IJASRM International Journal of Advanced Scientific Research and Management, Volume 3 Issue 2, Feb 2018.
www.ijasrm.com
ISSN 2455-6378

Water Management System – A Case Study

Shivanna, S., Vyshnavi, D.R., H.P. Mahendrababu

Department of Civil Engineering , Sir.M Visvesvaraya Institute of Technology,
International Airport Road, Bangalore-562 157.

Abstract

Rain water harvesting system has becoming more and more important in recent years. Groundwater is the most dependant source of water for the day to day requirement for various needs in the absence of alternate sources of water supply. This is true particularly in urban pockets where some of the establishments depend mostly or wholly on groundwater sources for their needs. The rain water falling on a square kilo meter of land area in one year, if properly utilized will make significant changes in the water budget of a region and augment the water system. Sir M Visvesvaraya Institute of Technology (Sir MVIT) is having a total area of 131 acres, out this 6 acres is occupied by the buildings and it is a perfect location to implement the rain water harvesting through roof top structure as well as other rain water harvesting strictures. The study area is falling in latitude N 13^0 08' 30'' and longitude E 77^0 36' 00'' falling in Survey of India Topo sheet No. 57 G/12. The area forms part of Southern plateau and it is an undulatory terrain with rocky ridges at certain places. Geologically the area is underlined by massive granitic gneisses intruded by dyke rocks. Ten bore wells have been drilled at different places in the campus to supply water for day to day demand. At present only two bore wells are in working condition and they are yielding 2000 litre per hour by each bore well. But this water is not sufficient and it meeting only 20% of the demand. The rest of the water required has been met from outside suppliers through tankers by paying large sums. In the study area the normal rainfall ranges from 0.8mm in January to 187mm during September. The average annual rainfall is 946.1mm. An attempt has been done to harvest rain water for 150 rainy days in a year through roof top rain water structures, which intern reduces supply of water from outside atleast during 150 rainy days. At present the college is purchasing 3,26,000 litres per day and it is meeting 80% of the demand only by paying Rs. 17,600/- per day.

Key words: *Rainfall, Rain Water Harvesting, Groundwater, Roof Top, Sir MVIT*

1. Introduction

Groundwater is most dependent source of water for the day to day requirements for various needs in the absence of alternate source of water supply. At present SIR M Visvesvaraya Institute of Technology (Sir MVIT) depends for water requirements through local supply by tankers of different capacities to a tune of 80% involving huge expenditure on the Institute budget and remaining 20% is met by the existing tube wells in the campus. It is also observed that these tube wells are showing reduction in discharge. This is due non-existence rain water harvesting structures to recharge ground water body. The Institute has an area of 135 acres area of land and it is a perfect location to implement rain water harvesting and artificial recharge to ground water through different conservation structures over a period of time. With the natural resources available in the form of rain, roof top rain water harvesting in three units can be implemented to harvest rain water. This water can be stored during 150 rainy days and it will reduce the supply from outside [4,2,3].

2. Objectives of the Study

The main objective of this study is to develop roof top rain water harvesting system for direct use to minimize the local purchase of water through tankers during rainy season for curtailing the expenditure to the Institute. It also improves the yield of the existing bore wells and water quality The source for this development is the effective utilization of rain water falling on the roof tops otherwise it will be going as run off.

3. Location

Sir MVIT campus is located 1.5 kms west of Hunasamaranahalli on Bangalore-Hyderabad National Highway (NH-7). The institute encompasses 135 acres of land falling in Latitude N 13^o 08' 30" – Longitude E 77^o 36' 00" falling in Survey of India Topo sheet No. 57G/12. The study area is well connected with network of roads, railways and airport.

IJASRM International Journal of Advanced Scientific Research and Management, Volume 3 Issue 2, Feb 2018.
www.ijasrm.com
ISSN 2455-6378

Table: 1 – Showing Climatological Parameters of the study area.

