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Potential of Rain Water Harvesting and Ground Water Improvement at RVCE

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Potential of Rain Water Harvesting and Ground Water Improvement at RVCE

Pavan Bandakli B R [α] & M Lokeshwari [σ]

Abstract- Water is a primary resource for the development of any country. Increase of population in urban areas has resulted in failure of typical water supply system to meet the growing demand. Rainfall is the major source of fresh water. To reach the water demand, utilization of rain water by adopting decentralized rain water harvesting approach is need of the hour. The present study area is R V College of Engineering, Mysore road, Bengaluru. Annual rainfall records and the data required for estimation of potential of rain water and runoff coefficients of different catchment surfaces were collected. It was observed from the study that RVCE campus has the potential of collecting 21.49 Million liters of water annually from roof tops of different buildings and 32.72 Million liters of water by runoff from major catchment areas like play grounds, pavements, parks and sites. 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 RVCE campus by adopting RWH technique.

Keywords: rain water harvesting, ground water recharge.

I. Introduction

2.5% of Earth's water is fresh water out of which 68.9% is of Glaciers and Ice caps, 30.8% is locked up in ground. Only 0.3% is surface water which serves most of life needs [1]. Water is a primary requirement for our daily activities, Safe and readily available water is required for public health, food production, recreational use, drinking and domestic use. Water management is directly relatable to the economic growth of the country, Water availability is one of the primary criteria for setting up of industries which are associated with local and foreign investments. Majorly many parts of North Karnataka are facing water crisis which is also an indirect reason for poor generation of employment opportunities hence many youths are heading towards metropolitan cities like Bengaluru resulted in rapid increase of population failure of typical water supply system to meet the requirement.

According to Composite Water Management Index, August 2019 released by NITI Aayog 5 out of 20 world largest cities are under water stress are in India, Indian urban population is expected to reach 600 million by 2030 with expected demand supply gap of 50Bcm [2].

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In recent years India has experienced weak monsoons resulted in drought conditions at many places. Ground water table is reducing day by day in many parts of the country, Punjab which produces 10% of India's paddy utilizes 80% ground water for paddy irrigation depleting its own ground water resource, 70% of India's thermal power faces water stress by 2030 which contributes 83% of India's energy power generation in 2016, Presently 40% of India's thermal power plants are in water scare regions, 14 of them faced shutdown in 2013-16 due to water scarcity [2].

Recently Indian government introduced ministry of jalshakthi, which launched programs like Jalshakthi abhiyan to encourage and promote water conservation, Rain water harvesting, renovation and rejuvenation of water bodies, bore well structures. Once a drought village Jakhni of Bunderkhand district, Uttar Pradesh is emerged as self-water reliable village by adopting methods like collection and storage of rain water, Restoration of ponds, Grey water usage with no external funding. Sustainable water management has to be incorporated in private and public buildings to overcome the water demand. Decentralized approach has to be adopted in order to achieve this state. Rain water harvesting by roof top water collection and ground water improvement by simple techniques are the easy, suitable and sustainable solutions for the problems associated with water requirement and its management.

II. Rain Water Harvesting and Ground Water Recharge

Rain water is the ultimate and primary source of fresh water. Lakes, ponds, Rivers, Ground water are the secondary sources. Rain water has highest potential to meet the demand of people if public are involved in conservation of rain water in their houses, public building's, Institutions. Rain water harvesting has been carried out from decades from simple harvesting techniques like collection of water through small drums by using normal cloth as a filter medium to modern techniques. Rain water harvesting is defined as collection of rain water from the surface where it falls, either it may be roof top harvesting or open space harvesting. Rain water harvesting potential depends on catchment area, intensity of rainfall. Rain water collected is stored and utilized or the water from open source can be utilized for ground water recharging.

Rain water is collected from roof tops and is filtered to remove dry leaves, waste materials, dirt present on the roof top, the water is taken to storage tank which can be overhead tank, surface tank and overhead tank by using down take pipes. The stored water can be treated and can be used as potable water or can be used for non-potable purposes like irrigation, gardening etc. The stored water can also be used for recharging of ground water by different methods such as recharging through establishment of recharge pits or trenches, constructing artificial recharge wells or by using abandoned or existing bore wells.

