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Rain Water Harvesting At Sree Dattha Institute of Engineering and Science

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Abstract:- *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 "Water" resulting in augmentation of pressures on the permitted freshwater resources. Ancient method of damming river and transporting water to urban area has its own issues of eternal troubles of social and political. 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. The technical aspects of this paper are rainwater harvesting collected from rooftop which is considered to be catchment areas Institutes departmental building at Sree Dattha Institutions Sheriguda Campus. First of all, required data are collected i.e. catchment areas & hydrological rainfall data. Water harvesting potential for faculty apartments was calculated, and the recharge pits with suitable design is being considered. Volume of pits has been calculated with most*
appropriate method of estimation. Optimum location of tank on the basis of hydrological analysis was done in the campus. Finally, Gutter design, its analysis, first flush and filtration mechanism are also dealt with in detail.

Keyword*: Rain water harvesting, first flush mechanism, Roof water system Gutter for conveyance, Recharge pits, Methods of distribution harvested rain water*

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I. Introduction

For approximately two centuries, water management in cities followed the principles of control and domination, well represented by urban drainage, which is sized so that the urban environment isfree of floods . With the continuous urbanization process, larger drainage systems are required,which increasingly interferes with the natural cycle of water. The main impacts of urbanizationon the water cycle are the increase in runoff and the anticipation of peak flows, the reduction ofevapotranspiration and groundwater quantity supply, and the deterioration of surface water quality.In addition, the concern about water shortage is a target for studies all over the world, in local level, mostly in regions that already suffer from lack of water, and in global level. Demonstrated that while water consumption increased fourfold in the 20th century,the population suffering from water scarcity rose from 0.24 billion (14% of the worldpopulation)in the 1900s to 3.8billion (58%) in the 2000s.

II. Components of Rainwater Harvesting System

A rainwater harvesting system comprises of components for - transporting rainwater through pipes or drains, filtration, and tanks for storage of harvested water. The common components of a rainwater harvesting system are: -

Catchments: The surface which directly receives the rainfall and provides water to the system is called catchment area. It can be a paved area like a terrace or courtyard of a building, or an unpaved area like a lawn or open ground. A roof made of reinforced cement concrete (RCC), galvanized iron or corrugated sheets also be used for water harvesting.

Gutters: Channels which surrounds edge of a sloping roof to collect and transport rainwater to the storage tank. Gutters can be semi-circular or rectangular and mostly made locally from plain galvanized iron sheet. Gutters need to be supported so they do not sag or fall off when loaded with water. The way in which gutters are fixed mainly depends on the construction of the house, mostly iron or timber brackets are fixed into the walls.

Conduits: Conduits are pipelines or drains that carry rainwater from the catchment or rooftop area to the harvesting system. Commonly available conduits are made up of material like polyvinyl chloride (PVC) or galvanized iron (GI).

First-flushing: A first flush device is a valve which ensures flushing out of first spell of rain away from the storage tank that carries a relatively larger amount of pollutants from the air and catchment surface.

Filters: The filter is used to remove suspended pollutants from rainwater collected from rooftop water. The Various types of filters generally used for commercial purpose are Charcoal water filter, Sand filters, Horizontal roughing filter and slow sand filter.

Recharge structures: Rainwater Harvested can also be used for charging the groundwater aquifers through suitable structures like dug wells, bore wells, recharge trenches and recharge pits. Various recharge structures are possible - some which promote the percolation of water through soil strata at shallower depth (e.g., recharge trenches, permeable pavements) whereas others conduct water to greater depths from where it joins the groundwater (e.g. recharge wells). At many locations, existing structures like wells, pits and tanks can be modified as recharge structures, eliminating the need to construct any fresh structures. Some of the few commonly used recharging methods are recharging of dug wells and abandoned tube wells, Settlement tank, Recharging of service tube wells, Recharge pits, Soak ways /Percolation pit, recharge troughs, Recharge trenches, Modified injection well.