Month	Temperature °C		R.H %		Rainfall	PET	Wind speed
	Max.	Min.	830 hrs	1730 hrs	mm	mm	Kmph
Jan	26.7	15.0	77	40	3.3	117.4	10.4
Feb	29.7	16.5	67	29	10.2	130.0	9.7
Mar	32.3	19.0	63	24	6.1	166.2	9.4
Apr	33.4	21.2	70	34	45.7	158.2	9.0
May	32.7	21.1	75	46	116.5	156.5	11.8
Jun	28.9	19.7	82	62	80.1	126.5	17.1
Jul	27.2	19.2	86	68	116.6	115.7	17.5
Aug	27.3	19.2	86	66	147.1	114.2	15.2
Sep	27.6	18.9	85	62	142.7	108.2	12.1
Oct	27.5	18.9	83	64	184.9	105.1	8.2
Nov	26.3	17.2	78	59	54.3	98.3	8.5
Dec	25.7	15.3	78	51	16.2	102.9	9.6
Annual	28.8	18.4	77	50	923.7	1500.5	11.5

4. Physiography and Drainage

The study area forms as a part of Southern plateau of Indian subcontinent. It is an undulatory terrain and at certain places it exhibits rocky ridges of granitic gneisses. The area is 906-915m above mean sea level and the major drainage in the areas. soil. The maximum temperature is 38^{o} C during March=April and it falls gradually to around 26^{o} C during December-January. Various climatological parameters for the study area are shown in Table - 1. The area remains humid throughout the year and the wind speed attains a maximum during southeast monsoon period ranging from 15 to 17 km per hour

Table-2: Statistical Analysis of Rainfall data for the study area.

Month	Mean	Std.Dev.	Coeff. Var	Highest Rainfall		Lowest Rainfall		Rainfall as % of annual
	(mm)	(mm)	(%)	(mm)	Year	(mm)	Year	
Jan	1.2	3.9	333.1	18.6	1986	0	1971	0.13
Feb	7.4	16	216.2	57.9	2000	0	1972	0.78
Mar	13.4	25.5	189.7	101	1981	0	1972	1.42
Apr	37.3	31.8	85.3	96.8	1976	0	1994	3.94
May	102.4	44.6	43.6	200.6	1999	0	1994	10.82
Jun	92.1	64.9	70.4	226.5	1983	16	1981	9.73
Jul	106.3	60.5	56.9	246.3	1975	36	1997	11.24
Aug	138.8	79.4	57.2	383.8	1998	45	1984	14.67
Sep	224.3	111	49.5	516.6	1986	80.3	1994	23.71
Oct	153.4	80.2	52.3	325	1997	10	1988	16.21
Nov	51.6	51.1	99	181	1991	1	1996	5.45
Dec	17.9	23.1	129.2	82.1	1993	0	1974	1.89

is Vrishabavathi and Pinakini and ultimately joins river Arkavathi. The major part of the study area is covered by red

5. Rainfall

Rain fall is the primary source of ground water and other sources are seepage from surface water bodies. An attempt has been made to study rain

IJASRM International Journal of Advanced Scientific Research and Management, Volume 3 Issue 2, Feb 2018.
www.ijasrm.com
ISSN 2455-6378

fall, its distribution and periodicity based on statistical approach (Table – 2).
The monthly normal rain fall ranges from 0.8 mm in January to 187mm in September. The average annual rainfall is 946.1mm. Monthly and annual rainfall statistics, seasonal statistics for the Yelahanka Rain gauge station are shown in Table3.

Table-3: Seasonal and Annual Rainfall in the study area.

Mar – May			Jun – Sep			Oct – Dec			Annual		
Mean mm	Std. Dev	Coef. Var. (%)	Mean mm	Std. Dev.	Coef. Var. (%)	Mean mm	Std. Dev.	Coef. Var. (%)	Mean mm	Std. Dev	Coef. Var. (%)
153.1	66.8	43.7	561.5	183.7	32.7	222.9	107.4	48.2	946.1	237.4	25.1

6. Groundwater Condition

The occurrence and movement of groundwater is through secondary porosity developed from the erosion and structural deformation undergone by the rocks. The groundwater conditions prevailed in Archean crystalline province is mostly under unconfined to semi-confined condition. The rocks have undergone different degree of weathering with fissures and fractures [11]. The movement groundwater is through weathered zone and it varied in thickness from 10 to 20 metres. The productivity.

Table - 4 Details of groundwater abstraction structures in the campus.

