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Model of Rainwater Harvesting System

Prof. Akash N Ka Patel[1], Pavar P. Nandsingh[2], Pavar V. Satpalsingh[2], Prof. Purvesh Raval[1]
[1]Professor, Department of Civil Engineering, Apollo Institute of Engineering and Technology, Gujarat Technological University Nava Naroda, Ahmedabad, Enasan, Gujarat, India
[2]US Scholar, Department of Civil Engineering, Apollo Institute of Engineering and Technology, Gujarat Technological University Nava Naroda, Ahmedabad, Enasan, Gujarat, India

ABSTRACT

As the world population increases, the demand increases for good quality of drinking water. Surface and groundwater resources are being consumed faster than they can be recharged. Rainwater harvesting is an old practice that is being adopted by many nations as a viable decentralized water source. This project is to prepare a model for rainwater harvesting from rooftops and we are designing Rainwater harvesting system in a residential building to use the rooftop rainwater and recharge ground water from excess water & concrete roads of residential houses then making demo model to show different collaborative techniques.
Keywords : Rainwater Harvesting, Rooftop Rainwater Harvesting, Bore-Well Recharge, Reuse of Stored Water

I. INTRODUCTION

Water is our most precious natural resource , Its uses are innumerable and its importance cannot be overestimated. Its role ranges from domestic uses, agriculture, and industry to religious ceremonies, recreation, landscape decoration and even therapy. Water is basic to life. Despite the obvious need for a sufficient, year-round water supply to sustain life, there is still a lack of water, much less clean water for many of the world's poor. The lack of water is bound to get worse. Estimates of the number of people without water put the number at about one-fifth of the world's population. For developing countries the number could be one-half.

Due to over population and higher usage levels of water the surface sources are being over stressed which has led to boring of tube wells at individual as well as at local government's level. The replenishment of ground water (GW) is drastically reduced due to paving of open areas. Indiscriminate exploitation of GW results in lowering of ground water table (GWT) rendering many bore-wells dry. To overcome this situation bore wells are drilled to greater depths. This further lowers the GWT and in some areas this leads to higher concentration of hazardous chemicals such as fluorides, nitrates and arsenic. In coastal areas, over exploitation of GW results in seawater intrusion thereby rendering GW bodies' saline. In rural areas also, government policies on subsidized power supply for agricultural pumps and piped water supply through bore wells are resulting into decline in GWT. The solution to all these problems is to replenish GW bodies with rainwater by manmade means.

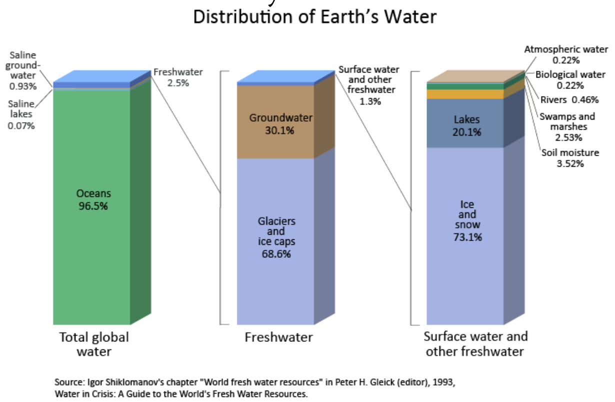


Fig 1. Distribution chart of water on earth

Distribution of earth's water on the land we can describe as its total globe water is distributed in 96.5% percentage in oceans, saline water percentage is 0.93% and also 0.07% percentage of saline lakes.

Freshwater of total available water is founded in 68.6% percentage in Glaciers and ice caps, 30.1% percentage is present in earth as Groundwater, other 1.3% percentage of surface water and other freshwater in which 73.1% percentage is in the Ice and snow, lakes have 20.1%.The rest of water from the entire fresh water present on the earth have 0.22% percentage of water atmosphere as in the forms of clouds and gases, 0.22% of water presented as biological water, in rivers there is 0.46% percentage of fresh water, swamps and marshes holds 2.53% percentage of fresh water, rest of 3.52% percentage of soil water is presented as the soil moisture.

Types of rainwater harvesting methods

1.Rooftop rainwater harvesting

2.Surface runoff rainwater harvesting

3.Ground water recharge

Rooftop rainwater harvesting

Rooftop Rain Water Harvesting is the technique through which rain water is captured from the roof catchments and stored in reservoirs. Harvested rain water can be stored in sub-surface ground water reservoir by adopting artificial recharge techniques to meet the household needs through storage in tanks.

The Main Objective of rooftop rain water harvesting is to make water available for future use. Capturing and storing rain water for use is particularly important in dry land, hilly, urban and coastal areas. In alluvial areas energy saving for 1m rise in ground water level is around 0.40 kilo watt per hour.

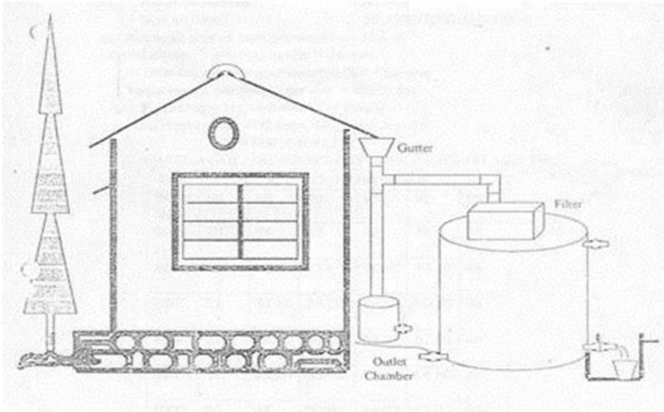


Fig 2. Rooftop Rainwater harvesting

Need for Rooftop Rain Water Harvesting

1. To meet the ever increasing demand for water
2. To reduce the runoff which chokes storm drain
3. To avoid flooding of roads
4. To augment the ground water storage and control decline of water levels
5. To reduce ground water pollution
6. To improve the quality of ground water
7. To reduce the soil erosion
8. To supplement domestic water requirement during summer, drought etc.

