. In every building pipe network is such that, all the water from roof of buildings can collect and flow on road surface as a drainage way. In Amba Township all roads levels are maintained such that water can flow by gravity from higher elevation to lower elevation

Drainage network is the network of roads which can permit the easy flow of rain water. Percolation well is a well which collects water and stores it as a ground water. Percolation tanks are artificially created surface water bodies, submerging a land area with adequate permeability to facilitate sufficient percolation to recharge the ground water. These can be built in big campuses where land is available and topography is suitable. Surface run-off and roof top water can be diverted to this tank. Water accumulating in the tank percolates in the solid to augment the ground water. The stored water can be used directly for gardening and raw use. Percolation tanks should be built in gardens, open spaces and roadside green belts of urban area. In Amba Township in sector 3(A, B)there are presently 4 percolation wells which collect all surface water and store into ground water . There are total 5 sectors in Amba

Township which also collect rain water through road network so all the water are flow into direction towards main percolation well should be recharge.

2.2.5. Calculation:-

Total Area of Sector-3 (A, B)
A = 44022 Sq.m

Artificial recharge to ground water is a process by which the ground water reservoir is augmented at a rate exceeding that obtaining under natural conditions or replenishment. Any man-made scheme or facility that adds water to an aquifer may be considered to be an artificial recharge system. Based on the above factors, the water harvesting potential of site could be estimated using the following equation:-
Rain Water harvesting potential = Amount of Rainfall * Area of catchment * Runoff coefficient.

Rain water Harvesting by Terrace:-

Total Terrace Area of Sector-3 (A, B) A = 22011 Sq.m
Average Annual Rainfall in mm R = 740.3 mm
= 0.740 m
Runoff co-efficient for a flat terrace C = 0.60

Annual water harvesting potential through total terrace = A * R * C
= 22011 * 0.740 * 0.60
= 9772.884 Cubic meter
= 97, 72,884 lit

Rain water Harvesting by Surface Drainage:-

Total Road Area of Sector-3(A, B) A = 8000 Sq.m
Average Annual Rainfall in mm R = 740.3 mm
= 0.740 m
Runoff coefficient for a R.C.C road C = 0.82

Annual water harvesting through total Surface drainage = A * R * C

= 8000 * 0.740 * 0.82

= 4854.4Cubic meter

= 48, 54,400 lit

Annually Total Rain water Harvesting:-

Annually Total Rain water Harvesting = Total Rain water harvesting By Roof-top + Total Rain Water harvesting By Surface drainage

= (97, 72,884) + (48, 54,400)

Annually Total Rain water Harvesting = 1, 46, 27, 284 lit

2.2.6. Result & Analysis

Here we study only for sector-3 (A, B). Which collect annually 1, 46, 27, 284 lit water and this much amount of water can be absorbed by 4 percolation well and if there is high intensity of rainfall then excess amount of runoff can be flown towards the main percolation well through the road network as shown in figure-5 (A, B). So this way we can harvest the rain water and increase the ground water. We can harvest annually 1, 46, 27, 284 lit water which is 29.68% of total water demand. So by using Rain water harvesting methods we can harvest and store the rain water into ground aquifer or into percolation well.

Benefits of rain water harvesting by recharging well:-

- This is an ideal solution of water problems where there is inadequate ground water supply.
- To utilize the rainfall runoff, which is going to sewer or storm drains.
- Rainwater is bacteriologically pure, free from organic matter and soft in nature.
- It will help in reducing the flood hazard.
- To improve the quality of existing ground water through dilution.
- To remove bacteriological and other impurities from sewage and waste water so that the water is suitable for re-use.
- Rainwater may be harnessed at place of need and may be utilized at time of need.
- The structures required for harvesting the rainwater are simple, economical and eco-friendly.

- This is an ideal solution of water problems where there is inadequate ground water supply or surface resources are either lacking or insignificant.
- To utilize the rainfall runoff, which is going to sewer or storm drains.
- Rainwater is bacteriologically pure, free from organic matter and soft in nature.
- It will help in reducing the flood hazard.

2.3. Mumbai, Maharashtra.

It is compulsory for new buildings in Mumbai to collect and store rainwater, but the municipal corporation has done little to enforce this rule in 12 years. Sumesh Lekhi's housing society in Mumbai's Versova suburb decided to install rainwater harvesting facilities in their colony as far back as 2001. They planned to collect rainwater during the monsoon months and use the stored water for things like flushing toilets and washing cars, so that they could reduce their dependence on the municipal water. The Municipal Corporation of Greater Mumbai sources water from seven reservoirs. The water levels fluctuate with the rains.

To reduce the dependence on the reservoirs, in 2002, the municipal corporation made rainwater harvesting mandatory for all new building constructions in Mumbai covering more than 1,000 square meters. In 2007, the rule was made even more stringent: all new constructions covering more than 300 square meters were required to have in-built rainwater harvesting facilities, without which buildings would not be given occupational certificates.

The rule aimed to ensure that buildings would store enough water during the monsoon for non-essential purposes for the rest of the year.

But in the 17 years since the rule came into force, rainwater harvesting has been poorly implemented across Mumbai.

There is no clear data available on how many new building constructions have rainwater harvesting facilities. But if most residents went looking around in their own neighbour-hoods, they would be hard pressed to find one. In the buildings that do have the infrastructure to harvest rainwater, the stored water often goes unused.

Take Mr. Lekhi's housing society, for instance. The building is located in a suburb along the western coast of Mumbai. A few years after the rainwater harvesting facilities were installed; residents found that the stored water was turning saline and brackish.

