Roof Top Rain Water Harvesting in Rural Areas: A Case Study of Vidhani Village, Jaipur

Rakesh Kumar Saini, Yaspal choudhary,
Mohit Kumar, Himanshu Meena
Department of Civil Engineering
Poornima Group of institutions, Sitapura, Jaipur

***Abstract* -In present scenario we are facing water problem in rural areas due to lack of portable water and supply system. Rajasthan has been always facing such problem due lack of rain as well as day by day decreasing water level of water table. People living in village areas are facing problem of water scarcity, water contamination and shortage of proper water sources in Rajasthan. 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. In last few years it has been observed that there has been change in rainfall pattern in Rajasthan region. The rainfall intensity has increased considerably in these years. Since the time of rainfall is less and intensity is more the runoff of storm water has also increased. In our study we are trying to store storm water by roof top rain water harvesting using cheapest material and simplest design special for rural areas. This project will ensure use of storm water during rainy season will help in ground water recharging for dry season as well as villagers will get contamination free water during monsoon.**

Keywords: Roof Top Harvesting,

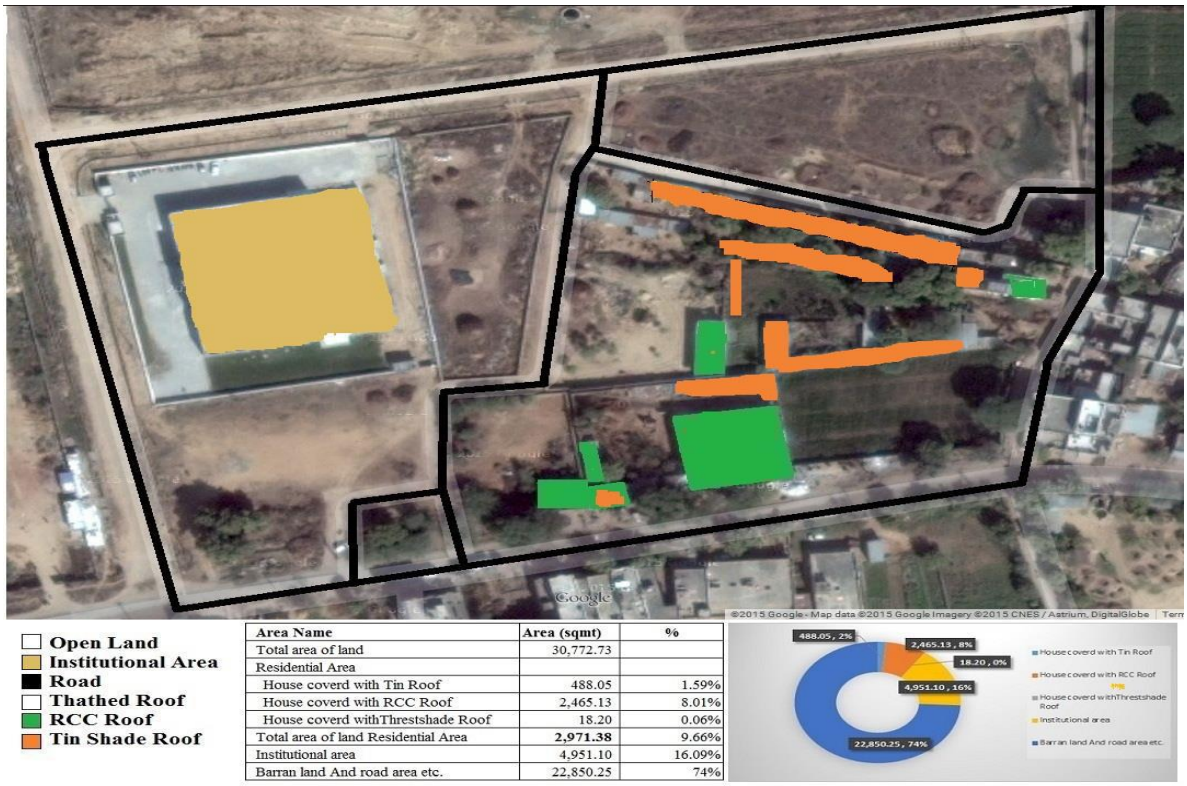
I. INTRODUCTION

Rainwater Harvesting is a simple technique of catching and holding rainwater where its falls. Either, we can store it in tanks or we can use it to recharge groundwater depending upon the situation.

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.

II. STUDY AREAS

As discussed earlier in the section of introduction – importance of rainwater harvesting at Vidhani village, we clearly came to know the all the advantages which we can draw out by implementing this small but highly efficient technique in the campus. Thus to increase the potential, benefits of this system and draw maximum advantages from it, we need to have large rooftop areas which will be going to act as catchment areas. More the catchment areas more will be the surface runoff and thus more will be the amount of harvested water. Therefore as much as possible, we have included and considered all the major buildings having large rooftop areas. Hence, study areas includes residence, one institutional building. Given below a satellite picture, fig no.4, showing majority of the buildings considered for rainwater harvesting system at Vidhani village Jaipur.