Advantages of Rain Water Harvesting

1. Provides self-sufficiency to your water supply
2. Reduces the cost for pumping of ground water
3. Provides high quality water, soft and low in minerals
4. Improves the quality of ground water through dilution when recharged to ground water
5. Reduces soil erosion in urban areas
6. The rooftop rain water harvesting is less expensive
7. Rainwater harvesting systems are simple which can be adopted by individuals
8. Rooftop rain water harvesting systems are easy to construct, operate and maintain
9. In hilly terrains, rain water harvesting is preferred
10. In saline or coastal areas, rain water provides good quality water and when recharged to ground

water, it reduces salinity and also helps in maintaining balance between the fresh-saline water interface

11. In Islands, due to limited extent of fresh water aquifers, rain water harvesting is the most preferred source of water for domestic use
12. In desert, where rain fall is low, rain water harvesting has been providing relief to people

Safety Consideration

Storage in Ground Water Reservoir

1. For rooftop rain water harvesting through existing tubewells and handpumps, filter or desilting pit should be provided so that the wells are not silted.
2. Such tubewells if pumped intermittently, increase the efficiency of recharge.
3. If the ground water reservoir is recharged through, shaft, dug well etc., inverted filter may be provided.

Storage in Tanks

1. A storage tank should not be located close to a source of contamination, such as a septic tank etc.
2. A storage tank must be located on a lower level than the roof to ensure that it fills completely.
3. A rainwater system must include installation of an overflow pipe which empties into a non-flooding area. Excess water may also be used for recharging the aquifer through dug well or abandoned handpump or tubewell etc.
4. A speed breaker plate must be provided below inlet pipe in the filter so as not to disturb the filtering material.
5. Storage tanks should be accessible for cleaning.
6. The inlet into the Storage tank should be screened in such way that these can be cleaned regularly.
7. Water may be disinfected regularly before using for drinking purpose by chlorination or boiling etc.

How Much You Can Collect

Collection efficiency how efficiently the rainfall can be collected depends on several considerations. Collection efficiencies of 80% are often used depending on the specific design.

Rainfall Reliability

The first step is to determine how much water would be generated from roof area. Average monsoon rainfall is used for this purpose.

Formula:

Total quantity of water to be collected (cu.m.)
= Roof Top Area (Sq.m.) x Average Monsoon Rainfall (m) x 0.8

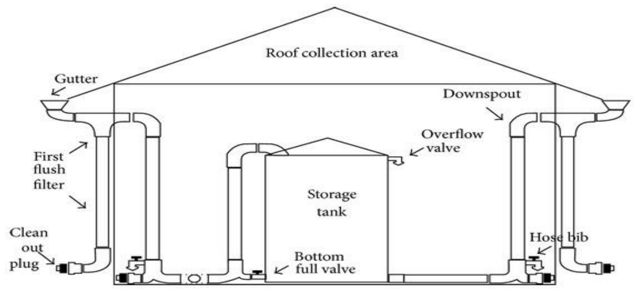


Fig 2. Components of Rooftop rainwater harvesting

SURFACE RUNOFF RAINWATER HARVESTING

The storage of rain water on surface is a traditional technique and structures used are small dams such as checkdams, ponds,tanks etc. Check dams are constructed to impound the surface water in them and excess of water is allowed to flow over the dam. There is also another way of collecting surface runoff rainwater harvesting which can be done by storage reservoir to store the great amount of rainwater from the precipitation, but on the other side it is also very expensive or we can say most expensive amongst all of the methods or ways which can be utilize. It requires a careful design which should be strong enough to sustain such amount of loads and it should also be watertight and free from contamination.

GROUND WATER RECHARGE

The concept of recharging ground water has become necessary in todays time we are using the ground water in a large amount which has caused the depletion of the ground water table. Due to depletion of ground water table the ground water is getting contaminated the water table is getting lower with the time, so people find the way to artificially recharge by making wells, trenches, pits and by constructing recharge shafts, lateral shafts, borewells.

Scope of rainwater harvesting

- It can be used in sanitation purpose.
- It can be used for industrial use.
- It can be used in watering roadside arboriculture.
- Treated water can be used for domestic and irrigation purposes.
- It can be supply to the various water scarce regions in India.
- The water dependency on ground water can be decreased if the rainwater harvesting can collect a decent amount of water.
- Rooftop rainwater harvesting requires not much filtering process to further utilization.
- The amount of water used in the daily consumption such as sanitation purpose, in bathrooms, kitchens considerable, treated water from the road arterials can be used in these purposes.

Objective of study

1) To prepare RWH system to use rainwater in residential building and making model to understand.
2) Rain water harvesting from rooftops then reuse & store it.
3) Recharge the ground water table from excess water.

II. LITERATURE REVIEW

SIMULTANEOUS DESIGN OF WATER REUSING AND RAINWATER HARVESTING SYSTEMS IN A RESIDENTIAL COMPLEX

Mariana García-Montoyaa, Andrea Bocanegra-Martíneza, Fabricio Nápoles-Riveraa

They have designed proposed residential complex where one objective is the minimization of the fresh water consumption and the other objective is the minimization of the total annual cost. Their proposed model accounts for the variability in the water demands through the different hours of the day and for the different seasons of the year. The seasonal dependence of the rainwater has also been considered in the optimization model. A case study for the city of Morelia in Mexico is presented. The results show that significant reductions can be obtained in the total fresh water consumption and in the total cost.