Sl No	Location	Type of structure	Water level m. (bgl)	Depth (m.)	Remarks
1	Near Ladies Hostel	Open well	GL	5	Seepage water- well dries up in summer
2	Ladies Hostel	Bore well	20	60	Well in use. Discharge approx. 2000 litrs / hour
3	Near boys	Bore well	25	200	Well in use. Discharge approx. 1000 litrs / hour
4	Near Open well	Open well	GL	12	Withstands even in summer also. The well should be put to use effectively. Discharge approx. 4000 litrs / hour
5.	Near Boys mess	Bore well	NA	NA	Reported yielding more than 2000 ltrs/ hour. The well should be put to use effectively
6	Opp. Mess block	Bore well	NA	NA	Abandoned due to poor yield
7	PG Hostel	Bore well	NA	NA	Reported yielding more than 1000 ltrs/ hour.
8	Adj. mess block	Bore well	NA	NA	Abandoned.
9	Old Bore well	Bore well	NA	NA	Pump & Motor fallen in the bore. Good source. Withstands more than 12 hours / day Reported yielding more than 2000 ltrs/ hour. The well should be put to use effectively
10	New Bore well	Bore well	NA	NA	Reported yielding more than 2000 ltrs/ hour. The well should be put to use effectively.

of aquifers generally depends on the precipitation in general and weathered zone, fissures and fractures in particular. The area is categorized as over-exploited, where the stage of groundwater withdrawal is more than groundwater recharge. The situation leads to decline in groundwater, reduction in discharge of bore wells leads to dry after some time if remedial measures are not taken [3]. The groundwater abstraction structures in the study area are shown in Table – 4

IJASRM International Journal of Advanced Scientific Research and Management, Volume 3 Issue 2, Feb 2018.
www.ijasrm.com
ISSN 2455-6378

7. Land Use

Out of 131 acres of land in the college campus, about 6 acres are occupied with buildings, 44 acres with green area development, 6 acres with roads and pavements and 75 acres is occupied with number of pay grounds.

8. Water Requirement

The water requirement of the Sir MVIT establishments in the 131 acres campus is essentially for various colleges, hostels, staff quarters gardens etc.

Total area of the Institute	5,46,480 m^2 (135 acres)
Roof Top of the Buildings	24,288 m^2 (6 acres)
Paved and Road area	24,288 m^2 (6 acres)
Greenland/Vegetation	1,78,112 m^2 (44 acres)
Play Grounds	3,03,600 m^2 (75 acres)
Average annual Rainfall in the study area	946.1mm

At present total water requirement is 3,93.600 liters per day. Out of which 65,600 liters per day are pumped from the two existing bore wells and remaining 3,28,000 liters per day are purchased from outside. The outside supply will be done in different size tankers. The conservative estimate spend for purchase of water in year (say 300 days) will be Rs. 55,20,00/-.

The above mentioned demand and expenditure is as on present day position. The demand for local purchase of water goes on increase by about 10% due to rapid development of campus with additional colleges, hostels and staff quarters. Besides this the present groundwater abstraction structures in the campus starts decreasing in yield by 10% every year due to not enhancing recharge to groundwater body. After few years existing two bore wells will go dry. In view of the alarming situation the campus needs a strong rain water harvesting system and it tremendously boost the harvested water for direct use during rainy season and ensure effective recharge to groundwater body. This will ensure the groundwater abstraction structures improve its yield and arrest decline of groundwater levels.

9. Roof Top Rain Water Harvesting System

Rain water harvesting concept involves tapping the rain water where it falls. A major portion of the rain water that falls on the earth's surface run off into streams, rivers and finally reaches to Sea. An average of 8-12 percent of total rain fall recharge only is considered to recharge the aquifers. [1,10] Various components of Roof Top Rain Water Harvesting System are gutter pipes, down pipes, down pipe joint, filter chamber and storage sump. Roof tops need special attention because of certain advantages like Roof top rainwater harvesting is one of the appropriate options for augmenting ground water recharge/ storage in urban areas where natural recharge is considerably reduced due to increased urban activities and not much land is available for implementing any other artificial recharge measure. Roof top rainwater harvesting can supplement the domestic requirements in rural areas as well [10, Ramakrishnan, 2008). Rainwater is safe, free from organic matter and is soft in nature. It improves the quality of ground water through dilution and the structures required for harvesting rainwater are simple, economical and eco-friendly. The roof top available in the campus is shown in Table – 5.

Table- 5: Roof Top Rainwater harvesting from the following buildings.