III. Study Area

R V College of Engineering is spread over 50.97 acres located at Bengaluru south which receives an average annual rainfall of 877.8 mm [3]. Satellite view of RVCE campus is shown in figure 1 below. The main motto of the institution to achieve sustainability in terms of water, energy and waste management, in road to achieve this the institution has setup rain water harvesting units in three phases across the campus which has collection capacity of 3.6 lakh liters in total, two bore wells are also established for the purpose of ground water recharging, Campus also has Reverse osmosis water treatment and softening plant of 22000 liters capacity and Sewage treatment plant of 50 kld output [4].

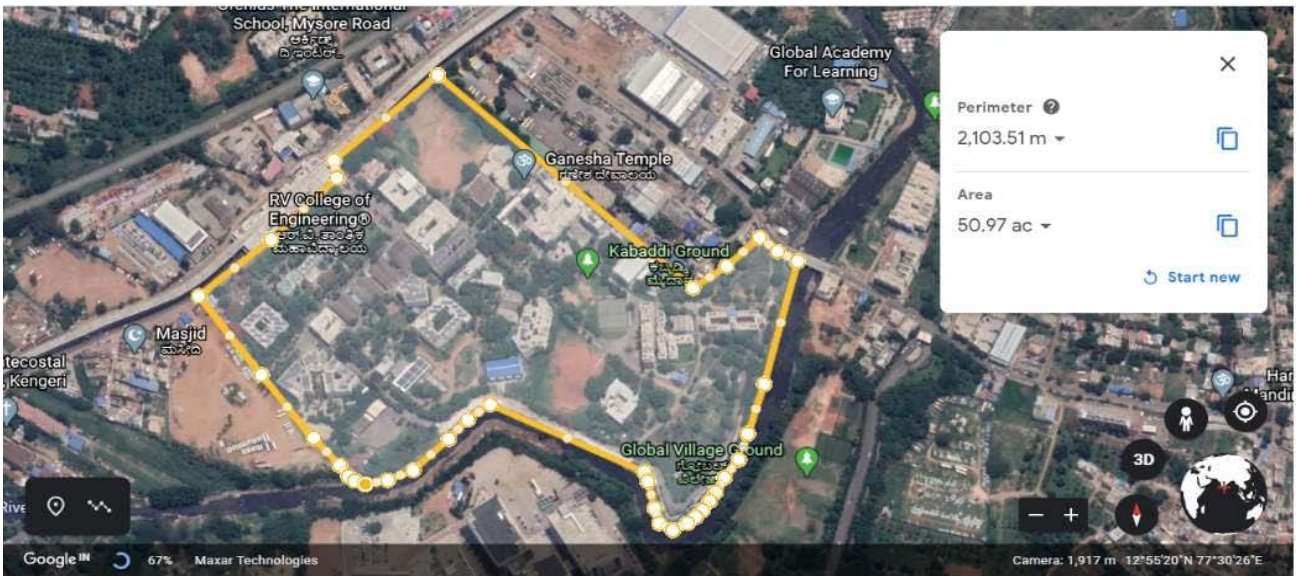

Figure 1: Satellite view of R V College of Engineering (Source: Google Earth®)

IV. Objectives

Present study aims at estimating potential of rain water and runoff which can be collected annually from different roof top area of different buildings located at RVCE.

V. Methodology

1. Obtaining roof top area of different buildings at RVCE campus using Google earth.
2. Collection of rainfall data from India Meteorolgical Department (IMD) website.
3. Runoff co-efficient of different materials are obtained from
4. A building is considered and the monthly/annual water demand and monthly/annual rain water yield from the roof top area is measured and the rain water harvesting tank capacity is determined according to IS 15979: 2008.
5. Similar calculations are extended to other buildings of RVCE to obtain total potential of Rain water.

VI. Estimation of Rain Water Harvesting Capacity

New Cauvery hostel, Male residential hostel for 2nd and 3rd year students is considered to estimate rain water harvesting capacity, Satellite image of new Cauvery hostel is shown in figure 2 below.