"The water was corroding building pipelines and causing cars to rust, so people stopped using that water," said Lekhi, a citizen activist who has observed several other buildings in his neighbourhood facing the same problem. "In another nearby area, I know of buildings that stopped using harvested rainwater because it was getting contaminated by waste water from a slum nearby."

2.3.1 Depleting water resources

Every day, residents of Mumbai consume more than 3,500 million litres of water, supplied by reservoirs located to the north of the city. In November 2018, when water levels in all the reservoirs dropped to 75% of their total holding capacity, the Municipal Corporation of Greater Mumbai announced 10% water cuts for the whole city.

The monsoon in 2018 had not been good enough to fill up the lakes, and the corporation hoped that relatively small water cut for eight months leading up to the 2019 monsoon would help conserve enough water for the city. By the beginning of June, the municipal corporation had to start dipping into the lakes' reserve stocks to continue supplying water to Mumbai.

The start of this year's monsoon has not proved promising enough. Even though three days of intense rainfall at the start of July led to civic chaos and several deaths in the city, the catchment areas of Mumbai's reservoirs did not receive enough rain to help significantly increase their water levels.

On July 4, the seven lakes – Vihar, Tulsi, Bhatsa, Tansa, Upper Vaitarna, Middle Vaitarna and Modak Sagar – had a stock of 1.7 lakh million litres of water, which is only 12.02% of their total holding capacity. This is much less than the 22.4% of stock that the lakes held on the same date in 2018. In a bid to keep conserving water, Mumbai's municipal corporation has not yet rolled back the water cuts to the city's residents.

At a time when erratic rainfall is the new normal and reservoirs supplying water to major Indian cities are drying up, saving water through on-site methods like rainwater harvesting becomes increasingly crucial.

But in Mumbai, even though the rule for rainwater harvesting exists on paper, civic authorities have shown little inclination to take it seriously and ensure its implementation.

2.3.2. Where is the data?

Up till two decades ago, Mumbai had several wells scattered across the city and suburbs that residents used to draw groundwater. The Golanji Hill Water Reservoir located in Sindhu Nagar in Parel was built in the British era. Its latitude and longitude is 18.999 sq.m and 72.8478 sq. m respectively. The Bhandup filtration plant, the biggest such facility in Asia operated by the Brihanmumbai Municipal Corporation (BMC) 24/7 since it began operations in 1980. The Bhandup plant treats bulk of the 3,753 million litres a day (MLD) supplied to the city. Every day, three to four tonnes of chlorine is used to treat water. The remaining supply is purified at the smaller Panjrapur plant in Thane district. The British set up the first water pipe supply to Mumbai way back in 1860, catering to approximately seven lakh people. Since then, the water network has expanded exponentially as the population burgeoned. Today, the city has an intricate pipeline network adding up to a gargantuan 4,000km. The Banganga, Banganga Talav or Banganga Tank, (also known as Metamuse) is an ancient water tank which is part of the Walkeshwar Temple Complex in Malabar Hill area of Mumbai in India. The Tank was built in the 1127 AD, by Lakshman Prabhu, a minister in the court of Silhara dynasty kings of Thane. It was rebuilt in 1715 AD, out of a donation for the Walkeshwar Temple by Rama Kamath. The main temple has been reconstructed since then and is at present a reinforced concrete structure of recent construction. However, with rapid concretisation of the city, most of these wells are now out of use and the city's groundwater has depleted significantly over the years.

"Groundwater recharge is very important, but has become difficult because concretisation prevents rainwater from percolating into the ground," said Indrani Malkani, a trustee of V Citizens' Action Network, a non-profit organisation working for civic rights in Mumbai. Storing rainwater in tanks is a more viable form of rainwater harvesting in Mumbai, but there is little information about the success of its implementation in the city's new buildings.

Month-wise Details of Penalty

Month (in 2017)	Properties penalised	Penalty (IN RUPEE LAKHS)
January	**12,213**	104
February	**11,847**	206
March	**10,682**	89.36
April	**11,043**	99.63
May	**11,288**	100
June	**11,089**	102
July	**10,706**	97.28

*BWSSB

2.4. Guwahati, Assam:-

One of the most important technologies that is relevant to Assam, an Indian province with seasonal water scarcity and falling water tables despite abundant precipitation, is rainwater harvesting.

In cities like Guwahati, the main commercial centre of Assam,rainwater harvesting could provide the additional benefit of quickly draining areas prone to flooding after heavy downpours.

Many of the large and small cities get flooded after a few hours of precipitation as most wetlands, which were the natural sinks for drainage, have been filled-up for construction and development by short-sighted urban planners. The landscape is dotted with hills which have been encroached, leading to mushrooming of buildings where there were abundant forests. Most natural streams disappeared after the deforestation of the hills and the rainwater gushes down adding to the flooding problem. By construction of sink wells, rainwater can be used to recharge the underground aquifers in these cities that also face acute water shortage during the dry season.

Utilizing existing technology for rainwater harvesting could be very useful for Assam because of abundant rainfall. It can be installed on rooftops of buildings in cities like Guwahati for recharge of aquifers and these would provide the residents with ample water supply during the dry season. Testimonials from cities like Pune, with widespread use of large-scale rainwater harvesting technologies, has indicated considerable monetary savings for residents within a year after installation of the systems as they did not have to buy water from tankers. This also translates to considerable savings in carbon emissions from the constant plying of water tankers from distant areas to the cities as well as better traffic management.

Another benefit of rainwater harvesting is that the catchment, conveyance and storage can be suitably modified to the needs of the area. So both paved and unpaved surfaces as well as rooftops can be used as catchment and simple pipes or existing drainage used for conveyance to underground storage tanks, recharge aquifers or natural sinks like ponds for storage. This flexibility makes it suitable for the different terrain and landscape of the cities and towns of Assam.

