JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

RAIN WATER HARVESTING FOR UNIVERSITY B. D. T COLLEGE OF ENGINEERING, DAVANAGERE

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Abstract: The rapid increase of industrialization, urbanization and population increase in the last few decades had caused a dramatic increase in the demand for surface water, as well as ground water. While rain water harvesting system is a best approach to water conservation. The present study area is University B.D.T College of Engineering, Davanagere, Karnataka, India. The data required for estimation of harvesting potential of rain water were collected. It was observed from the study that UBDTCE campus has the potential of collecting 14.80 Million liters of water annually from roof tops of different buildings and 56.63 Million liters of water by runoff from major catchment areas like play grounds, pavements and parks. The collected water can be used for flushing, gardening purposes, further ground water recharging can be done by artificial recharging techniques. Sustainability in water management can be achieved at UBDTCE campus by adopting RWH technique.

Index Terms **- Rain Water Harvesting, Harvesting Potential, Store, Ground Water Recharge.**

I. INTRODUCTION

2.5 percent of Earth's water is fresh water out of which 68.9 percent is of Glaciers and Ice caps, 30.8 percent is locked up in ground. Only 0.3 percent is surface water which serves most of life needs. The rainwater harvesting consists of a wide range of technologies used to collect, store and provide water with the particular aim of meeting demand for water by humans and/or human activities. Educational institutes can play important role in spreading water literacy by establishing Raincenter. That proves to be important step to encourage society. Especially technical institute should take lead in this activity. Before establishing Raincenter its potentiality should be checked so as to design cost effective system for long term use. It is an environmentally sound solution that can prevent many of the environmental issues that are frequently brought on by conventional large-scale projects using centralized methods. A simple method of capturing and storing rainwater as it falls is called rainwater harvesting.

II. OBJECTIVES OF THE STUDY

i. Estimating the harvesting Potential of rain water which can be collected annually from different rooftop area of different buildings located at University B.D.T College of engineering, Davanagere.
ii. Collection and storage of rain water from rooftop of UBDTCE campus.
iii. Estimating the runoff Potential of rain water which can be harvested annually from runoff water of UBDTCE campus.
iv. Recharging the underground water by artificial recharge techniques by using runoff water.

III. STUDY AREA

The city of Davanagere is located in the state of Karnataka in southern India at an elevation of about 602.50 meters above mean sea level. University B.D.T college of engineering (UBDTCE), is situated in the center of Davanagere, Karnataka, India. The location of the study area is 14° 27' 6" N latitude and 75° 55' 3" E longitude. Which is of total area 21.15 acres. Satellite view of the University B.D.T College of Engineering as represented in figure 1.

Figure 1: Satellite view of the University B.D.T College of Engineering, Davanagere

IV. METHODOLOGY

For the proper rain water harvesting system in the study area is need to collect the data which are required for the analyses of complete project and design aspects.

4.1 Rainfall Data Collection

The Annual rainfall data is taken from the power access climate data under India Meteorological Department. Thus Annual rainfall data of the UBDTCE Campus for 20 years is collected. Rainfall data of UBDTCE campus for 20 years as represented in table 1.

