

Design of Rooftop Rainwater Harvesting Tank for Katpadi Region, Tamil Nadu

Shubham Jain^{#1}, Pankaj Thakur^{#2}, Siddharth Singh^{#3}, Mehul Srivastava^{#4}

[#]School of Mechanical and Building Sciences
VIT University, Vellore-632014, India

Abstract — Rainwater harvesting introduced in Tamil Nadu in 2001, by the State Govt., has had substantial influence on the availability of drinking water for the people. It has been implemented on more than 95% of the households and other commercial buildings in the state. In this study an attempt has been made to study the design of roof top rainwater harvesting tank for Katpadi region Vellore district of Tamil Nadu. Based on the rainfall and population density data of the year 2014, the design parameters for the rain water harvesting system have been developed and thus an optimum tank size has been determined. Study reveals that an optimum tank size of 23 m³ is sufficient for the maximum storage of rainwater water during the dry season.

Keywords — Catchment Area, Rain Water Harvesting, Roof top, Runoff.

I. INTRODUCTION

Rain water harvesting and storage is not a contemporary practice but has been a part of human civilization since ancient historic times. Studies by Central Ground Water board suggest that the ground water in many parts of India would dry up till the year 2025, and hence an effective and efficient way is required to cope up with the decreasing ground water levels. One such method is by practicing Roof top rainwater harvesting for domestic use.

Practicing rainwater harvesting improves both the quality and quantity of ground water as suggested by a case study in Jamia Millia Islamia, New Delhi [1]. Also studies done on rainwater in Dhaka City suggest that the rainwater quality is sufficiently good for domestic use and the method is cost effective to be used during critical periods as well as normal periods [2].

The Storage of rain water above or beneath earth surface is a traditional technique and different structures are used for this purpose mainly Underground tanks, ponds, check dams, weirs, etc. on the contrary recharging ground water using rainwater is a fairly new concept and structures mainly used are recharge Pits, recharge trenches, dug wells, hand pumps, Gravity head recharge wells, recharge shafts, Lateral shafts with bore wells, etc [3]. Since our study is to correlate the rainfall and population density of the

Katpadi region to assert an optimum tank size for adequate rainwater conservation using traditional & eco-friendly Rooftop harvesting system (RTHS).

The rain water harvesting movement launched in 2001 by Tamil Nadu government is a foundation of prosperous Tamil Nadu that will be free from water scarcity problems. It has had a prodigious impact in recharging the ground water table in the state. Amendments made to Section 215 (A) of the Tamil Nadu District Municipalities Act, 1920 and Building Rules 1973, have made it indispensable to provide RTHS in all new buildings [4]. Adequate measures have been taken to rejuvenate the pre-existing Rain Water harvesting structures (RWHS) in public and private buildings, besides laying down new buildings in the region. Information Education and communications (IEC) activities are being regulated in Town Panchayat areas to sustain the momentum of the program.

Similar study on design of rooftop rainwater harvesting system in Mysore district suggested a storage tank size of 706 m³ for rooftop area of 11107 m² [5]. While designing a RWH tank, the ratio of tank Volume to catchment area (V/A) shall be between 0.15-0.2 m but it varies with the rainwater demand to catchment area ratio (D/A) which lies between 0.001-0.02 m/day [6].

II. METHODOLOGY

A. Study Area

Katpadi is a locality in the northern part of Vellore city in the state of Tamil Nadu, India as shown in Fig. 1. It lies north to the Palar river. Katpadi is located 213 meters above sea level at co-ordinates 12.98°N, 79.13°E. It lies 216 m above sea level. The average maximum temperature recorded during summer season is 45°C which slumps down to 10°C during winter season [7]. The area has a semi-arid climate with alarming high temperatures prevailing throughout the year and profuse rainfall. Average yearly rainfall (1098mm) is measured at a Rain Gauge located in Katpadi and rainfall data collected from “State Ground and surface water resources data Centre, Chennai”. The rainfall data of the year 2014 rainfall data was used for study.



Fig. 1 Map of Vellore District, Tamil Nadu

B. Design of roof top rainwater harvesting system

The mean average yearly rainfall in the study area is 1291.9 mm and a 4 month dry season. The roof area is taken to be 50 m² for a household of 5 members. The runoff coefficient is taken to be 0.9 [8]. There are 5 members in a household and average rainwater consumption of 20 litres per person per day [9] and thus require 36500 litres per year or about 3050 litres per month. Water supply = roof area * rainfall * runoff coefficient, which is equal to 58095 litres per year. In order to meet the annual water demand 36500 litres is necessary.

The max difference between cumulative demand and cumulative storage gives the volume of the tank which can be obtained from Fig 3.