Rainwater harvesting also avoids the fields of Assam to remain flood proof. In cities like Guwahati, the main commercial centre of Assam,rainwater harvesting could provide the additional benefit of quickly draining areas prone to flooding after heavy downpours.

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METHODOLOGY

Firstly we started with selecting the topic of our project. With a lot of discussion and researching the problems and various methods of green computing, we choose it to be the solution of a long prevailing problem of drought in India, RAINWATER HARVESTING. Further with the teachers consent and some more discussions we started our case study on different states located in different parts of India

To start with, we chose the first state to embark with rainwater harvesting as a tradition to be followed by all the societies in India. It was Tamil Nadu state to start underground water tanks system. We found a research performed by the Tamil Nadu association itself. It gave us the maximum amount of information about the Tamil Nadu rainwater harvesting. We also did a research on the history of Tamil Nadu and their temples which included the rainwater tanks. There are various sites that provided us with the information. Later we decided to do one of all states in all the primary directions of India. We selected Maharashtra as Mid-West state since it's our living state, Assam as the Eastern state, Gujarat as the Northern state and as mentioned earlier Tamil Nadu as the Southern state. We further chose one city in each state to talk about.

For Tamil Nadu we chose the capital of the state, Chennai. Searched for, the most commonly used site Wikipedia for the information. We searched for the rainwater harvesting specifically in the region of Chennai. We read and cropped the amount of information we found there. The various numerical information and charts where also available on certain sites mentioned in the reference. Tamil Nadu has a lot of potential in rainwater harvesting is what we have learnt from the research. It has been using these potentials since a long time now. The state needs to continue using its resources to gain full advantage of the rainwater harvesting.

Next for Gujarat, we chose Gandhi nagar. Most of the information and the numerical data were availed from the researches conducted earlier. We read and clubbed the different pieces of information and data from different sites. It was easy to form the paragraphs with a lot of cordial information provided. We found some of the numerical information in a pdf of Gujarat monsoon. Gujarat is a dry state but still can cope with the water scarcity by the means of rain water harvesting. There is a lot of potential in Gujarat for rainwater harvesting.

For Maharashtra we selected our very own Mumbai city. We searched for various sites on Google. We also met a BEST employee Mr. Jyotiba Harer who handles the working of the HANGING GARDEN water tank. Sir explained us a lot about the working of the various tanks working in Mumbai overall. He also told us the history and mechanism of the tanks. We researched the given tank names on Google for further information. Sir helped us a lot to understand the overall working of the rainwater harvesting in Mumbai. We spoke for an hour getting to know the Government schemes, timings of the tanks and pipes, how are they cleaned, maintained and used over the years. Though there are a few tanks built by the Britishers have been not in use for past few years, many of the tank architectures are very strong and work on the gravity. The rainwater harvested is then purified and drawn to the households through pipes working on gravity. One tank provides water to a thousand and up societies in the locality. We later also searched for recent working sources of rainwater harvesting.

At the end we chose Assam and its capital Guwahati as the Eastern state and a city in it. Assam is a green state and has a lot of tea plantations. Its most important aspect for rainwater harvesting is irrigation. Assam also receives a considerable amount of rainfall. If it is harvested correctly Assam would never face a water scarcity. The sloppy landscapes of the state help the rainwater to flow and percolate in the land. Hence bunds can be built. Channels flowing through the field can help the water to directly seep in the ground. There is a lot of potential in Assam for the rainwater harvesting.

Findings or Results

In India, rainwater harvesting has been in practice for more than 4000 years. It is basically a simple process of accumulating and storing of rainwater. Rainwater harvesting, since ancient times, has been applied as a supply for drinking water, water for irrigation, and water for livestock. Every year as the summer sets in, water becomes scarce across the length and breadth of India. The systems are easy to construct from locally sourced inexpensive materials, and it has proved to be a success in most areas. The prime advantage of rainwater is that the quality of water is usually good, and it does not necessitate any treatment before consumption. Household rainfall catchments can significantly contribute where the source of drinking water is contaminated and scarce.

The history of rainwater harvesting and management can be traced back to Biblical times, and interestingly, this old technology has made a super comeback in a new way in a new world, promising to deliver a sustainable solution in eradicating the menace of a global water crisis.

Unfortunately, in the modern era, the age-old methodology of rainwater harvesting was greatly neglected. Years of negligence, and short-sighted water management policies that mostly rely on over-exploitation of ground and river water, has once again brought rainwater harvesting to the fore because of its life-saving qualities.

Rainwater harvesting and management hold tremendous potential for alleviating storm-water runoff and reducing groundwater consumption, particularly in urban areas. Though the costs of installing modern rainwater harvesting systems, storing, and treatment of rainwater was an area of concern earlier, but now with the advent of new technologies, the investment has a positive return.

Today, rainwater harvesting systems are acting as incredible support systems in many Indian cities, providing a superb alternative to the main water supply, especially during dry seasons. Moreover, the advantages of storing rainwater are not only limited to a particular individual or a family, but it is coming off as a lifesaver for many urban communities as well.

Widespread installation of these systems is also revitalizing the natural properties of land, helping to improve the quality of groundwater, raising its level, and preventing wells and tube wells from drying up. Additionally, efficient deployment of rainwater harvesting systems is limiting surface runoff of water, which is reducing soil erosion, and increasing its fertility.

The most important use of water is obviously in our homes. Domestic water use can be used for both indoor and outdoor household purposes. The daily uses include drinking, cooking bathing, washing clothes and dishes, brushing teeth, watering the garden, washing pets and many more.