1.0 OBJECTIVES OF RAINWATER HARVESTING ARE:
2.0 Reduces urban flooding&Ease in constructing system in less time.
3.0 Economically cheaper in construction compared to other sources, i.e. dams, diversion, etc.
4.0 Rainwater harvesting is the ideal situation for those areas where there is inadequate groundwater supply or surface resources.
5.0 Helps in utilizing the primary source of water and prevent the runoff from going into sewer or storm drains, thereby reducing the load on treatment plants.
6.0 Recharging water into the aquifers which help in improving the quality of existing groundwater through dilution.

III. Literature Review

As water harvesting is a very old tradition and has been used for years, several techniques have been developed so far. Extensive literature is available on RWH with respect to various methods, its impacts on groundwater quantity, quality and its modeling. Literature related to the various methods of recharge estimation, applications of remote sensing and GIS in artificial recharge, studies on groundwater modeling, RWH implementation and its impact studies was collected and a critical review was carried out, as shown in the following sections.

Chiew *et al.* (1992) estimated groundwater recharge by adopting an integrated surface and groundwater modeling approach. The model was calibrated against stream flow and potentiometric head data, with recharge estimated as an output from the calibrated model. The model was applied to the Campuses River Basin in north-central Victoria and the results showed that this modeling approach can satisfactorily quantify the spatial andTemporal distribution of regional recharge rates resulting from rainfall and irrigation water. The simulations forecasted by the integrated model were better than those forecasted when the surface and groundwater models were used separately.

Osterkamp *et al.* (1995)analyzed the techniques of groundwater recharge estimates in both arid and semi arid areas with examples from Abu Dhabi.

Ramesh Chand *et al.* (2005) assessed the groundwater recharge via neutron moisture probe in Hayatnagar micro-watershed, India. The soil moisture values were calculated using neutron moisture probe from a total of eight sites at Hayatnagar micro-watershed at regular intervals of time for two hydrogeological cycles. The total volume of water (recharge) as a result of the rise in water-level was estimated and it was found to vary from 0.22 to 0.37 m, with an average of 0.30 m. The effective specific storability component as a result of increase in water level was estimated and it was found to changefrom 6.9 to 10.6%, with an average value of 9.0%.

Sharda *et al.* (2006) assessed the groundwater recharge from water storage structures in a semi-arid climate of India. Groundwater recharge was calculated as 7.3% and 9.7% of the annual

Rainfall by Water Table Fluctuation(WTF) method for the years from 2003 to 2004, respectively, while the average recharge for two years, was estimated as 7.5% using Chloride Mass Balance method. The study has further revealed that a minimum of 104.3 mm cumulative rainfall was required to produce 1 mm of recharge from the water storage structures. An empirical linear relationship was found to reasonably connect the changes in the chloride concentration with the water table rise or fall in the study area.

Sturm *et.al* (2009) described Rainwater Harvesting as an alternative water resource in rural sites in Central Northern Namibia and presented the results of the examinations of rainwater harvesting (RWH) in central northern Namibia as a part of the trans-disciplinary research project Cure Waters (Cuvelai-Etosha Basin in central-northern Namibia). On the basis of various conditions, suitable solutions for RWH were developed, and evaluated. The main aim was to analyze their technical and economical feasibility as well as their affordability for future users. In detail, two small-scale RWH systems were investigated i.e., roof catchments using corrugated iron roofs as rain collection areas and ground catchments using treated ground surfaces.

Subash Chandra *et al.* (2011) developed lithologically Constrained Rainfall (LCR) method for quantifying spatio-temporal recharge distribution in crystalline rocks of Bairasagara watershed and Maheshwaram watershed of India. The LCR method requires three input criteria i.e. vadose zone thickness, soil resistivity, and precipitation. The average recharge at Bairasagara watershed was found varying from 7.5% to 13.8% with a mean of 10.5% during 1990-2002. The study concluded that the LCR was a generalized, least cost method developed to quantify natural recharge spatially and temporally from rainfall in hard rock terrain.

