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ESTIMATED WATER DEMAND AND ROOFTOP RAIN WATER HARVESTING POTENTIAL OF DAHIWADI COLLEGE CAMPUS IN MAN TAHSIL OF SATARA DISTRICT (MAHARASHTRA)

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ABSTRACT

Dahiwadi College campus is located in drought-prone area of Satara district, where the average annual rainfall is 500 mm. Dahiwadi College is situated in 6 acres of campus area and 4957.18 sq. meter area of roof surface. The total population of college is 4,386 comprising of students and the staff, administrative staff and the daily visitors to the campus. The present study is entirely based on the primary as well as the secondary data. Runoff Coefficient and Annual rainwater harvesting potential (ARHP) is measured by using Pecey, Amold and Cullis, Adrian (1989) formula. The present paper intends to measure water demand and supply gap and the rooftop rain water harvesting potential in the College campus during 2020-21. Results obtained from the present study show that 8772 liter drinking water is required per capita per day. Rooftop rainwater harvesting potential is 18,18,844 liters. Thus, it is suggested that Rooftop rain water harvesting practice is more applicable in various colleges located in drought prone areas of Maharashtra and India.

Key Words: Rainwater Harvesting, Runoff Coefficient, Potential, drought-prone.

1. INTRODUCTION

Rain water harvesting is the process of collecting and storing water for future productive use. Rooftop rain water harvesting is one of the technique through which rain water is captured from the roof catchments and stored in reservoirs. Geographically this method is highly useful in drought-prone, hilly and coastal areas. Water is a one of the most important resource for survival of human being as much as food, air etc, but very few attentions are paid for its economical use and conservation. As we know day by day increasing pressure of population on water resources leads to over pumping of ground water, the water table is going down abnormally, so there is a need of conservation of this precious resource.

2. THE STUDY REGION

For the purpose of present investigation campus of Dahiwadi College Dahiwadi located in Man tahsil of Satara district of Maharashtra has been undertaken. It lies between $17^0\ 40'54''$ north latitude and $74^0 37'47''$ east longitude. Dahiwadi College campus is located in drought-prone area of Satara district, where the average annual rainfall is 500 mm.

Dahiwadi College comprises of 6 acres of campus area with 78797.95 sq. ft. built up area and 4957.18 sq. meter area of roof surface. The population of college is about 4386 including students, teaching and non-teaching staff and daily college visitors. College has 712 sq. meters area of fruit garden and 1550 sq. meter area of botanical garden. At present, college has built-up 4 underground reservoirs having 170000 liters of capacity.