4.1. Let us discuss the different uses of water in detail.

1. Domestic Use:

The most important use of water is obviously in our homes. Domestic water use can be used for both indoor and outdoor household purposes. The daily uses include drinking, cooking bathing, washing clothes and dishes, brushing teeth, watering the garden, washing pets and many more. Therefore, a good quality domestic water storage tank is a must for our all household needs.

2. Irrigation:

This is the second most important use of water in India. These include water allocations to farms, orchards, horticultural crops, pastures, crop cooling and harvesting, chemical application, for frost a freeze protection. The other uses include self-supplied water to irrigate private and public parks, golf courses, stadiums, parks, and so on.

3. Industrial Use:

This is the most valuable resource of our nation. The uses include processing, cleaning, transportation, dilution, and cooling. Major water using industries are paper, steel chemical, and petroleum refining.

4. Commercial Uses:

Commercial uses include fresh water for hotels, restaurants, office buildings and other commercial properties, educational, civilian & military institutions.

5. Use in Power generation:

The water has enormous potential to generate electric power with heat and water called hydroelectric power and geothermal energy respectively. The sources of heat include the following: fossil fuels, geothermal or nuclear fission.

6. Mining Use:

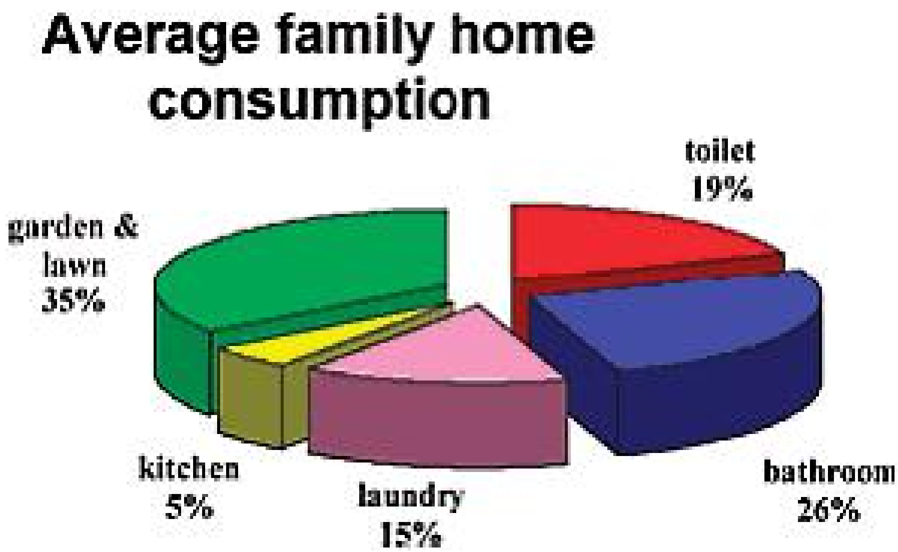
Mining uses for water refers to extraction of minerals such as solids (coal and ores), liquids (crude petroleum), and natural gas.

7. Aquacultural Use:

Aquacultural use refers to farming of aquatic organisms like fish and others.

8. Recreational Use:

Water plays an important role in recreational activities such as swimming, rafting, boating and so on. It is understood that water is the most important natural resource gifted to us by nature. Clean water is scarce and has become one of the major problems in India. Let’s save water and keep our water bodies clean as much as possible.



India is facing an overall water stress of 153,663,296 units, water scarcity of 201,170,756 units and a total absolute scarcity of 262,640,492 units. The numbers are increasing day by day. The country that pumps more groundwater than any other has reached a water supply and food safety reckoning that threatens to upend political and economic stability, and long-term public health.

In this special report, building on years of on-the-ground coverage, Circle of Blue reveals how a nation of 1.3 billion people, by failing to protect its water, is courting disease and economic hardship as well as social upheaval.

Hand in hand with the groundwater depletion and contamination, is a food supply "toxic time bomb" of global implications. When irrigation wells go dry, farmers turn to untreated waste water that is laced with industrial chemicals and human sewage.

As one villager said, "The water moved from providing life to taking lives." Delhi is running short — maybe even out — of groundwater. A harrowing report in June warned that Delhi, along with 20 other Indian cities, could reach "zero groundwater levels" by 2020.

Groundwater Plummets in Delhi

Experts warn that Delhi could reach "zero groundwater levels" by 2020.

Dirty aquifers and water scarcity are destabilizing the world's second-largest country and seventh-largest economy. As its water reserves get dirtier and smaller, India is losing the capacity to safeguard public health, ensure farm productivity, grow the economy, and secure social stability. From the rice paddies and sugar cane fields of Punjab, in northwest India, to the coconut groves and rice paddies in Tamil Nadu, the country's southernmost state, and in almost every state in between, water pollution and the effect it has on supply have combined to produce a freshwater calamity. Dirty aquifers and water scarcity are destabilizing the world's second-largest country and seventh-largest economy. As its water reserves get dirtier and smaller, India is losing the capacity to safeguard public health, ensure farm productivity, grow the economy, and secure social stability.

India is more dependent on water pumped from aquifers than any other nation it accounts for about a quarter of global demand for groundwater, according to the World Bank. More than 90 percent of groundwater in India is used for irrigated agriculture. The remainder 24 billion cubic meters supplies 85 percent of the country's drinking water. Roughly 80 percent of India's 1.35 billion residents depend on groundwater for both drinking and irrigation.

The waters of the Hindon River, a tributary of the Yamuna River once so vital to raising crops, are too polluted with chlorinated compounds, bacteria, and heavy metals to safely use for agriculture. The condition of groundwater is just as treacherous. State health authorities have declared that Doula Village's drinking water aquifers — tapped by 60-meter-deep wells and contaminated by arsenic, nitrate, fluoride, and metals — are unfit for human consumption.