They have made a demo model consists of synthesizing the water network in the residential complex to satisfy all the water demands in the different periods through the installation of rainwater collection and storages systems, grey water recycling and reusing units and the optimization of the entire operation for the system. They have made optimal solution consider the network configuration and operating conditions with the minimum cost and with the minimum fresh water consumption. For that they have shown schematic representation where only two housing units (which are also the potential rainwater catchment areas) and five uses (toilet, shower, dishwasher, laundry and gardening) are considered; however, the superstructure is general and can be extended for more units and uses. In this figure, the dashed lines represent the output water from each use, the continuous lines show the water that can be recycled to new uses and the thick lines indicate the harvested rainwater. Different treatments can be considered for regenerating grey water and rainwater, in such a way that the quality of this water can satisfy the demands of the different uses. They have made such arrangement so that wastewater can be mixed only with water of the same quality and all the water discharged to the environment must be treated to satisfy the environmental regulation. The rainwater and reclaimed water must be stored in different storage devices, because rainwater has a better quality water than used water.

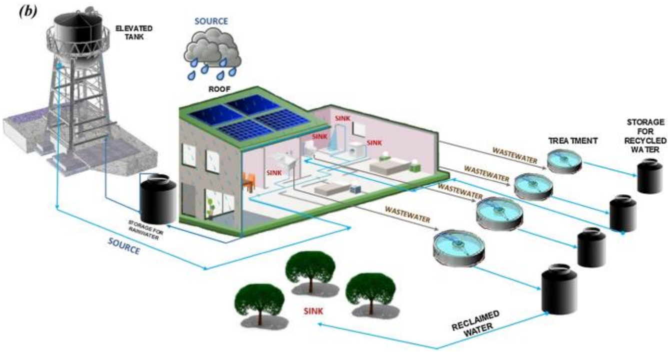


Fig 3. water reusing and rainwater harvesting in a housing complex.

To show the advantages of the proposed methodology, different scenarios were analyzed. One corresponds to the case when the proposed methodology without constraints was implemented, other corresponds to the case when only the rainwater harvesting is considered without involving the grey water recycling and reusing and finally the other corresponds to the case when only the grey water recycling and reusing was considered without involving the rainwater harvesting. In addition, the proposed methodology was applied to solve the multi-objective optimization problem, and constructing a Pareto curve, then some attractive scenarios from the Pareto curve were identified and discussed. Scenario X corresponds to the case where neither grey water nor harvested rainwater are considered , Scenario Y corresponds to the case when only rainwater harvesting is allowed scenario Z when only recycling grey water is allowed and Scenario A which corresponds to the case when the integrated system was considered .

Scenario Y considers the economic optimal solution for the case when it is considered the rainwater harvesting whereas the recycling and reusing of grey water was not involved. For this case, the TAC is US$631,610/year, and it is constituted mainly by fresh water, pumping fresh water and operating cost for treatment units, more-over other costs are associated to the capital cost for pipes from units, capital cost of treatment units, capital cost for rainwater harvesting, capital cost for pipes for harvested rainwater, capital cost for pipes for rainwater harvesting, capital cost for rainwater storing, capital cost for the elevated reservoir, for pumping harvested rainwater, for treating rainwater and the total investment represents 1.27% of the TAC. In this case, the total demand of water is satisfied with fresh water and rainwater the required fresh water is 502,116 m3/year, the captured rainwater is 36,260 m3/year and the discharged water to the environment is 415,034 m3/year. Comparing Scenario Y with respect to Scenario X, a decrement of 6.73% in the fresh water consumption and a reduction of 1.94% in the total annual cost are observed.

RAINWATER HARVESTING: USING URBAN ROOF RUNOFF FOR RESIDENTIAL TOILET FLUSHING

Rainwater harvesting can be a key component of efforts to promote metropolitan sustainability, by using rainwater harvesting from urban catchments to reduce the use of potable water. In this paper they examine the reliability with which roof runoff harvested, stored and used for toilet flushing, can reduce residential potable water consumption. The focus is on roof runoff as opposed to other sources, due to the proliferation of rooftops in metropolitan areas and the relative ease with which these sources can be accessed. They have analysed four US cities with Storage and Reliability Estimation Tool (SARET) and then compared them. Reliability contours are generated that allow visualization of gradients in long-term reliability. The analysis indicates that residential toilet flushing demand could be met with 50–94% reliability, the range being determined by differences in per capita demand, roof area and precipitation patterns. The results are discussed with respect to the assumption of stationary precipitation patterns, the algorithm used by the model to develop the reliability ensembles, the assumed initial condition of the simulations and other differences between the metropolitan areas are studied.

The results are presented using contour plots constructed in MATLAB (Mathworks, Natick, MA). In Fig., the contours depict the reliability with which toilets can be flushed using harvested rainwater from catchments of different areas (horizontal axis) connected to storage tanks of different volumes (vertical axis). Each row of plots corresponds to a different city and each column depicts results for a different toilet flushing demand (210–420 lpd). For simplicity, the results in different cities will be discussed with respect to a 'base case' corresponding to a hypothetical 100m2 roof connected to a 5m3 storage volume with 280 lpd of toilet flushing demand. This case corresponds to a roof area that is common in all cities and a tank volume that is likely to fit in a typical building basement. In general, the reliability with which the base case RWH system can meet toilet flushing demand drops by 30–37% as the demand doubles from 210 to 420 lpd. In Chicago, the reliability drops from 87% with a demand of 210 lpd to 50% with a demand of 420 lpd. Reliabilities in New York City and Philadelphia drop from 93.9% and 93.1% respectively at the 210 lpd demand level to 59% and 57.7% respectively at the 420 lpd demand level. The reliability of RWH systems in Seattle drops from 82.8% to 52.4% over the same range in demand. At a particular demand, the reliability with which residential toilet flushing demand can be met with roof runoff varies by less than 10% between cities for the base case. With 280 lpd demand, systems in New York City and Philadelphia would display reliabilities of 82% and 81% respectively, while systems in Chicago and Seattle would have reliabilities of just over 70%. At the 350 lpd demand level, RWH systems in New York City would achieve reliabilities of 69.7%, those in Philadelphia attain reliabilities of 68.3%, Seattle of 61.7% and Chicago 60%.