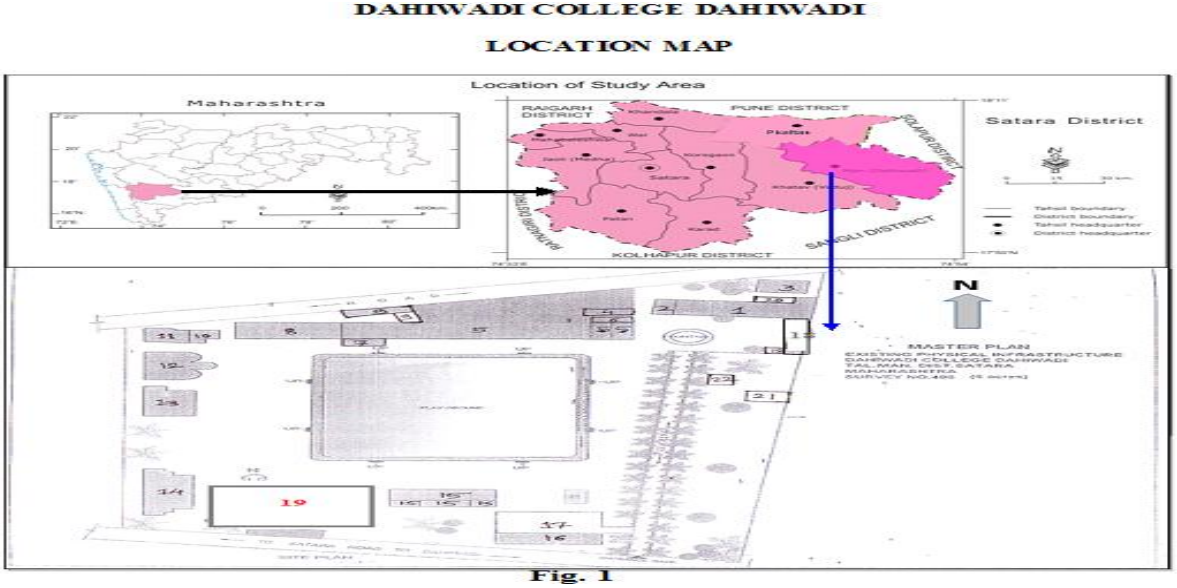

Fig. 1

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3. OBJECTIVE

1. To find out the present status of water requirement and supply gap.
2. To measure the rooftop rainwater harvesting potential in the Dahiwadi College campus during 2020-21.

4. DATA SOURCE AND METHODOLOGY

The present study is entirely based on primary and secondary data. Primary data collected directly form field survey in which type of roof surface, area of roof, average of daily water supply to college campus, depth and number of boar wells, daily persons visited to college etc. and secondary data regarding strength of students and staff, Built-up area collected from college records, Socio – Economic Review and District Statistical Abstract of Satara, District Gazetteer etc. Rooftop rainwater harvesting innovative method is used for this study. The per capita daily water requirement is calculated as number of persons x 2 liters. The daily, annual and dry day's water requirement has been calculated in liters. Runoff Coefficient and Annual rainwater harvesting potential of the study region is measured by using formula given by Pecey, Amold and Cullis, Adrian (1989) as follows.

Annual Rainwater Harvesting Potential (ARHP) = R x AC x RC

R - Rainfall (in metre), AC - Area of catchment (in square metre), RC - Runoff coefficient.

5. WATER REQUIREMENT AND SUPPLY GAP

There are number of estimates in the world belonging to the water requirement for human being, for drinking and also for domestic purpose. According to World Health Organization, it is estimated that average 2.5 liter daily water intakes per capita per day required. According to U.S. Environmental Protection Agency average daily water intake 2.0 liters per capita per day is required. National Academy of Sciences also estimated daily 2.0 liters water requirement for per person. For the present study water requirement 2.0 liters per person per day is taken into consideration. The total population of the college is 4386 including all students, all teaching and non-teaching staff and daily visitors. Analysis revealed that 8,772 liters water required for daily and 32, 01,780 liters for annually for drinking purpose. Estimated daily domestic water demand of the college is about 10,500 liters and annual demand is about 38, 32,500 liters. Estimated daily drinking and domestic water requirement is 19,272 liters and 70, 34,280 liters annual.

It is observed that average 12,000 litres daily and 4380000 liters annually ground water extracted from 3 bore wells in the college campus for the purpose of drinking and domestic use. Drinking water demand is totally fulfilled through ground water extraction but for the domestic water demand and supply gap is about -547500 liters per annum. Present investigation shows the total demand and supply gap is -7272 liters daily and -2654280 liters annually (Table 1). It has also been increased from 8,000 to 12,000 liters per day in every summer season leads to severe problem of water scarcity in the summer season. College has fulfilling been total water demand and especially domestic water demand through providing water tankers in every summer season.