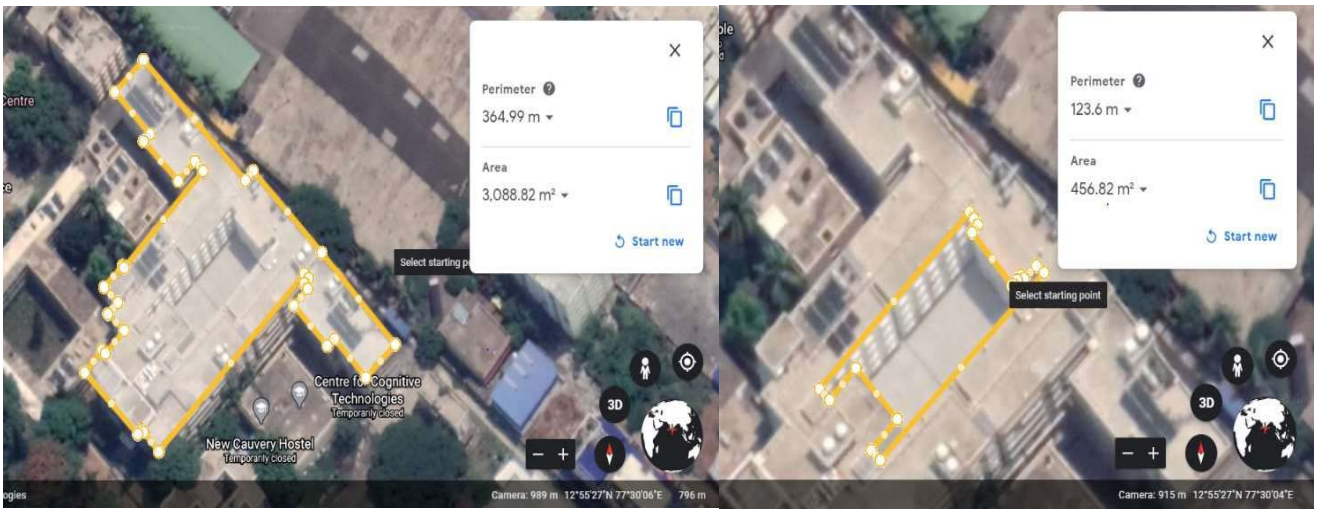

Figure 2: Satellite image of New cauvery hostel (Source: Google Earth®)

Annual rain water yield is given by the formula
Q = A x R x C x F
Where Q = Annual rainwater yield
A = Catchment area in m2
R = Annual precipitation
C = Runoff coefficient of catchment material

Annual rain water yield of Cauvery hostel
Catchment area, A = 2632 m2
Annual precipitation, R = 877.8mm
Runoff coefficient of RCC roof, C = 0.8 [5]
Filter efficiency, considering F = 0.8

Q = A x R x C x F
Q = 2632 x 877.8 x 0.8 x 0.8 = 1478637
liters = 1478.637 m3

Annual water demand of Cauvery hostel for flushing purpose
Number of people residing at New Cauvery hostel = 528
Quantity of water require for flushing per person = 10 liters
Total Quantity of water required monthly = 528 x 10 x 30 = 158400 liters = 158.4 m3
Total Quantity of water required annually = 528 x 10 x 365 = 1927200 liters = 1927.2 m3

a) *Calculation of storage tank size according to monthly demand*

Table 1: Calculation of storage tank size according to monthly demand

Month	Average Rainfall (mm)	Monthly yield(l)	Cumulative yield(l)	Monthly demand(l)	Cumulative demand(l)	Volume stored(l)	Surplus(l)
May	96	161710	161710	158400	158400	3310	3310
June	85.7	144359	306069	158400	316800	0	0
July	100.3	168953	475022	158400	475200	0	10553
August	117.8	198431	673453	158400	633600	39853	40031
September	194.6	327799	1001252	158400	792000	209252	169399
October	154.5	260252	1261504	158400	950400	**311104**	101852
November	43.9	73948	1335452	158400	1108800	226652	0
December	15.8	26614	1362066	158400	1267200	94866	0
January	2.3	3874	1365940	158400	1425600	0	0
February	6.4	10780	1376720	158400	1584000	0	0
March	16	26951	1403671	158400	1742400	0	0
April	44.5	74959	1478630	158400	1900800	0	0
Total	877.8	1478630		1900800			

Table 1 shows the calculation of storage tank size according to monthly demand, Minimum storage required is the difference of maximum volume stored and surplus water left at the end of the year which equals to 311104 liters, Hence, Storage tank of capacity 311.1 m3 is suggested for the hostel with roof top area of 2632 m2 which yields 1478637 liters annually which could meet the demand of flushing purpose with 76.72% water reliability.