Sl No	Details	Roof area (m^2)
1	Basic Science Block	245
2	Mechanical Engineering	1,245
3	Electrical & Civil Engineering	1.245
4	Library	700
5	MBA & MCA	1,400
6	New Block	2,809
7	KCDS	2,938
8	KHRC	878
9	Mechanical Workshop	2,530
10	Auditorium	450
11	Transport Shed	750
12	Foundry	221
13	Smithy	195
	Structure 01	**15,606**
14	Ladies Hostel	2,994
15	Staff quarters	769
16	Principal quarters	314
17	Ladies Hostel	1,100
18	Staff quarters	1,100
	Structure 02	**6.277**
19	Men's Hostel Unit - 2	1,300
20	Men's Hostel Unit – 3	296
21	PG Hostel Unit	781
22	Men's Hostel Unit – 1	448
23	Physical Education Block	364
24	Canteen/Shops/ATM	1,010
	Structure 03	**4,199**

9.1 *Rain Water Available for Harvesting*

In the first structure the available roof area (m^2) 15,606 (RTRWH – 15606* 0.85* 0.946) and the

water can be harvested is 84 m ³ / day (150 days during rainy season). In the second structure the roof top available is (sq m) 6,277 and water can be harvested is: 34 m ³ / day (150 days during rainy season). In the third structure the roof top area available (sq m) 4199 and the water can be harvested is: 23 m ³ / day (150 days during rainy season)

Table 6: Total Rain water available from 3 RTRWH structures and the likely cost benefit.

Harvesting Structure	During rainy Season($m^{3)}$ (1000 liters)		Cost benefit (Rs.) @ Rs. 350/-For 5 m^3(5000 liters)	
	Per day	For 150 days	Per day	For 150 days
Structure 1	84	12,548	5,880	8,78,360
Structure 2	34	5,047	2,380	3,53,290
Structure 3	23	3,376	1006	2,36,320
Total	141	20,971	9,266	**14,67,970**

10. Conclusions

The scarcity of water is increasing day by day and there is an urgent need of implementing rain water harvesting structures. At present the institute is purchasing large quantity of portable water from outside by spending Rs. 18,400/- per day for getting 3,28,000 litres per day if roof top rain water harvesting has been implemented in all three structures and they can collect 1,41.000 litres per day and for 150 rainy days it will be 2,11,50,000 litres of water. The institute can save Rs. 11,86,463/- . At present the institute is spending Rs.55,20,000 /- for purchasing water for three hundred days in a year and it meets 80% of the demand. Based on the above reasons roof top rain water harvesting systems is an urgent need.

Acknowledgement:

The authors are thankful to 2013 batch (B.E. Civil Engineering) students Sriram Mustapure, Venkatesh, B.R., Maruthi, P.B. and Pavan Kumar for their help in the field study.

References

[1] Central Groundwater Water Board (2009): Roof top Rain water harvesting system., Special Publication of CGWB, pp.1-16.

[2] L.C. Curtis (1998): Rainwater Harvesting – a possible seasonal addition to Bangalore water supply. Jour. Geol. Soc. India., Volume 51, pp.11-20.

[3] M.C. Reddy (2012): Rainwater harvesting and artificial recharge to groundwater in Sir MVIT, Bangalore (*unpublished report*), pp.1-67.

[4] Radhakrishna, B.P (1997): Rainwater Harvesting (Editorial) Jour. Geol. Soc. India., pp.1-10.

[5] Radhakrishna, B.P (2003): Rain water harvesting, Memmoir 51, Geological Society of India, pp.289-300.

[6] Radhakrishna, B.P (2005): Groundwater Exploitation in Bangalore and other Metropolitan cities. Jour. Geol. Soc. India, Volume.65, pp.397- 402.

[7] Radhakrishna, B.P (2008): Water Supply and Sanitation in the Indian context Jour. Geol. Soc. India, Volume.71, pp.606- 612.

[8] Ramakrishnan, S. (2008): Basics of Groundwater Science and Rainwater Harvesting Techniquecs. Special Publication, Geol. Soc. India., pp.1-74.

[9] Ramasesha, C.S (2011): Roof top rain water harvesting to supplement fresh water supply in greater Bangalore city. Memoir 79, Geol. Soc. India., p. 238.

[10] Subhajyoti Das (2011): Bangalore – Water problems of the faster growing city in India. Memoir 79., Geol. Soc. India., p.89.