Residents and school children attending Doula Village's primary Paatshaola No.1 School have few options for fresh water. Neither the village, the state, nor the national government have dug into their treasuries to drill a much more expensive 150-meter well to reach a clean aquifer.

Drought and overconsumption also have drained India's freshwater reservoirs, which are lower than they've ever been. The NITI report, released by Nitin Gadkari, Minister of Water Resources, River Development and Ganga Rejuvenation, said India was snared in "the worst water crisis" in its history. The report found that at least 600 million Indians — almost half the country — contends with high or extreme water stress.

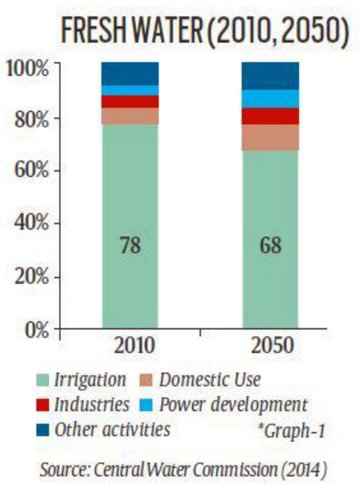
With no access to adequate supplies of well water — clean or polluted — and no money to dig deeper wells, many farmers in important agricultural districts turn to the only other available source of water: raw or slightly treated discharges from sewage pipes and treatment plants.

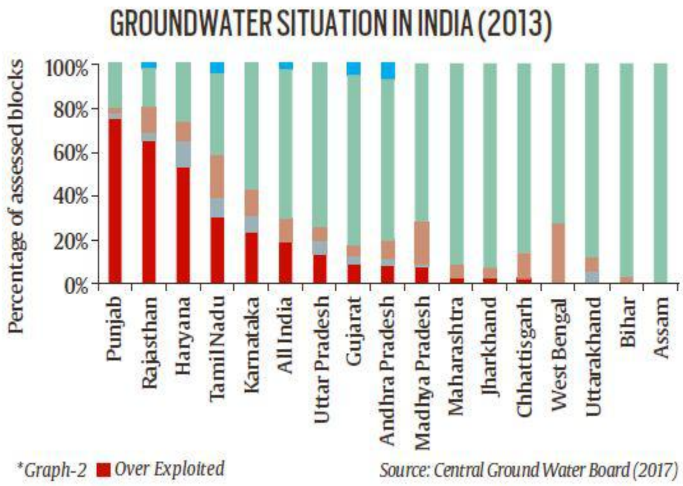
As per World Bank data, India accounts for 25 % of global demand for groundwater. More than 90 % of groundwater in India is used for irrigated agriculture. The remaining 24 Billion m^3 supplies 85 % of the country's drinking water. Approximately 80 % of India's 1.35 Billion populations depend on groundwater for both drinking and irrigation.

Even though that, History tells us that both floods and droughts were regular occurrence in ancient India. Perhaps this is why every region in the country has its own traditional water harvesting techniques that reflect the geographical peculiarities and cultural uniqueness of the regions. The basic concept underlying all these techniques is that rain should be harvested whenever and wherever it falls.

The graph given below shows the monthly average rainfall data from 1990 to 2010 :-

Months	Rainfall(mm)	Months	Rainfall(mm)
Jan	0.6	July	167.57
Feb	0.3	August	193.78
March	0.2	Sept	126.75
April	3.02	Oct	40.18
May	20.54	Nov	0.3
June	108.70	Dec	0.4
Total=662.31mm			





Discussion

The country that pumps more groundwater than any other has reached a water supply and food safety reckoning that threatens to upend political and economic stability, and long-term public health.

When drought occurs, rainwater harvested in past months can be used. If rain is scarce but also unpredictable, the use of a rainwater harvesting system can be critical to capturing the rain when it does fall. Many states with arid environments, use rainwater harvesting as a cheap and reliable source of clean water. To enhance irrigation in arid environments, ridges of soil are constructed to trap and prevent rainwater from running down hills. Even in periods of low rainfall, enough water is collected for crops to grow. Water can be collected from roofs and tanks can be constructed to hold large quantities of rainwater.

In addition, rainwater harvesting decreases the demand for water from wells, enabling groundwater levels to be further sustained rather than depleted.

Rainwater harvesting provides an independent water supply during water restrictions. In areas where clean water is costly, or difficult to come by, rainwater harvesting is a critical source of clean water. In some states, rainwater is often harvested to be used as a supplemental source of water rather than the main source, but the harvesting of rainwater can also decrease a household's water costs or overall usage levels. Rainwater is safe to drink if the consumers do additional treatments before drinking. Boiling water helps to kill germs. Adding another supplement to the system such as a first flush diverted is also a common procedure to avoid contaminants of the water.

We need to think of groundwater as a common pool resource; the challenge however is that this common pool resource is almost invisible.

In villages, the perception often is, “This is my land and hence the water below it is my water.” But the question we’ve been asking communities to think about is, “How can you own the water below your land, when the water in your well has come from underneath someone else’s land and the water from under your land is naturally going to flow underneath your other neighbour’s lands?”

Once this has been explicitly stated and explained, people are quick to understand it especially if you use science derived from data that has been collected by communities themselves.

But while the science is about hydro-geology and the mapping of water sources, the more important aspect is the application of this science – which is effective only if it involves bringing the resource (aquifers) and communities and villages together in the processes and solutions – what we call Participatory Ground Water Management (PGWM).

The conventional thinking is that check dams—which are essentially percolation tanks– will collect water that will percolate and recharge the groundwater. A common misconception among both the communities as well as organizations working in watershed management is that it is the wells that are being recharged.