IV. Methodology

HYDROLOGICAL ANALYSIS

On the basis of experimental evidence, Mr. H. Darcy, a French scientist enunciated in 1865, a law governing the rate of flow (i.e. the discharge) through the soils. According to him, this discharge was directly proportional to head loss (H) and the area of cross-section (A) of the soil, and inversely proportional to the length of the soil sample (L). In other words.

$$Q \propto H/K \times A$$

Where:

Q = Runoff

Here, H/L represents the head loss or hydraulic gradient (I),

K is the co-efficient of permeability hence, finally,

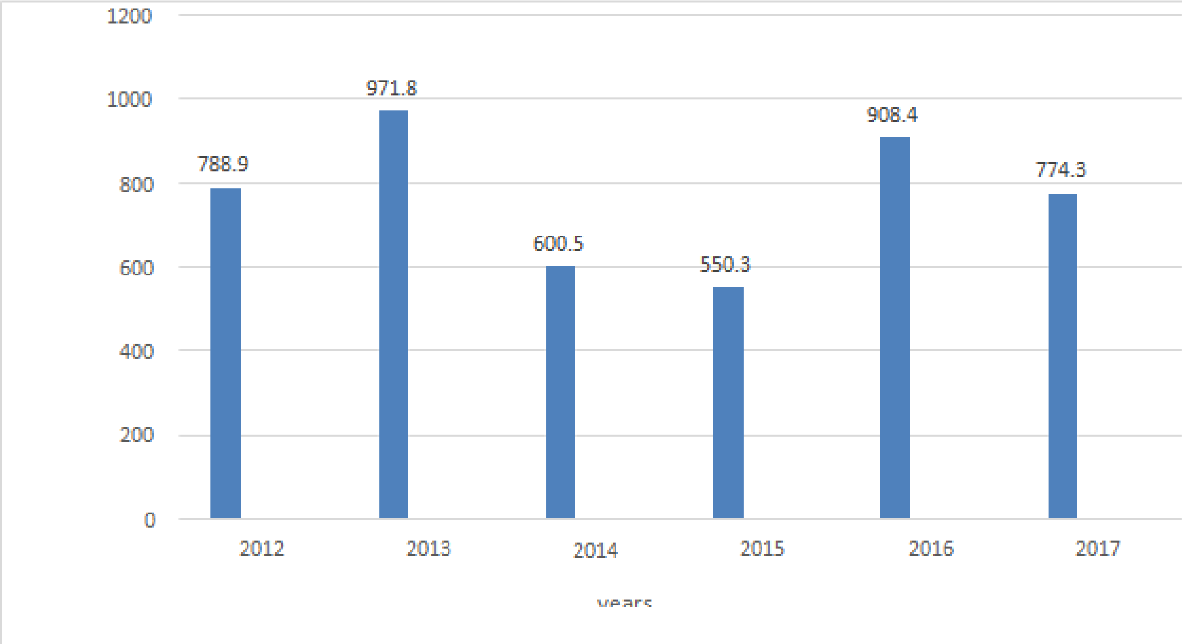
Q = K. I. A.

Similarly, based on the above principle, water harvesting potential of the catchment area was calculated.
The total amount of water that is received from rainfall over an area is called the rainwater legacy of that area. And the amount that can be effectively harvested is called the water harvesting potential. The formula for calculation for harvesting potential or volume of water received or runoff produced or harvesting capacity is given as: -

Volume of water Received (m3) =
= Area of Catchment (m2) X Amount of rainfall (mm) X Runoff coefficient

Runoff coefficient for any catchment is the ratio of the volume of water that runs off a surface to the volume of rainfall that falls on the surface. Runoff coefficient accounts for losses due to spillage, leakage, infiltration, catchment surface wetting and evaporation, which will all contribute to reducing the amount of runoff.Runoff coefficient varies from 0.5 to 1.0. In present problem statement, runoff coefficient is equal to 1 as the rooftop area is totally impervious. Eco-Climatic condition (i.e. Rainfall quantity & Rainfall pattern) and the catchment characteristics are considered to be most important factors affecting rainwater Potential.