Table- 1 Projected Water Demand and Supply of Dahivadi College (2020-21)

Total Population of the College (Students + Staff + Guests)		**Estimated water requirement (Drinking + Domestic) Liters per day**		**Estimated ground water extracted and supply in liters (through 3 bore wells)**		**Estimated water demand and supply gap in liters**	
Daily	Annual	Daily	Annual	Daily	Annual	Daily	Annual
1	2	3	4	5	6	5 - 3	6 - 4
4386	1600890	19272	7034280	12000	4380000	-7272	-2654280

Source: Field survey, 2017-18

6. Rooftop Rain Water Harvesting in Dahiwadi College Campus

6.1 Roof Surface Area and Annual Rain Water Harvesting Potential

As many as 20 buildings surveyed in Dahiwadi college campus. Out of which 10 buildings of concrete rooftop having (52.78 per cent) 2616.60 sq. m. rooftop area and estimated annual rooftop rain water potential is (48.75 per cent) 886751 liters. Its collection efficiency is 70 % (0.7 coefficient), which is second the largest efficiency in the college campus. Roof surface of metal sheets observed for 09 buildings comprised with about (46.38 per cent) 2299.27 sq. m. area and estimated annual capacity of (50.56 per cent) 919700 liters which is second largest with respect to roof surface area and largest with respect to rain water harvesting potential of the college. Its collection efficiency is 80 % (0.8 coefficients).

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Table- 2 Type of Roof Surface and Annual Rainwater Harvesting Potential (ARHP)

Sr. No.	Type of Roof Surface	No. of Buildings	Total area in sq. meters	Total Area in %	Total (ARHP) in liters	Total (ARHP) in %
1	Concrete rooftop	10	2616.6	52.78	8,86,751	48.75
2	Corrugated metal sheets	09	2299.27	46.38	9,19,700	50.56
3	Brick pavement	01	41.31	0.25	12,390	0.68
4	Total	20	4957.18	100	18,18,844	100

Source: Field Survey, 2017-18

Remaining a single construction of brick pavement shows very less proportion (0.25 per cent) 41.31 sq.m area of roof surface and estimated annual rain water harvesting potential is 12,390 liters (0.68 per cent) and also efficiency is very less i.e. 50 % (0.5 coefficient), hence this roof surface is not much useful for rain water harvesting (Table- 2). Both the concrete and metal sheets type of roof surfaces highly suitable for rooftop rainwater harvesting purpose because of its collection efficiency is 70-80 per cent. Therefore, rooftop rain water harvesting method is more applied for both types of roof surface buildings in the college campus.

6.2 Water Demand and Rooftop Rain Water Harvesting Potential

Dahiwadi college campus has a huge potential of rain water harvesting. It is estimated that, 1818844 liters water made available throughout the year. Annual drinking water demand of the college is about 3201780 liters. In this way annually 56.80 per cent requirement of drinking water can be meet from Rooftop RWH in the entire college campus. In the dry days drinking water demand is about 2482476 liters which is 73.26 per cent completed through rain water harvesting. Annual domestic water demand of the college is about 38377500 liters. Annually 47.45 per cent requirement of domestic water can be meeting from Rooftop RWH.

In dry days (243 days) domestic water demand is about 2971500 liters out of which 77.53 per cent completed through the rooftop RWH, it shows that in dry days domestic water demand is also extensively fulfilled by using harvested water. Total drinking and domestic water demand of the college is 7034280 liters out of which 25.85 per cent total water demand completed annually. Dry day's water demand is less than annual demand i.e. 5453976 liters out of which estimated that 33.34 per cent water demand are completed through rain water harvesting. Thus, it is proved that by using rooftop rainwater harvesting method water scarcity in the college campus can be minimized up to some extent and water collected can be used for drinking and domestic purpose.

6.3 Annual Rooftop Rain Water Harvesting Potential

Very High Potential (Roof Area 500 sq. m. & above)

There is positive correlation between roof surface area and rain water harvesting potential. At present Indoor Sport Complex building having highest potential of rooftop rain water harvesting in the college campus. Indoor Sport Complex building has 864 sq. m. roof surface area, which is highest as compared to other campus buildings also because of metal sheet roof surface its collection efficiency is 80% per cent. So its estimated rooftop rainwater harvesting potential is 345600 liters per year.

Another Wing - 'B' Building having roof surface area is 700.3 sq. m. and estimated annual rain water potential is 245105 liters & second largest harvesting potential in the college campus. Two buildings total annual estimated rooftop rainwater harvesting potential is 32.5 per cent out of overall existing potential of the college.