But wells are only the sources of water and a mechanism to access water and distribute it according to needs and often, demand. Wells are not the resource; aquifers are the resource. (Aquifers are underground layers of porous and permeable rock capable of storing groundwater and transmitting it to wells and springs.)

If you can identify your aquifer, then you know precisely where to put your recharge structure (or, check dam). So now, instead of four check-dams that you would place in areas where 'water collects', you could make do with two accurately positioned check dams where the aquifers are, thereby reducing costs by half while also ensuring optimal recharge.

Usually, once the watershed programme is implemented, no one cares about what happens to the water in the aquifer. Farmers tend to dig deeper, make larger wells with the presumption that unlimited water is now available for the taking. Such actions are not necessarily sustainable.

It is therefore important to move the focus from wells (sources) to aquifers (resources). By changing this lens, the focus then shifts from merely looking at what is going in and coming out to a variety of aspects: How do you balance livelihoods and ecosystem needs, or what happens to economic returns from groundwater and how does the drinking water security get affected when an aquifer depletes.

5.1. Rainwater harvesting can be done in various ways:

1. Traditional

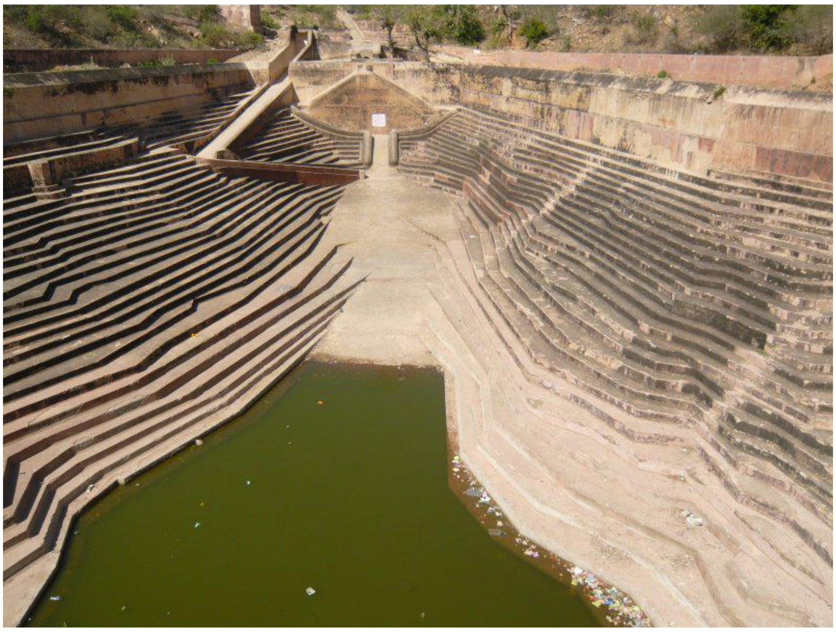
Archaeological evidence shows that the practice of water conservation is deep rooted in the science of ancient India. Excavations show that the cities of the Indus Valley Civilization had excellent systems of water harvesting and drainage. The settlement of Dholavira, laid out on a slope between two storm water channels, is a great example of water engineering. Chanakya's Arthashashtra mentions irrigation using water harvesting systems.

Sringaverapura, near Allahabad, had a sophisticated water harvesting system that used the natural slope of the land to store the flood-waters of the river Ganga. Chola King Karikala built the Grand Anicut or Kallanai across the river Cauvery to divert water for irrigation (it is still functional) while King Bhoja of Bhopal built the largest artificial lake in India. Drawing upon centuries of experience, Indians continued to build structures to catch, hold and store monsoon rainwater for the dry seasons to come. These traditional techniques, though less popular today, are still in use and efficient. Here is a brief account of the unique water conservation systems prevalent in India and the communities who have practised them for decades before the debate on climate change even existed.

i. **Jhalara**

Jhalaras are typically rectangular-shaped step wells that have tiered steps on three or four sides. These step wells collect the subterranean seepage of an upstream reservoir or a lake. Jhalaras were built to ensure easy and regular supply of water for religious rites, royal ceremonies and community use. The city of Jodhpur has eight Jhalaras, the oldest being the Mahamandir Jhalara that dates back to 1660 AD.

ii. Bawari:



Bawaris are unique step wells that were once a part of the ancient networks of water storage in the cities of Rajasthan. The little rain that the region received would be diverted to man-made tanks through canals built on the hilly outskirts of cities. The water would then percolate into the ground, raising the water table and recharging a deep and intricate network of aquifers. To minimize water loss through evaporation, a series of layered steps were built around the reservoirs to narrow and deepen the wells.

iii. Taanka

Taanka is a traditional rainwater harvesting technique indigenous to the Thar Desert region of Rajasthan. A Taanka is a cylindrical paved underground pit into which rainwater from rooftops, courtyards or artificially prepared catchments flows. Once completely filled, the water stored in a taanka can last throughout the dry season and is sufficient for a family of 5-6 members. An important element of water security in these arid regions, taankas can save families from the everyday drudgery of fetching water from distant sources.

2. Non-traditional

In 1992, American artist Michael Jones McKean created an artwork in Omaha, Nebraska, at the Bemis Centre for Contemporary Art that created a fully sustainable rainbow in the Omaha skyline. The project collected thousands of gallons of rainwater, storing the water in six daisy-chained 12,000 gallons tanks.The massive logistical undertaking, during its five-month span, was one of the largest urban rainwater harvesting sites in the American Midwest.

3. Rainwater harvesting by freshwater-flooded forests

Rainwater harvesting is possible by growing freshwater-flooded forests without losing the income from the used, submerged land. The main purpose of the rainwater harvesting is to use the locally available rainwater to meet water requirements throughout the year without the need of huge capital expenditure. This would facilitate the availability of uncontaminated water for domestic, industrial, and irrigation needs.