Area Name	Area (sqmt)	%
Total area of land	30,772.73	
Residential Area		
House coverd with Tin Roof	488.05	1.59%
House coverd with RCC Roof	2,465.13	8.01%
House coverd withThrestshade Roof	18.20	0.06%
Total area of land Residential Area	2,971.38	9.66%
Institutional area	4,951.10	16.09%
Barran land And road area etc.	22,850.25	74%

Fig. 1. VIDHANI VILLAGE, JAIPUR (Google Earth)

III. DATA COLLECTION

3.1 Rainfall Data Collection

The latitude 26.7745355 and longitude 75.8795378 are the geo coordinate of the Vidhani.
Vidhani is small village has total 103 families residing.
Vidhani Village is located at latitude 26.7745355N and longitude 75.8795378E in Jaipur district of Jaipur at an elevation of about 219 meters above mean sea level. Vidhani has a tropical climate and receives moderate rainfall during Southwest monsoon (June-September) and retreating

Northeast monsoon (December-January). Average annual rainfall ranges between 650mm.
The average monthly rainfall data are being taken from the Orissa premier Science and Technology organization, National Informatics Centre (NIC), Bhubaneswar. Again it's followed that, „Vidhani" is a village and thus has a uniform average rainfall throughout the city in all location. Thus monthlyrainfall data of the Jaipur city is given below in the table no.1 which is assumed to be same for the station of Vidhani.

TABLE-1RAINFALL DATA

Year : 2012					
District	Station	Catchment	Annual Rainfall	Annual Rainy Days	Highest Daily Rainfall
Jaipur	Amber	408	788.5mm	35	142mm On 22 Aug 2012
Jaipur	Bairath	403	649mm	35	132mm On 22 Aug 2012
Year : 2013					
District	Station	Catchment	Annual Rainfall	Annual Rainy Days	Highest Daily Rainfall
Jaipur	Amber	406	854.0mm	46	96mm On 12 July 2013
Jaipur	Bairath	403	931mm	48	147mm On 09 July 2013

IV.DETERMINATION OF CATCHMENT AREA

The rooftop surface area is nothing but the catchment area which receives rainfall. Catchment areas of the different Houses and Institutional building are measured. This measurement was done manually with the help of „reinforced fiber tape‟ which is the simplest technique known as „tape survey‟. Before using the tape, tape was checked for any zero error and also length of the tape was also carefully checked for its accuracy. Those places which area not accessible to land on, are measured by using the ruler from tool box of „Google Earth‟. Given below the table no. 2 for calculated the rooftop areas of all the buildings suited inside the Village

TABLE-2 CATCHMENT AREA

Sr. No.	Particulars of items	Nos.	Length	Width	Quantity (SqMeter)
1	Roof type 1	1	9.80	4.00	39.20
2	Roof type 2	1	9.70	3.45	33.47
3	Roof type 3	1	9.90	3.45	34.16
4	Roof type 4	1	8.50	3.90	33.15
5	Roof type 5	1	30.20	3.90	117.78
6	Roof type 6	1	24.50	3.00	73.50
7	Roof type 7	1	2.80	6.00	16.80
8	Roof type 8	1	40.00	3.50	140.00
Total Quantity		488.05			

TABLE-3 HOUSES WITH RCC ROOF

Sr. No.	Particulars of items	Nos.	Length	Width	Quantity (SqMeter)
1	Roof type 1	1	40.00	25.00	1,000.00
2	Roof type 2	1	50.00	15.00	750.00
3	Roof type 3	1	17.50	19.30	337.75
4	Roof type 4	1	10.60	7.30	77.38
5	Roof type 5	1	20.00	15.00	300.00
Total Quantity		2,465.13			

Sr. No.	Particulars of items	Quantity (SqMeter)
1	House covered with Thatched Roof	18.2
2	Institutional Area covered with RCC Roof	2970.66

TABLE-4 MATERIAL AND COST ANALYSIS FOR UNDERGROUND TANK

Sr. no.	Particular	No.	Length(m)	Breadth(m)	Height/ depth(m)	Quantity(m3)
1	Earth work in excavation	1	2.50	2.00	1.00	**5.00**
2	Cement concrete 1:3:6 in foundation	1	2.50	2.00	0.10	**0.50**
3 I class brick work in 1:4 cement mortar						
Long wall		2	2.50	0.01	1.00	0.05
Short wall		2	2.00	0.01	1.00	0.04
Total Quantity				**0.09**		
4	R.C.C work for slab as cover	1	2.50	2.00	0.12	**0.60**
5 12mm plastering inside with 1:4 cement mortar						
Long wall		2	2.50	0.01	1.00	0.06
Short wall		2	2.00	0.01	1.00	0.05
Below slab as cover		1	2.50	2.00	0.01	0.06
Total Quantity				**0.17**		