Table 1: Rainfall data of UBDTCE campus for 20 years

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual (mm)
2001	0.05	0	0	49.08	58.94	236.79	358.51	217.25	128.21	136.98	25.91	1.1	1212.81
2002	0	8.12	0.17	13.18	60.89	297.14	135.94	306.34	73.92	207.49	8.52	0.03	1111.76
2003	0.07	6.59	14.21	40.81	9.55	311.4	237.55	201.38	65.86	156.87	6.85	5.68	1056.81
2004	0.1	0.16	17.34	26.63	260.54	251.47	339.24	259.69	142.79	74.12	17.78	0	1389.85
2005	5.04	0.36	0.73	64.87	61.13	362.07	638.36	266.34	223.71	145.65	17.03	0.28	1785.56
2006	0.49	0	20.03	12.34	195.87	377.84	292.03	229.12	267.41	159.3	70.24	0	1624.68
2007	0.05	0	3.06	43.14	93.63	529.81	354.54	404.17	404.36	124.67	26.21	3.4	1987.05
2008	0	5.99	144.14	13.9	78.91	287.47	268.32	360.07	183.63	60.75	49.95	1.35	1454.48
2009	0	0	20.86	16.85	101.14	305.15	541.24	254.14	308.43	144.2	114.66	24.19	1830.85
2010	3.66	0	3.15	37.39	80.38	333.59	631.75	323.87	305.14	161.83	209.66	3.64	2094.05
2011	0	0.61	0	66.4	46.72	269.92	431.83	442.82	182.65	74.95	23.89	0.02	1539.81
2012	0	0	0.01	70.44	20.18	355.11	250.58	411.96	169.77	97.75	74.67	0.66	1451.15
2013	0	11.87	3.09	23.61	154.8	346.36	479.93	237.31	248.83	112.96	16.19	0.26	1635.2
2014	0.01	2.89	8.09	28.62	147.57	214.43	468.55	536.71	153.26	134.19	28.06	12.5	1734.86
2015	0.3	0.92	22.96	35.65	122.31	134.13	104.57	187.6	148.73	61.82	42.43	2.35	863.78
2016	1.17	0	0.72	8.74	70.91	182.05	180.58	82.02	76.71	38.27	2.03	12.37	655.59
2017	0.01	0	6.43	22.07	35.52	124.44	129.85	113.17	163.48	140.05	5.17	0.75	740.95
2018	1.99	1.18	19.43	35.87	98.6	153.64	110.04	98.42	45.13	41.09	6.98	0.1	612.46
2019	0.32	0.67	2.72	19.95	31.43	135.09	161.56	245.48	195.99	279.39	21.47	14.1	1108.18
2020	0.72	1.15	1	46.86	76.49	162.01	359.98	200.88	266.82	269.17	12.54	9.66	1407.28

(Source: Power access climate data under India Meteorological Department)

From the above table of rainfall data, the annual rainfall is computed and monthly rainfall of UBDTCE campus as represented in table 2.

Table 2: Monthly rainfall of UBDTCE campus

Sl.No	Month	Rainfall (mm)
1	January	0.69
2	February	2.02
3	March	14.40
4	April	33.82
5	May	90.27
6	June	268.49
7	July	323.75
8	August	268.94
9	September	187.74
10	October	131.07
11	November	39.01
12	December	4.62
Total		1364.82 mm

4.2 Population Data

The population data of University B.D.T College of Engineering is collected to estimate the water demand per day. The population data as represented in table 3.

Table 3: Monthly rainfall of UBDTCE campus

Sl.No	Description	Data
1	Teaching staff	78
2	Non-teaching staff	57
3	Students	2283
4	Total	2418
5	Water demand	45 lpcd
Water consumption per day		108810 liters

4.3 Determination of Catchment Area

The rooftop surface serves as the rainwater catchment area. Measurements are made of the various buildings catchment area at University B.D.T College of Engineering. The simplest method, known as a tape survey, was used to perform this measurement

manually. Before using the tape, the tape's length was carefully checked to ensure accuracy and for any zero errors. Measuring the rooftop area of different buildings in college campus as represented in figure 2.

Figure 2: Measuring the Rooftop Area of Different Buildings in College Campus

The roof top area /catchments area from which we can collect water is measured. The rooftop area of various buildings in the campus of University B.D.T College of Engineering as represented in table 4.

Table 4: Rooftop area of buildings in the UBDTCE campus

Sl.No	Building Name	Rooftop Area (m^2)
1	Computer Science Block	1668.50
2	Hydraulic Lab	202.50
3	Mechanical Lab	202.50
4	Basic Workshop	322.65
5	Thermal Power Engineering Lab	322.65
6	Chemistry and Analytical Department	827.00
7	High Voltage Lab	95.40
8	Department of Mechanical Engg	624.50
9	Department of MBA	323.30
10	Wash Room	32.70
11	Dept of Studies in Civil Engg	625.50
12	Library	602.20
13	CAED Lab	210.50
14	Industrial and Production Department	403.50
15	Concrete Lab	613.20
16	Canteen	261.00
17	BMTC Lab	306.60
18	foundry and Forging Lab	230.00
19	Material Testing Lab	306.60
20	Machine Shop	306.60
21	Main Building Block	2468.17
22	Sports Room	176.70
23	Old Alumini Building	390.00
24	New Building	1170.00
25	New Auditorium	2640.00
Total Rooftop Area		15332.27 m^2

4.4 Estimation of Harvesting Potential

The water harvesting potential refers to the volume which can be harvested effectively.