VII. Annual Water Yield of Different Buildings at RVCE

Similarly annual water yield from different roof tops of different buildings is calculated by obtaining roof top areas of determined using Google earth and represented in table 2 below, figure 3 represents satellite image of civil department.

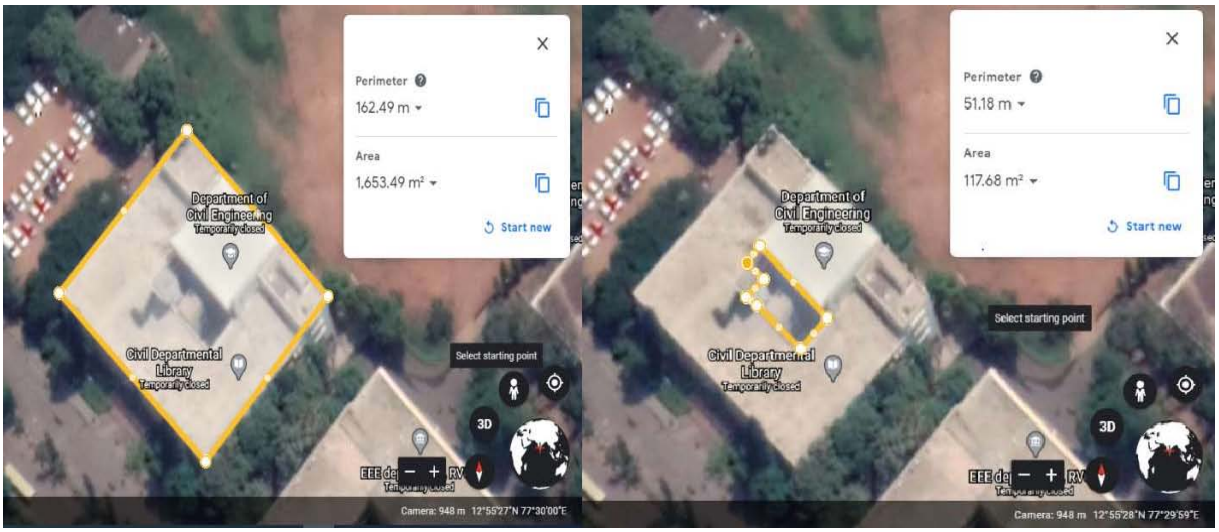

Figure 3: Satellite image of civil department building (Source: Google Earth®)

Table 2: Annual water yield from different roof tops of different buildings of RVCE

Sl. No.	Building name	Area	Annual water yield
1	Department of CV	1535.81	862805.77
2	Department of ME	1431.69	804311.98
3	Department of CSE	1063.36	597387.14
4	Department of EC	1262.1	709037.68
5	Department of EEE	1773.06	996090.92
6	Department of AS and ISE	1911.81	1074039.56
7	Department of BT and EIE	1050.23	590010.81
8	Department of MCA	1596.28	896777.33
9	Department of TE	894.95	502775.75
10	CRC Complex	803.41	451349.31
11	Department of CE	1586.42	891238.06
12	Administrative block	1330.78	747621.55
13	Mechanical PG block	486.43	273272.48
14	Department of IEM	925.75	520078.94
15	Old sports complex	547.44	345990.83
16	New sports complex & Gym center	1239.1	826638.30
17	Food Court	1354.09	855806.54
18	Bank and Post office	153.29	86117.09
19	Aero-space lab	862.21	575204.43
20	Library building	873.11	490506.21
21	Hospital Building	301.61	169442.08
22	Cognitive and Research Block	863.28	484983.78
23	Workshops	3213.01	2143488.935
24	Old cauvery hostel	1251.64	703161.33
25	New cauvery hostel	2632	1478636.54
26	Sir m v hostel	2041.95	1147151.17
27	Chamundi hostel	1159.33	651302.31

28	Dj hostel	1061.77	596493.89
29	Employee's residence	393.74	221199.98
30	Miscellaneous	1265.24	799651.92
	Total annual yield		21492572.62

By harvesting rain water from different buildings of RVCE we can collect 21492572 liters of water annually making RVCE 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.