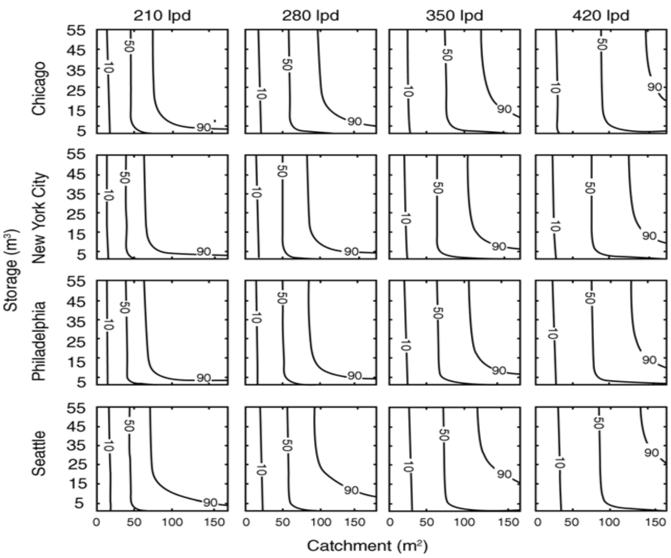


Fig 4. Contour plots showing the reliability (in %) of flushing toilets with rainwater.

In all four cities, roof area has a stronger absolute effect on system reliability than tank volume or demand. The larger the roof area, the more reliable the RWH system, with the importance of roof area essentially the same in all four cities. Tank volume has the second largest absolute impact on system reliability, with slightly larger positive impacts in Seattle than in the other cities. The higher importance of tank volume in Seattle could be due to the benefit of greater capacity to store water before dry-season dry spells in Seattle. Increases in demand have a greater negative effect on system reliability in Chicago and Seattle than in Philadelphia or New York, possibly explained by the lesser annual precipitation amounts in the former cities.

RAINWATER HARVESTING- A CASE STUDY OF AMBA TOWNSHIP,GANDHINAGAR

Anant D. Patel, Asst. Prof. Pratima K. Shah

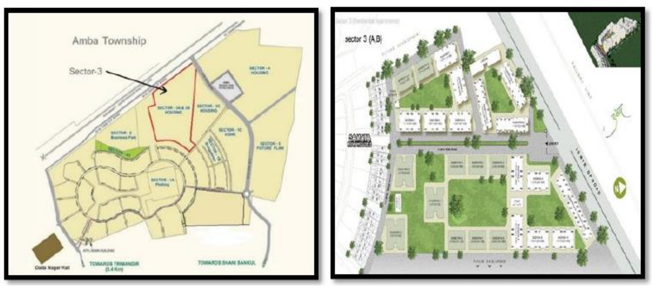


Fig 5. (a) Plan of Amba Township (b) Plan of Sector-3 (A,B) (Source:-www.ambatownship.com)

They have calculated total area of roof top of all buildings in Amba Township which is 22011 Sq.m and and evaluate from data that average annual rainfall in Gandhinagar is 740.3mm. Amba Township is 10kms away from the Gandhinagar, so there is no any water supply from Municipal of Gandhinagar. There is no any reliable source of water in Amba Township. So there is need to dug a private bore wells in Amba Township. But day by day buildings are constructed and population of city are increasing as faster way. Due to this,water demand is also increase.They have implemented Rainwater Harvesting Scheme in amba Township of Gandhinagar. They have taken runoff co-efficient value as 0.60 for flat terrace and 0.82 for R.C.C. roads.

RAINWATER HARVESTING IN INDIA: SOME CRITICAL ISSUES FOR BASIN PLANNING AND RESEARCH

M. Dinesh Kumar, Shantanu Ghosh, Ankit Patel, O.P.Singh and Ravindranath

In the most water-scarce regions of India, RWH offers limited potential. In many other regions, which have medium rainfalls but experience 'medium to high evaporation', the poor groundwater potential of the hard-rock that underlie these regions pose a constraint for recharging. This was illustrated by water-level fluctuation data in the wells of the Ghelo River basin in Saurashtra. The economic evaluation of water harvesting systems poses several complexities due to the problems in quantifying their hydrological impacts, and their various benefits. The economics of water harvesting cannot be worked out for structures on the basis of individual benefits, but on the basis of incremental benefits. In many water-scarce basins, there is a strong tradeoff between maximizing the hydrological benefits from RWH and making them cost-effective. In many water-scarce basins, RWH interventions lead to the distribution of hydrological benefits rather than to their augmentation. This was also illustrated by the historical flow series data from the Ghelo River basin. There is an optimum level of water harvesting that a basin can undergo to optimize the gross value product of water vis-à-vis economic, social and environmental outputs basin-wide.

RAINWATER HARVESTING IN THE WATER-SCARCE REGIONS OF INDIA: POTENTIAL AND PITFALLS

M. Dinesh Kumar, Shantanu Ghosh, Ankit Patel, O.P.Singh and Ravindranath

Water harvesting initiatives are driven by firm beliefs and assumptions, some of which are:

1) There is a huge amount of monsoon flow, which remains un-captured and eventually ends up in the natural sinks, especially seas and oceans, supported by the national level aggregates of macro hydrology.

2) Local water needs are too small and as such exogenous water is not needed.