The Harvesting potential or Volume of water Received (m^3) = Area of Catchment (m^2) x Amount of rainfall (m) x Runoff coefficient.

A runoff coefficient, which is typically used to take into account infiltration, evaporation, and other losses. Runoff coefficient for different types of surface areas as represented in table 5.

Table 5: Runoff coefficient for different types of surface

Sl. No.	Types of Area	Value of "K"		
		0-5 % slope Flat land	5%-10% Slope Rolling land	10%-30% slope Hilly land
1	Wooden land or Forested area	0.30	0.35	0.50
2	Pastures	0.30	0.36	0.42
3	Cultivated Areas	0.50	0.60	0.72
4	Single family residence	0.30		
5	Urban areas	0.55	0.65	-

(Source: Table 7.31, Hydrology and runoff computation Chapter, Irrigation Engineering and Hydraulic Structures, by S K Garg)

According to Indian Standards 15797:2008, which provides criteria for roof top rainwater harvesting. The average rainfall data for the site and the table represented below is used to calculate the typical annual runoff from rooftop regions anywhere. Water availability for given roof top area and rainfall as represented in table 6.

Table 6: Water availability for given roof top area and rainfall (For flat roofs)

Sl. No	Roof Top Area m^2	Rainfall in mm												
		100	200	300	400	500	600	800	1000	1200	1400	1600	1800	2000
		Water Availability in m^3												
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
i)	20	1.60	3.20	4.80	6.40	8.0	9.60	12.80	16.0	19.20	22.40	25.60	28.80	32.0
ii)	30	2.40	4.80	7.20	9.60	12.0	14.40	19.20	24.0	28.80	33.60	38.40	43.20	48.0
iii)	40	3.20	6.40	9.60	12.80	16.0	19.20	25.60	32.0	38.40	44.80	51.20	57.60	64.0
iv)	50	4.00	8.00	12.0	16.0	20.0	24.0	32.0	40.0	48.0	56.0	64.0	72.0	80.0
v)	60	4.80	9.60	14.40	19.20	24.0	28.80	38.40	48.0	57.60	67.20	76.80	86.40	96.0
vi)	70	5.60	11.20	16.80	22.40	28.0	33.60	44.80	56.0	67.20	78.40	89.60	100.8	112
vii)	80	6.40	12.80	19.20	25.60	32.0	38.40	51.20	64.0	76.80	89.60	102.4	115.2	128
viii)	90	7.20	14.40	21.60	28.80	36.0	43.20	57.60	72.0	86.40	100.80	115.2	129.6	144
ix)	100	8.00	16.0	24.0	32.0	40.0	48.0	64.0	80.0	96.0	112.0	128	144	160
x)	150	12.0	24.0	36.0	48.0	60.0	72.0	96.0	120	144	168	192	216	240
xi)	200	16.0	32.0	48.0	64.0	80.0	96.0	128	160	192	224	256	288	320
xii)	250	20.0	40.0	60.0	80.0	100	120	160	200	240	280	320	360	400
xiii)	300	24.0	48.0	72.0	96.0	120	144	192	240	288	336	384	432	480
xiv)	400	32.0	64.0	96.0	128	160	192	256	320	384	448	512	576	640
xv)	500	40.0	80.0	120	160	200	240	320	400	480	560	640	720	800
xvi)	1000	80.0	160	240	320	400	480	640	800	960	1120	1280	1440	1600
xvii)	2000	160	320	480	640	800	960	1280	1600	1920	2240	2560	2880	3200
xviii)	3000	240	480	720	960	1200	1440	1920	2400	2880	3360	3840	4320	4800

(Source: IS 15797:2008, Roof Top Rainwater Harvesting Guidelines, Table 1)

V. Results and Discussion

5.1 Estimation of Harvesting Potential of Different Buildings at UBDTCE

From IS 15797:2008 of roof top rainwater harvesting guidelines, the total amount of rainwater that can be collected from any roof surface is estimated and the net volume of rainwater collected annually is 14808.02054 m^3. Volume of rainwater collected from each building rooftop as represented in table 7.