VIII. Estimation of Runoff Potential

Runoff is defined as the ratio of precipitation that makes its way towards rivers or oceans as surface or subsurface flow to the precipitation received. After undergoing infiltration and other loses from the rainfall, to determine potential runoff water that can be collected from different catchment surfaces like playgrounds, parks, pavements etc. present at RVCE campus, figure 4 and figure 5 shown below gives satellite image of cricket ground and site respectively. area of the catchment surfaces are determined using Google earth and represented in table 3, runoff coefficients of different surfaces were collected and annual water yield from runoff is obtained by knowing area and average annual rainfall of the catchment.

Annual water yield, Q is obtained by using the formula

$Q = R \times A \times C$

Where, R is the average annual precipitation

A is the catchment area

C is the runoff coefficient

Runoff coefficient of pavements = 0.7-0.95,

parks = 0.1-0.25,

unimproved areas = 0.1-0.3,

tiles = 0.8-0.9, playgrounds = 0.2-0.35 [5].

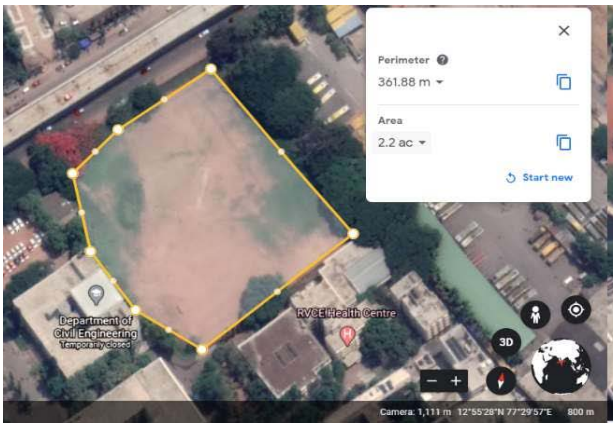

Figure 4: Satellite image of cricket ground (Source: Google Earth®)

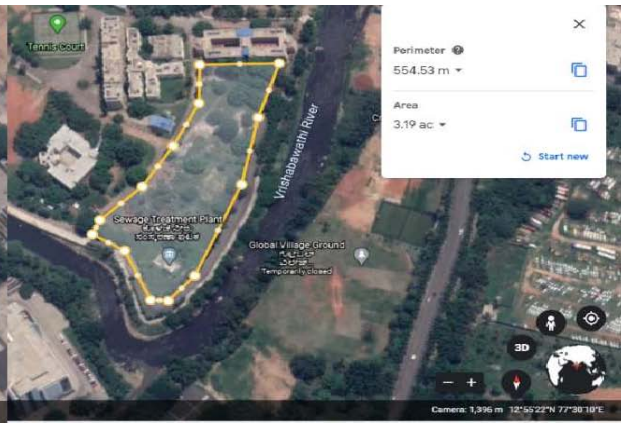

Figure 5: Satellite image of Site behind DJ block (Source: Google Earth®)

Table 3: Estimation of annual runoff potential of RVCE

Sl. No.	Type of catchment	Area (m^2)	Annual water yield(l)
1	Pavements	27913.06	11760975.1
2	Play grounds	20507.54	4950417.62
3	Unimproved areas/ sites	37633.28	8258623.3
4	Parks/greenery	24187.23	4246310.1
5	Brick/tiles/concrete	4996.95	3509058.17
	Total runoff		32725384.29

The runoff water which can be collected from different surfaces such as pavements, parks, sites, playgrounds located at RVCE campus is 32725384.29 liters which can be utilized for recharging of ground water by adopting recharge structures.

IX. Conclusions

The present study concludes that by adopting RWH facility to collect the water from roof tops of all the buildings of RVCE campus, 21.49 Million liters of water can be collected. It is evident that adopting RWH and artificial ground water recharge techniques in all the public buildings can be a solution to water availability and management problems at urban areas.

X. Recommendations

1. Sustainability in water management can be achieved at RVCE by adopting decentralized RWH and Ground water recharge structures.

2. Presently RVCE is collecting 3.6 Million liters of water annually from RWH, by adopting RWH technique to all the roof tops RVCE campus has potential of collecting 21.49 Million liters of water annually from roof tops of different buildings.
3. RVCE has the potential of collecting 32.72 Million liters of water by runoff from major catchment areas like play grounds, pavements, parks and sites, the run-off water collected can be used for improving ground water resources.
4. Open wells can be established near Bus parking, near temple, near DJ hostel and near food court in addition to the existing recharge structures for ground water recharge purpose.
5. Monitoring of existing RWH structures and Recharge structures needs to be done.

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