**III. TABLE I
RAIN WATER STORAGE AND DEMAND
CALCULATIONS**

Month	Rainfall (mm)	Runoff (m3)	cumulative storage (m3)	Cumulative demand (m3)	Difference (m3)
Jan	0	0	0	3.05	-3.05
Feb	0	0	0	6.1	-6.1
March	0	0	0	9.15	-9.15
April	0	0	0	12.2	-12.2
May	138.8	6.246	6.246	15.25	-9.004
June	148.2	6.669	12.915	18.3	-5.385
July	82.3	3.7035	16.6185	21.35	-4.7315
August	170.4	7.668	24.2865	24.4	-0.1135
Sept	350.6	15.777	40.0635	27.45	12.6135
Oct	275.8	12.411	52.4745	30.5	21.9745
Nov	76.8	3.456	55.9305	33.55	22.3805
Dec	49	2.205	58.1355	36.6	21.5355

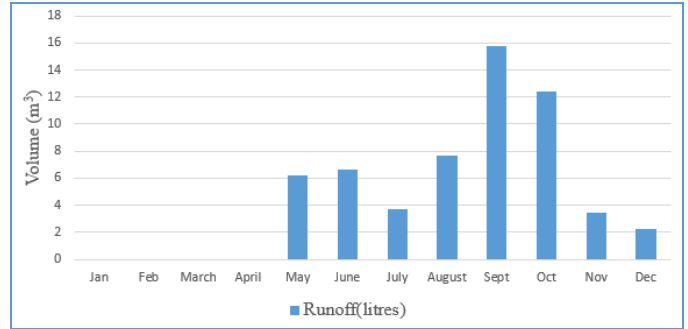


Fig. 2. Roof Top Runoff Volume in Katpadi during Year 2014.

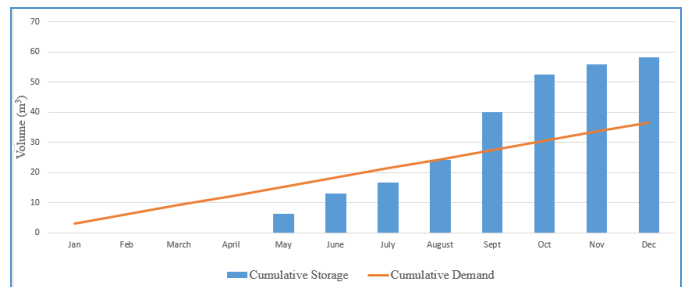


Fig. 3. Cumulative Storage and Demand of Katpadi during Year 2014.

IV. RESULTS

1. The cumulative storage is less than the cumulative demand from the month of January to August whereas cumulative storage exceeds the cumulative demand from September to December as the rainfall is quite significant in these months.

2. The optimum size of rain water harvesting tank for a 5 member family living under a roof of size 50 m² in Katpadi region is 23 m³.

3. The ratio of rainwater demand / Catchment area is 0.002 m/day.

4. The ratio of Tank Volume/ Catchment area is 0.46 m.

V. CONCLUSION

With the decreasing trend of ground water level in India, Roof top rainwater harvesting can prove to be highly beneficial for providing water for domestic purposes and this system can be implemented in states other than Tamil Nadu as well. The yearly rainfall can be harvested to supply a minimum of 20 litres of water per person per day by installing a tank of size 23 m³ in for a catchment area of 50 m². Thus the rainwater collected in the monsoon season can be used during the dry period and thus minimizing the ground water withdrawal.

REFERENCES

[1] Mohd. Saleem, Muqem Ahmed, Professor Gauhar Mahmood, Dr. S.A.M. Rizvi. Analysis of Groundwater Quality Improvement Using Rainwater Harvesting: A Case Study of Jamia Millia Islamia, International Journal of

- Modern Engineering Research (IJMER), Vol. 2, Issue. 5, Sep.-Oct. 2012 pp-3912-3916.
- [2] Sadia Rahman, M. T. R. Khan, Shatirah Akib, Nazli Bin Che Din, S. K. Biswas, and S. M. Shirazi, "Sustainability of Rainwater Harvesting System in terms of Water Quality," The Scientific World Journal, vol. 2014, Article ID 721357, 10 pages, 2014. doi:10.1155/2014/721357.
- [3] Che-Ani A.I, Shaari N, A. Sairi, M.F.M. Zain, M.M. Tahir, Rainwater Harvesting as an Alternative Water Supply in the Future, European Journal of Scientific Research, Vol.34 No.1 (2009), pp.132-140.
- [4] Tamil Nadu Govt. information website. [Online]. Available: <http://www.tn.gov.in/dtp/rainwater.html>.
- [5] Ramya R, Rudrappa Shetahalli. Design of Rooftop Rainwater Harvesting System for the Administrative Block of V.V.C.E., Mysore. Indian Journal of Applied Research, Vol.5, Issue 1, Jan 2015.
- [6] J.S. Mun, M.Y. Han. Design and operational parameters of a rooftop rainwater harvesting system: definition, sensitivity, and verification. Journal of Environmental Management, Vol.93, Issue 1, 2012, pp. 147-153.
- [7] Details on Katpadi region. [Online]. Available: <https://en.wikipedia.org/wiki/Katpadi.html>.
- [8] S. K. Garg, "Hydrology and runoff computation, Irrigation Engineering & Hydraulic Structure", 1987, pg. 674.
- [9] Pawar C.B., Patil S.S. and Pawar R.P. A Case Study of Rooftop Rainwater Harvesting of Renavi Village in Sangli District of Western Maharastra: New approach of watershed development in India. African Journal of Agricultural Research. Vol 9(25), pp. 1941-1947.