Table 7: Volume of rainwater collected from each building rooftop

Sl. No	Building Name	Roof top area (m^2)	Volume of water available (m^3)	Net volume of rainwater collected (m^3)
1	Computer Science Block	1668.50	1815.328	1633.795
2	Hydraulic Lab	202.50	220.32	198.288
3	Mechanical Lab	202.50	220.32	198.288
4	Basic Workshop	322.65	351.043	315.938
5	Thermal Power Engineering Lab	322.65	351.043	315.938
6	Chemistry and Analytical Department	827.00	899.776	809.798
7	High Voltage Lab	95.40	103.795	93.415
8	Department of Mechanical Engg	624.50	679.456	611.510
9	Department of MBA	323.30	351.750	316.575

10	Wash Room	32.70	35.577	32.0198
11	Dept of Studies in Civil Engg	625.50	680.544	612.489
12	Library	602.20	655.193	589.674
13	CAED Lab	210.5	229.024	206.121
14	Industrial and Production Department	403.50	439.008	395.107
15	Concrete Lab	613.20	439.008	395.107
16	Canteen	261.00	283.968	255.571
17	BMTC Lab	306.60	333.580	300.222
18	Foundry and Forging Lab	230.00	250.24	225.216
19	Material Testing Lab	306.60	333.580	300.222
20	Machine Shop	306.60	333.580	300.222
21	Main Building Block	2468.17	2685.368	2416.832
22	Sports Room	176.70	192.249	173.024
23	Old Alumini Building	390.00	424.32	381.888
24	New Building	1170.0	1272.96	1145.664
25	New Auditorium	2640.0	2872.32	2585.088
Total		15332.27 m^2		14808.02 m^3

By harvesting rain water from different buildings of UBDTCE we can collect 14808020 liters of water annually making UBDTCE campus self-reliable and self-sustainable in water usage. Collected water can be utilized for flushing, gardening purposes, since the daily requirement of the institution is high adopting RWH techniques is found to be simple and sustainable technique which can be implanted in the campus.

5.2 Estimation of Runoff Potential

The potential of runoff water that can be collected from different catchment surfaces like playgrounds, parks, pavements etc. present at UBDTCE campus is calculated by using formula,

Harvesting potential (m^3) = Area of Catchment (m^2) x Amount of rainfall (m) x Runoff coefficient

Where, average annual rainfall =1360 mm

Catchment area = 71180.73 m^2

Runoff coefficient = 0.65 (Considering vegetation pavements, parks, unimproved areas and playgrounds)

Losses = 10%

Then, Harvesting potential = 71180.73 x 1.36 x 0.65 x 0.9 = 56631.39 m^3

The runoff water which can be collected from different surfaces such as pavements, parks, playgrounds located at UBDTCE campus is 56631390 liters which can be utilized for recharging of ground water by adopting recharge structures.

VI. Conclusion

i. The present study concludes that by adopting RWH facility to collect the water from roof tops of all the buildings of UBDTCE campus, 14.80 Million liters of water can be collected annually.

ii. By storing the 14.80 Million liters of rain water in storage tank the daily water need of about 108810 liters is achieved by suppling water in dry period of the year which helps to conserve the water and fulfil needs of community in campus either for domestic purposes, laboratories, grading or other purposes.

iii. By the surface runoff 56.63 Million liters of water can be harvested annually.

iv. By adopting artificial ground water recharge techniques can help to ground water recharge and which will also help to increase water level of aquifer in campus area.

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