4. Rainwater harvesting by solar power panels

Good quality water resource, closer to populated areas, is becoming scarce and costly for the consumers. In addition to solar and wind energy, rain water is major renewable resource of any land. Vast area is being covered by solar PV panels every year in all parts of the world. Solar panels can also be used for harvesting most of the rain water falling on them and drinking quality water, free from bacteria and suspended matter, can be generated by simple filtration and disinfection processes as rain water is very low in salinity. Exploitation of rain water for value added products like bottled drinking water makes solar PV power plants profitable even in high rainfall/cloudy areas by the augmented income from value added drinking water generation. Recently cost effective Rain water collection in the already dug wells found to be highly effective in the bringing ground water level up in India.

5. Rainwater barrels:

Barrel installation is the cheapest and easiest way to start harvesting rainwater in your home. A barrel is simply installed underneath the downspout of the guttering so that rain falling on the roof is funneled into the barrel. Usually, the container will consist of a spigot under it to enable you draw water and irrigate your garden. Better still; a hose can be connected to the spigot or to a drip irrigation system.

Barrels are advantageous because they can effortlessly be sourced whether recycled or new. If you opt for the recycled barrel, make a point to know exactly what the barrel was used for in order to be sure that no chemical residues remain inside. If you reside in a mosquito infested area, make sure to include a lid for your barrel to mitigate the possibility of mosquitoes breeding in your barrel.

When winter month knocks, it is advisable to disconnect your barrel to prevent freezing and cracking. The major disadvantage to rain water barrels is that they have limited capacity; meaning prolonged rains would result in flooding. The barrels are easy to use and readily available for purchase at many locations, all at reasonable prices.

6. Dry system

This is a well-known method of rainwater harvesting. It's basically an improvement to the rain water barrel technique in terms of size. A larger water storage container is situated just a few steps from the property. This container provides a much larger storage capacity compared to the barrel. The gutter is then diverted to channel water into the tank. It's also easy to implement and relatively cheap. The name "dry" comes from the fact that the collection pipe dries up after any rainy day because it's meant to empty into the top of tank. The dry system is ideal for areas with huge storms.

7. Wet system

The wet system is the exact opposite of the dry system. This is because the collection pipes are ever full of water since they are located underground. Here, numerous collection pipes are connected to multiple downspouts on the building and channeled to empty into the storage tank underground. When there is no rain, the level stays constant, and the pipes are always full. Due to the ever availability of water inside the pipes, it is recommended that they be watertight to mitigate the possibility of leaking into the soil. The underground piping makes it relatively expensive to install compared to the dry and wet systems.

8. Green roof

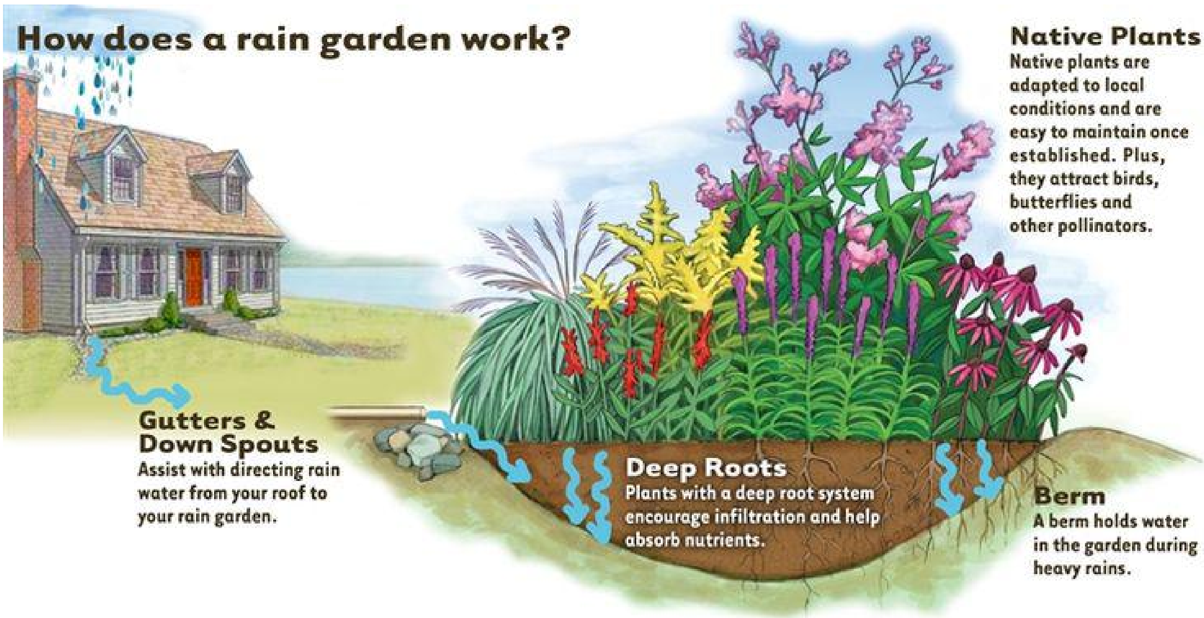
This method of rainwater harvesting literally cuts out the middleman. Instead of directing rainwater for storage in the tank and then channel it to the garden; you could install a green roof on your house to enable plants use the water instantly. But you have to lay down a lining for your roof's protection and include a drainage system to take care of the runoffs. Installing garden beds with plants that require low maintenance is the surefire way of maximizing your plot's productive space and leveraging the rainwater where it falls. Also, installing a green roof will add insulation to your house and cushion your roof from damage.