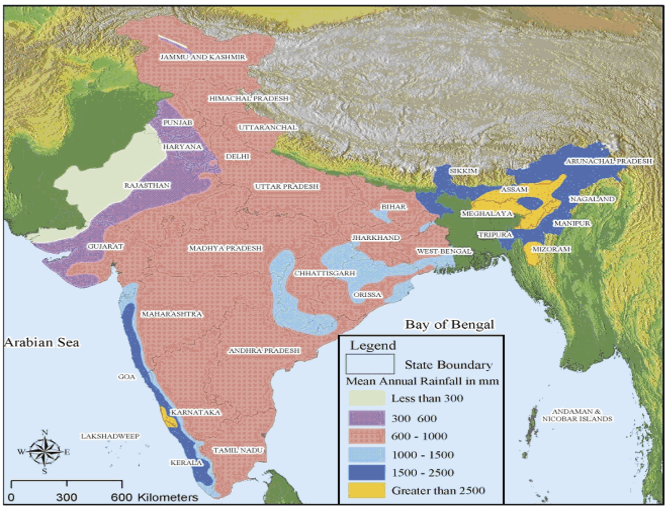
3) Local water harvesting systems are always small and, therefore, are cost effective.

4) Since the economic, social and environmental values of water are very high in regions hit by water shortages, water harvesting interventions are viable, supported by the assumption that cost effective alternatives that can bring in the same amount of water, do not exist.

5) Incremental structures lead to incremental benefits.

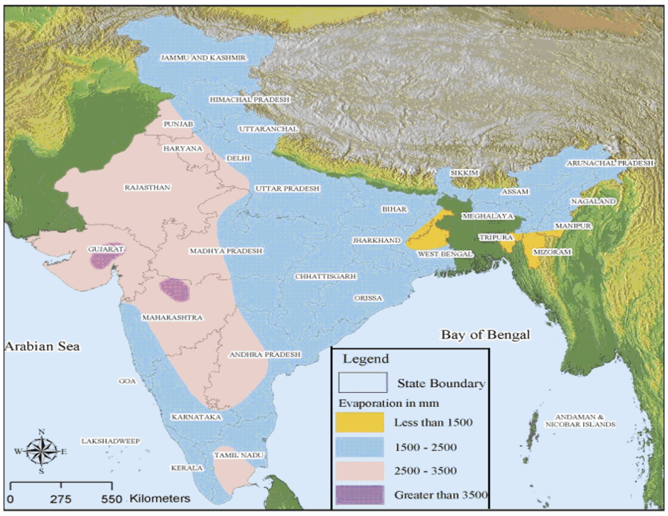
6) Being small with low water storage and diversion capacities, they do not pose negative consequences for downstream uses.

The analysis shows that Gujarat and Rajasthan have respectively 11 % and 42 % of area that fall under extremely low rainfalls (< 300mm); and 39 % and 32 %, respectively under low rainfall (300-600 mm). The other states by and large fall under medium rainfall (600 mm-1,000 mm) and high rainfall (1,000-1,500 mm) regimes. And in case of Orissa and Chattisgarh, 45 % and 40 %, respectively, fall under high rainfall regime (see Map 1).

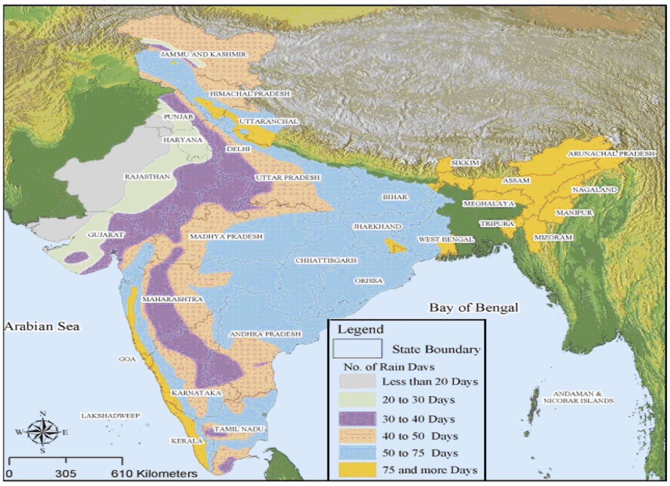


Map1 Average mean annual rainfall

As regards PE, the lion's share of the area in Gujarat and Rajasthan fall under high evaporation (2,500-3,000 mm); nearly 35-56 % of the geographical area of other states (except Orissa and Chattisgarh) falls under high evaporation regimes; the area of these states falling in the medium evaporation regime (1,500-2,500 mm) is in the range of 38-65 %. The entire areas of Orissa and Chattisgarh fall within the medium evaporation regime. Overall, a large section of the area (of the nine states considered) has medium rainfall, and medium to high evaporation. A significant portion of the area (of Gujarat and Rajasthan) has very low to low rainfalls and high evaporation (see Map 2 and Table 1).



Map 2 Average annual evaporation



Map 3 Average rainy days

The potential for water harvesting is lower when lower rainfall, is coupled with higher potential evaporation and inter-annual variability in rainfall and fewer rainy days. This is due to the following processes. First, the runoff potential by and large would be low in low-rainfall regions with a high dryness ratio. Second, evaporation from surface storage would be high due to high PE. Third, the probability of occurrence of very low rainfalls, causing heavy reductions in runoff, would be high, with consequent hydrological stresses.

EVALUATING TEMPERATURE AND PRECIPITATION VARIABILITY OVER GUJARAT, INDIA FROM 1957-2007

Aparna Rathore and Yogesh T Jasrai

Map 4 Gujarat showing IMD stations used in 1957-2007 rainfall analysis

The annual average minimum temperature of Gujarat during 1957 was 20.8°C which increased to 22.0°C, which shows an increase in the minimum temperature of Gujarat by about 1.2°C. The annual average minimum temperature for winter months (November, December, January and February) of Gujarat has also increased by 1.28°C over the past 50 years.

The annual average maximum temperature of Gujarat during 1957 was 32.7°C which increased to 33.4°C, with an increase in the maximum temperature of Gujarat by about 0.7°C. The annual average maximum temperature for summer months (March, April, May and June) of Gujarat exhibited an increase of about 1.2°C over the past 50 years.