5. OPTIMISTIC DETERMINATION OF SIZE & TYPES OF TAN

Just to start with, now let us consider only one house and proceed with calculation in details. And all the calculation in the later part of this project will be adopted for rest of the building. The total rooftop area of the house available for the rainwater harvesting is 2466m2. The cumulative runoff that can be captured from the paved area is calculated the cumulative rainfall runoff at the end of the year is calculated to be 1452m3. The tank capacity can be estimated to be a lower value accounting for the continuous consumption going on during period of rainfall.

6. Computation of Volume of Runoff per Year: As we know the formula for runoff discharge from section 3.1. is Total roof area of houses was calculated = 2,465m2 Average annual rainfall at Jaipur=650mm/year = .65 m3 /year Total volume of surface runoff water supposed to be collected=2465 x .65 = 1602m3/year

TABLE-4 COST ANALYSIS FOR UNDERGROUND TANK

Sr no	Particular	Quantity	Rate	Cost(Rs)	Unit
1	Earthwork in excavation	5.00	350.00	1,750.00	Cum
2	Cement concrete 1:3:6 in foundation with brick ballast	0.50	5,000.00	2,500.00	Cum
3	I class brickwork 1:4 cement mortar	0.09	3,500.00	315.00	Cum
4	R.C.C work for slab cover	0.60	6,000.00	3,600.00	Cum
5	12mm plastering inside with 1:4 cement mortar	0.17	3,000.00	504.00	Sqmt
Total Amount			8,669.00		
Water Charges		1.50%		130.04	
Engineering profit		10%		866.90	
Grand Total		9,665.94			

TABLE-5 TOTAL EXPENDITURE

Total Cost Analysis		
Sr. no.	Particulars	Rupees
1	Catchment area repairing	30000
2	Tin Shade roof	20174.29
3	RCC Roof	20576.81
4	Tiled Roofing over thached	2000.00
5	Institutional Area	24913.00
6	Filter	5000.00
7	Tank	9800.00
8	Contingency & other costs	8,000.00
9	Contingency & other costs	1,806.96
Contingency & other costs	9,227.11	
TOTAL	**131498.2**	

CONCLUSION

It is no denying that sustaining and recharging the groundwater along with judicious use of the limited fresh water resources is the need of the hour. If sufficient measures are not taken up immediately, we will face a crisis which will be detrimental to the very survival of mankind. Efficient management of water resources and education about judicious utilization of water resources along with measures of harnessing, recharging and maintaining the quality of water and water bodies has to be taken up on war footing. One of the most logical steps towards this goal would be acknowledging the importance of rainwater harvesting. This should not only encompass rooftop rainwater harvesting but also storm water harvesting systems. Storm water harvesting is yet to be acknowledged as a better alternative over rooftop water harvesting. One of the major hurdles in storm water harvesting is the poor state of storm water drain systems in India. A planned approach is hence needed in order to fully utilize the potential of rainwater to adequately meet our water requirements.

REFERENCES

[1] A Water Harvesting Manual for Urban Areas: Case Studies from Delhi. 2003. New Delhi: Centre for Science and Environment.
[2] Centre for Science and Environment. 2003. Site dedicated to Rainwater Harvesting. Accessed on various dates at Delhi, Central ground Water Board,
[3] Government of India Ministry of Water Resources. Government of India. 2003. Details on Water Harvesting. Accessed on various dates at http://www.cgwaindia.com/
[4] Key Issues. September 2000. Water harvesting: urgent need to reap rich rewards [Article] Indian Energy Sector, TERI 2000. Accessed on 15 May 2003 at http://www.teriin.org/energy/waterhar.htm
[5] Kumar, M. Dinesh. 2003. Paper: Roof Water Harvesting for Domestic Water Security: Who gains and who loses? Under review.
[6] A Water Harvesting Manual, Centre for Science and Environment http://www.cgwaindia.com/suo/home.htm
[7] http://www.rainwaterharvesting.org/urban/Components.htm
A Water Harvesting Manual, Centre for Science and Environment
[8] IS 1172: Indian Standard Code of Basic Requirements for Water Supply, Drainage and Sanitation. 2003. Ground Water in Delhi: Improving the sustainability through Rainwater Harvesting, Central Ground Water Board, Ministry of Water Resources.
[9] Government of India. 2003. Rainwater Harvesting: A necessity in South and Southwest Districts of NCT, Delhi. State Unit Office.