If you prefer you can create your own barrels for rainwater harvesting .Just a few components like Catchment area, conveyance system, first rain separator, filter unit, storage, delivery system, usage, recharge and supplies are needed to create your own barrel.

You will need to follow the instructions included with your rainwater harvesting kit to set things up and begin collection of the rainwater. For a DIY job, there are many resources available to you on the internet at no charge. You can definitely take advantage of the information whenever you need to and create your own rainwater harvesting system.

9. Create a Rain Garden

A rain garden is a sunken landscape that uses native plants, local soil, and mulch to remove pollutants from water, and allows it to percolate into the ground. It's easy to create, looks good all year-round and has a positive impact on the environment. Here's how to make a rain garden in your own backyard.



10. Make your own DIY Rain Chain

Rain chains are not only beautiful, simple to make requiring few tools and materials, but also a more attractive alternative to standard PVC (polyvinyl chloride) pipe downspouts. These fun, fashionable and environment-friendly accessories help avoid the runoff by transporting rainwater from the collecting pipe downwards to a drain or to a storage container. Check out the instructions for DIY rain chains here and decide which one would look great in your home!

11.Naturally recharge your wells and bore wells

Rooftop rainwater is led through pipes with a filter at the end to open dug wells for replenishing underground aquifers. Based on this idea, the ‘Mazhapolima’ (bounty of rain) Recharge Project of Thrissur was born. As a result, today, not only is there abundant water in summer, there is also reduced salinity, turbidity, and colour in the well water.

A recharge pit for bore wells is also a good idea as it pushes back the surface water into the groundwater system. Usually, a recharge pit is one metre in diameter and six meters deep, lined with concrete rings having perforations. These perforations let filtered and de-silted water seep from the sides increasing the groundwater table.

12. Set up a Splash Block

Setting up a splash block is a great idea to divert the flowing rainwater away from the structure's foundation. It is a piece of concrete or plastic of a roughly rectangular shape, and is placed below the downspout that carries rainwater from the roof of a house during rainfall. It absorbs the force of the water that is getting diverted from the roof, and also prevents holes from being dug in the garden due to the eroding force of the pouring water. Here's how to make one you.

13. Build a Rain Saucer

If you are looking for a fast DIY way to collect rainwater without much hassle, rain saucers form a great free standing rain collection system which fills up surprisingly fast. Looking like an upside-down umbrella, the rain saucer unfolds to form a funnel which fills the containers with rainwater. Since this easy-to-deploy system catches rain straight from the sky, it also decreases the chances of contamination. Here’s how you can make one.

Conclusion

Rainwater harvesting is something that thousands of families across the world participate in, and you could be the next to enjoy the multitude of benefits offered with rainwater harvesting. It is an easy, simple and worthwhile process, so it is only in your best interest to take a look at rainwater harvesting and its benefits to your home. You may discover many surprises and things that you did not know along the way! Rainwater harvesting is a viable option to supplement city water for non-potable human uses, such as irrigation. The overall efficiency of a rainwater harvesting system to supplement city water increases as area increases.

At the rate in which India population is increasing, it is said that India will surely replace china from its number 1 position of most densely populated country of the world after 20-30. These will lead to high rate of consumption of most valuable natural resource. What is resulting in augmentation of pressures on the permitted freshwater resources. In order to conserve and meet our daily demand of water requirement, we need to think for alternative cost effective and relatively easier technological methods of conserving water.

Rain water harvesting is one of the best methods fulfilling those requirements. Rainwater harvesting is the accumulation and deposition of rainwater for reuse before it reaches the aquifer. Uses include water for garden, water for livestock, water for irrigation, etc. In many places the water collected is just redirected to a deep pit with percolation. The harvested water can be used as drinking water as well as for storage and other purpose like irrigation.

The importance of rainwater harvesting lies in the fact that it can be stored for future use. Just as it can be used directly so also the stored water can be utilized to revitalize the ground level water and improve its quality. This also helps to raise the level of ground water which then can be easily accessible.

The present study has focused on the issue regarding availability quality water for household consumption and reduction of scarcity using roof top rain water harvesting technique. The rain water harvesting is one of the cost-effective measure to overcome the problems faced due to water scarcity. This approach computes the harvesting potential of rainwater based upon the catchment area characteristics. The quantity of water available from the catchment therefore depends upon the annual average rainfall, catchment area characteristics and extent of catchment area. The water demand can be assessed by working out the catchment area water supply and the actual demand of water. The study has quantified that the rain water harvesting structure provides 80% of the total annual requirement of the household. Hence, if this project is implemented then the problem due to water scarcity and quality of water will be solved. The salty water available from the bore well may be used for cleaning and other purposes.

This research helped us gain a lot of information on the rainwater harvesting in different parts of the country India.

On that note our mission should be:

i. Conservation of water.
ii. Since we cannot produce energy we can save it by preventing wastage.
iii. In the same way we cannot produce water but save it and protect our future.
iv. Watershed management can easily cope with climate change impact.
v. The benefits of water harvesting and water conservation not only for drinking water security but also for agriculture definitely reached.
vi. Rainwater harvesting prevents flooding of low lying areas.
vii. Rain water harvesting replenishes the ground water table and enables our dug wells and bore wells to yield in a sustained manner.
viii. It helps in the availability of clean water by reducing the salinity and the presence of iron salts.
ix. Storage of rainwater on surface for future use
x. Recharge to ground water.

By adopting Rain water harvesting technique you are benefitted by following ways.

- Water Saving.
- Flooding control.
- Drought mitigation.

- Water quality control.
- Ground water recharging.
- Improve quality of groundwater.
- Energy saving.
- Water supply (Domestic, industrial and agricultural).
- Save money on water bills by using own water sources.

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