Seasonal rainfall for various observatories for over 50 year's period (1957-2007) was analyzed. The annual average rainfall over Gujarat has increased by about 400 mm over the past 50 years. The rainfall shows a very high variability over Gujarat with an average rainfall of 700 ± 231 mm (Mean ± SD). The standard variation over all the stations varies around 230 to 500 mm.

RAINWATER HARVESTING (RWH) - A REVIEW

J.R.Julius, Dr.R.Angeline Prabhavathy, Dr. G.Ravikumar

As water is becoming scarce, it is the need of the day to attain self-sufficiency to fulfill the water needs.

- As urban water supply system is under tremendous pressure for supplying water to ever increasing population.
- Groundwater is getting depleted and polluted.
- Soil erosion resulting from the unchecked runoff.
- Health hazards due to consumption of polluted water.

SPATIAL AND TEMPORAL VARIABILITY OF RAINFALL IN ANAND DISTRICT OF GUJARAT STATE

Khadeeja Priyan

Rainfall variability

Rainfall variability has been defined as the deviation of rainfall from the mean or the ratio of standard deviation to the mean or the variability of coefficient of variation (Rathod and Aruchami, 2010). Rainfall variability has been discussed and studied in the context of climate change at global level, regional level and local level. Gadgil (2007) emphasized that there should be a clear understanding of the basic systems responsible for monsoon and the factors that lead to its variation before developing any predictability model. Rangarajan and Sant, (2004) used fractal dimensional analysis to analyze the time series data of three major climatic variables – temperature, pressure and precipitation, to study variability changes and the variability of south-west monsoon and north-east monsoon in India at local level and regional level using predictability indices. They concluded that the precipitation during south–west monsoon is affected by the temperature and pressure variability of the preceding winter. Large sets of rainfall and temperature data are examined using spectral and time series analysis to analyse climatic trends and interactions (Tularam and Elahee, 2010).

The rainfall in Gujarat varies from 300 mm in the North and Northwest to gradually increasing to 2500 mm in the Southern districts (GEC, undated). The coefficient of variation of rainfall in the state is as high as 50%.Gujarat state in India gets rainfall through South-West monsoon during June to September. Gujarat is one of the states in India where the highest one day rainfall exceeds 40 cm. As per the analysis of IMD for the period 1875-2009 maximum number of droughts occurred in Rajasthan (31 years) followed by Gujarat (30 years). Since the rainfall in the state varies from less than 500 mm in the arid Kutch regions to more than 2500 mm in the South Gujarat region.

The annual average rainfall in the district from 1901 to 2014 is 672 mm. The highest monthly rainfall recorded is 552 mm in July, 2006. The Borsad Taluka recorded a maximum of 732 mm in July, 2014. It has been noticed that the rainfall was 1000 mm or more in the years 2013 and 2014, and the rainy season in these years was extended to October month also. The mean rainfall and the standard deviation is the highest in July month only.

Map 5 Anand district, Gujarat

QUANTITY OF WATER REQUIRED FOR DESIGNING A WATER SUPPLY SCHEME

Tejas D. Khediya

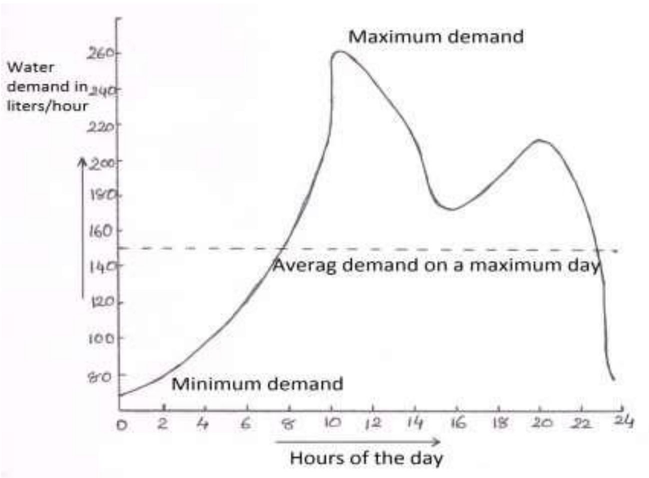


Fig 6. Hourly variation of the rate of consumption

Domestic water demand

The total domestic water consumption may amount to 55 to 60 % of the total water demand. This includes the water required in the houses for cooking, washing, bathing, drinking, gardening and sanitary purpose etc. The domestic demand depends upon the living conditions of consumer such as habits, social status, climate condition etc. As per IS-1172-1993 water requirement for domestic purposes for India is about 135 liters/day/capita under normal conditions.Table-1 shows the details of water requirement for domestic purpose.

	Use	Consumption in litres /day/ person
(a)	Drinking	5
(b)	Cooking	5
(c)	Bathing	55
(d)	Washing of clothes	20
(e)	Washing of utensils	10
(f)	Washing and cleaning of houses and residences	10
(g)	Flushing of Latrines etc.	30
	Total	135

Table 1Domestic water demand

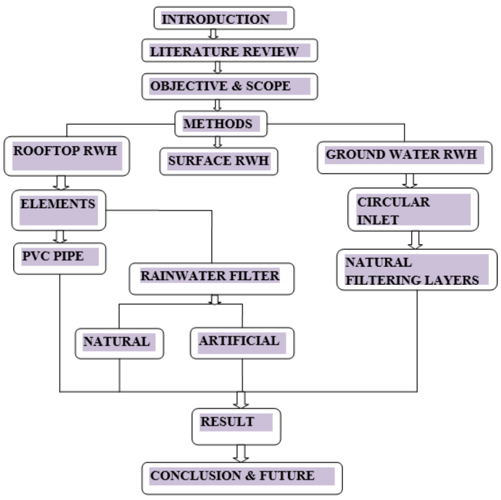
Industrial and commercial water demand

This consumption includes water used in factories, hotels, offices, hospital etc. The water requirements of industrial needs of a city are generally taken as 50 liter/day/person. This demand depends upon the nature of the city and types of industries. Generally 20 to 25% of the total water demand may be allowed for industrial water demand. The approximate quantity of water required for industries other than residences as per IS-1172-1993 is given in Table-2.