Graph:1



V. Methods

- ❖ RATIONING METHOD (RM)
- ❖ RAPID DEPLETION METHOD (RDM)

6.1 RATIONING METHOD (RM):

The Rationing method (RM) distributes stored rainwater to target public in such a way that the rainwater tank is able to service water requirement to maximum period of time. This can be done by limiting the amount of use of water demand per person. Suppose in this method, the amount of water supplied to student is limited which is equal to say, 45lt/day per capita water demand.

Again, Number of students in institute=1500

Then, Total amount of water consumption per day = 1500x0.045 = 67.5 m3/day

Total no. of days we can utilize preserved water = stored water/water demand

For total campus, volume of water stored in tank was taken approx. = 3000m3

Hence finally, no of days = 3000/67.5=44.44 days (or 1.5 months)

For long term storage of preserved water in good condition, preserving chemical should be added.

6.2 RAPID DEPLETION METHOD (RDM):

In Rapid Depletion method, there is no restriction on the use of harvested rainwater by consumer. Consumer is allowed to use the preserved rain water up to their maximum requirement, resulting in a smaller number of days of utilization of preserved water. The rainwater tank in this method is considered to be only source of water for the consumer, and alternate source of water has to be used till next rains, if it runs dries.

For example, if we assume per capita water demand =100lt/day = 0.1m3 /day Total amount of water consumption per day =1500 x0.1 =150 m3/day

Total no. of days, preserved water can be utilized = stored water/water demand

= 3000/150

= 20days

Hence, finally it is observed that, if the amount of water stored is equal to 3000 m3, then applying

1. RDM, consumer can only utilize the preserved stored water for about44.44day,
2. Where as in RM, preserved stored water can be utilized for a period of 20days.

VI. Types Of Tank

Two type of tank can be used for storing of rainwater discharged from the roof

- LINED STORAGE TANK.
- UNLINED STORAGE TANK.

In lined storage tank, earth work excavation is do ne and underground RCC water storage tank is constructed which is completely covered from the top. The land above the tank can be used for serving as playground or parking slot, etc. In unlined natural storage tank, earth excavation is done and all the water being allowed to fall directly in that pit and store it. In this method, we get two advantages. Firstly, our natural water gets recharged leads to augmentation of water level and ground condition, increasing prospects for better future cultivation and plantation. Secondly, underground water can be extracted anywhere within some limited areas from that pit and can be used to satisfy daily water demand.

VII. Results

In this section, we need to find out the optimum or best location for underground tank or recharging point if harvested water decided to recharge the underground reservoir. By implementing this project, we can arrest the problem of scarcity of water in the SDES campus.

- The total measure of annual rain water is**765mm.**
- The total amount of water collected in one year is upon**2500m^3/year.**
- Fordesigningofstoragetankistaken30%ofaverageannualrainfallistakenas230mm.
- Due to economic reasons tank is designed as 30% intensity ofrainfall.
- Hence, the tank is designed to the dimensions of **4×90×90m** of twonumbers.

VIII. Conclusion

This paper dealt with all aspect of improving the water scarcity problem in the SDES campus by implementing ancient old technique of rainwater Harvesting. Two alternatives have been suggested for tank design, which takes separate approaches towards the consumption of harvested rainwater. These results are given clearly in the table no. 11. Hence from this table, we can draw out a conclusion that a huge amount of water got collected from the rooftop surfaces of all the entire buildings. It is concluded that RCC tank which is to be constructed should be an underground one, so that upper surface of the tank can be utilized economically for any land purpose such as playground or cycle stands or any such small structure.

Hence it was finally concluded that implementation of RAINWATER HARVESTING PROJECT to the campus of SDES will be the best approach to fight with present scenario of water scarcity in all aspects, whether it is from financial point of view or from optimum utilization of land surface. Therefore, water is highly a precious natural resource which is always in high demand in the campus of SDES and thus, RAINWATER HARVESTING AT SDES campus is highly recommended.

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