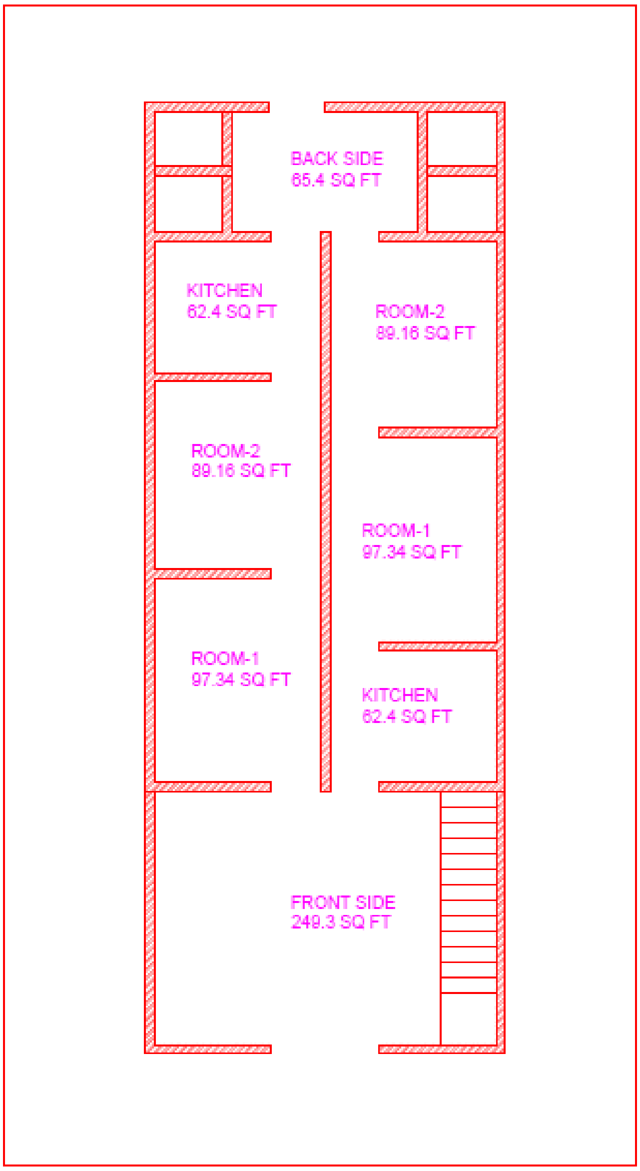
S.No.	Type of Building	Construction per capita per day Litres
1.	(a) Factories where bathrooms are required to be provided	45
	(b) Factories where no bathrooms are required to be provided	30
2.	Hospitals (including laundry) per bed	
	(a) No. of beds not exceeding 100	340
	(b) No. of beds exceeding 100	450
3.	Nurses homes and medical quarters	135
4.	Hostels	135
5.	Offices	45
6.	Restaurants (per seat)	70
7.	Hotel (per bed)	180
8.	Cinema concert hall and theatres (per seat)	15
	Schools	
	(a) Day Schools	45
	(b) Boarding schools	135
9.	Garden, sports grounds	3.5 per sq. m.
10.	Animals/vehicles	45

Table 2 Industrial and commercial water demand

III. METHODS AND MATERIAL



PLAN & CALCULATION



PLAN DRAWN IN AUTO CAD

IV. RESULTS AND DISCUSSION

4.1 Design Consideration

Rainwater storage tank of having
Length=8ft
Width=8ft
Height=8ft
Volume=512cu. ft
=14.498 cubic meter, consider 14500 cubic meter
=14500 liters

Tank sufficient to hold 14500 liters of water and excess amount of water will be conveyed to the ground water table.

4.1.2 Calculations

Rainwater Harvesting by Rooftops

Total Rooftop Area (A1)=74.234 Sq. m.
Average Annual Rainfall in mm (R)=750mm
=0.750m

Area description	Runoff coefficient (K)	Area description	Runoff coefficient (K)
Residential:-		Industrial:-	
Single-Family	0.30-0.50	Light	0.50-0.80
Multiunit, detached	0.40-0.60	Heavy	0.60-0.90
Multiunit, attached	0.60-0.75	Parks, cemeteries	0.10-0.25
Residential (suburban)	0.25-0.40	Play grounds	0.20-0.35
Apartment	0.50-0.70	Railroad yard	0.20-0.35
Pavement:-		Lawns, sandy soil:-	
Asphaltic and concrete	0.70-0.95	Flat, 2 percent	0.05-0.10
Brick	0.70-0.85	Average, 2-7 percent	0.10-0.15
Roofs	0.75-0.95	Steep, 7 percent	0.15-0.20

Table 3 Runoff Co-efficient Table

Runoff co-efficient for flat terrace c= 0.35 for Residential (suburban)
Annual water harvesting potential through total terrace = A * R * C
= 74.234 *0.750 * 0.35
= 19.486Cubicmeter
1cub. Meter = 1000 liters
Therefore 19.486 cubic meters= 19486 liters
Annually Total Rain water Harvesting
= 19486 liters in a single house

Roadways for rainwater harvesting

Assume 10Sqm of RCC road of residency is used for rainwater harvesting scheme.

Taking runoff co efficient for RCC roads = 0.825
Rainwater potential from roads = 10Sq.m. * 0.750 * 0.825
= 6.1875cub.m.
= 6187.5liters
Hence for 1Sq.m. it will have 618.75liters capacity.

4.2 Rainwater properties

Rainwater can be defined as a precipitation comes in the form of water droplets. The rainwater if it is directly collected from the environment it does not require much filteration because the rainwater falls in pure form of water apart from the first rain which contains harmful elements.

According to studies it is found that Rainwater is soft water on the hardness point of view.
Rainwater remains free from any odour and color which fulfills property of clean water.

4.3Rainwater filters

The rainwater may have the impurities which are finer because in the rainwater harvesting the rainwater is not directly collected from the climate but it has to go through the surface of the rooftop which could have such impurities which must be sieved before collecting the rainwater or allowing to go through the ground to meet the ground water.

The rainwater harvesting requires some simple filtering units which are capable of to remove the fine particles. These types of filters are not designed to remove the dissolved impurities.

4.3.1Natural filters

Natural filters are the filters made by using sand, gravel, charcoal in the order of their respective sizes from coarser to finer substance and the charcoal is made finer as finer we can get by crushing because finer charcoal will make water more pure.

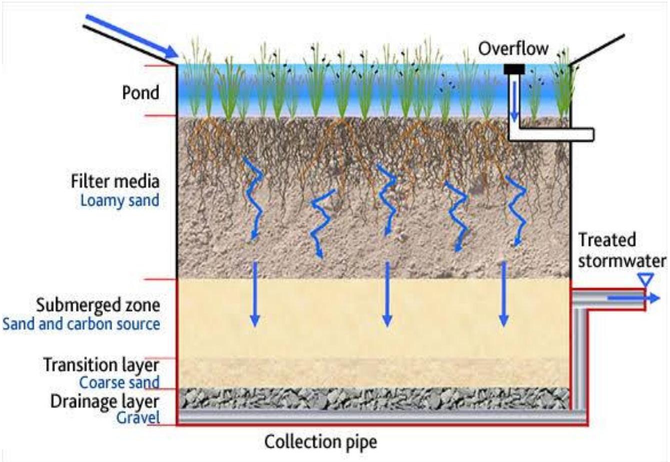


Fig 7. Filtering tank
Source : rainwaterfilter.org

4.3.2Artificial filters

Artificial filters are made up of PVC because of its strength and light weight anti corrosive properties in this types of filters manufactures design them according to the roof top size of the particular building. The smaller size of roof tops such as less than 100 sqm area will yield comparatively lesser pressure than the bigger size of area than it or in multi-storey building.

These types of filters are such made so that the unwanted first two rains which have the acidic property and other harmful substances are provisioned to carry out of the filter and to flush it off there is valve also provided.

Fig 8. Installed rainwater harvesting filter
Source: rainwaterfilter.in

Fig 8. Filtering net
Source: rainwaterfilter.in

Result

As per the IS-1172-1993 the domestic demand of water in India is 135 lpcd hence if we consider this we can say that we can serve water up to 19486 harvested water to seven members of the family up to sixteen days.

Costing

Element	No.	Dia.	Length	Rate	Per	Amount
Elbows	2	3"	-	50Rs.	n	100Rs.
C clamps	2	3"	-	50Rs.	n	100Rs.
PVC pipe	1	3"	23	20Rs.	Ft	460Rs.
Filter	1	-	-	3000Rs.	n	3000Rs.
Total cost	-	-	-	-	-	3660Rs.

- Elements used in Rainwater harvesting system

Image1- fittings of the pipes
Source- rainwater.in

Image2- PVC pipes
Source- rainwater.in

Image 3 - Rainwater filter
Source- rainwater.in

Model Making

Image 4 while cutting foam board

Image 5 placement of houses on board

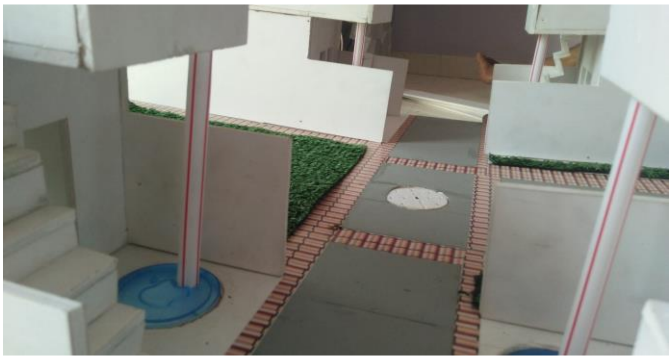


Image 6 model of rainwater harvesting system

Image 7 model of rainwater harvesting system

Image 8 model of rainwater harvesting system

Image 9 model of rainwater harvesting system

V. CONCLUSION & FUTURE SCOPE

- This study has shown that we have taken residential houses situated in Ahmedabad, Gujarat state which has annual average rain fall of 750 mm as per climate research data. We have taken run off co efficient of concrete roads as 0.825 and for rooftop rainwater harvesting as 3.25 for suburban area.
- We have also state about the use rainwater collection from the connecting roads of the societies by collecting rainwater from the circular inlet which is placed on the intersection of society roads after taking water from roads thereby convey water to the bore-well of society.
- So that it can be used in gardening purpose on daily basis or when it is required in special occasions and it also increase the ground water level.
- We can see that, we can obtain 19486 lit from single house and 618.75liters from concrete roads of 1sqm annually, we can also conserve water of rainwater by making circular inlet which can have One of the most logical steps towards this goal would be knowing the importance of rainwater harvesting.
- The encouragement of rainwater harvesting system implementation could be cure of water crisis in some places. Hence, an equal and positive thrust is needed in developing and encouraging the water harvesting systems.
- We have to catch water in every possible way and every possible place we can do. It can be concluded from above findings that rainwater, if we can conserve and utilize using the rainwater harvesting technology, can be an effective tool of replenishing ground water resources. So by using Rain water harvesting methods we can harvest and store the rain water into underground also.

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