High Potential (Roof Area 300 – 500 sq. m.)

The MCVC and Canteen building on the college campus show 425 sq. m area of metal sheet roof surface having 80 per cent collection ability, because of this estimated rain water harvesting potential to be 170000 liters. Auditorium and Ladies hostel building shows 350.9 sq. m. and 322.5 sq. m. area of roof surface having concrete surface so, its water collection capacity 70 per cent. Both buildings show high potential of rooftop rain water harvesting i.e. 122815 liters, 112875 liters respectively per year. Another important Golden Jubilee building has recently been constructed, which indicates 392.92 sq. m. concrete roof surface area with 108470 liters of potential annually. All these 4 building are felt in high potential and suitable for rooftop rain water harvesting.

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Table-3 BUILDING-WISE ANNUAL ROOFTOP RAINWATER HARVESTING POTENTIAL

Building No.	Building Name	Rooftop Area in sq. meter	Coefficients	Annual Rooftop Rainwater Harvesting Potential	
				Cu. m.	Liters
1	Indoor Sport Complex	864	0.8	345.6	345600
2	Wing - 'B' Building	700.3	0.7	245.105	245105
3	MCVC Building and Canteen	425	0.8	170	170000
4	Auditorium	350.9	0.7	122.815	122815
5	Chemistry & Zoology Laboratory	296.96	0.8	118.784	118784
6	Wing - 'C' Building	284.09	0.8	113.636	113636
7	Ladies Hostel	322.5	0.7	112.875	112875
8	Golden Jubilee Building	309.91	0.7	108.47	108470
9	Wing - 'A', Principal Cabin & Office	284.61	0.7	99.61	99610
10	Library	219.04	0.7	76.66	76660
11	Car & Motor Cycle Parking	186.12	0.8	74.44	74440
12	Gents and Ladies Toilet	166.44	0.7	58.254	58254
13	Bicycle Parking	93.06	0.8	37.224	37224
14	Principals Quarter	99.31	0.7	34.7585	34758.5
15	Boys Common Room	73.2	0.8	29.28	29280
16	Chemistry Apart Stores	44.2	0.8	17.68	17680
17	Botany Research Laboratory	42.5	0.7	14.875	14875
18	Staff Toilet	38.08	0.7	13.328	13328
19	Ladies Common Room	32.64	0.8	13.056	13056
20	Vermiculture	41.31	0.6	12.393	12393
Total		**4957.18**		**1818.844**	**1818844**

Source: Field Survey 2020-21

Medium Potential (Roof Area 100 – 300 sq. m.)

There are 6 buildings viz. Chemistry & Zoology Laboratory, Wing - 'A', Principal Cabin & Office, Wing - 'C' Building, Library, Car & Motor Cycle Parking and Gents and Ladies Toilet building shows medium potential of rain water harvesting. Roof surface of all these buildings made by metal sheets or concrete roof contains 70-80 per cent rain water collection potential. Chemistry and Zoology Laboratory acquired 296.96 sq. m. area having 118784 literts annual potential. Secondly Wing - 'A', Principal Cabin & Office building comprised with 284.61 sq. m area of roof surface and estimated annual potential is 99610 liters. Wing - 'C' Building covered 284.09 sq. m. area of roof surface and proposed potential is 113636 liters per year. Library of the college is acquired 219.04 sq. m., Car & Motor Cycle Parking acquired 186.12 sq. m. area and Gents and Ladies Toilet building acquired 166.44 sq. m. roof areas having 76660 liters, 58,254 liters, 74440 liters and 58254 liters respectively annual rain water harvesting capacity.

Low Potential (Roof Area below 100 sq. m.)

Remaining 08 buildings shows less rain water harvesting potential. Due to below 100 sq. m. roof surface area of all buildings. Buildings such as Principals Quarter, Bicycle Parking, Boys Common Room, Botany Research Laboratory, Chemistry Apart Stores, VermicSulture, Staff Toilet, and Ladies Common Room etc. are not much use full for rain water harvesting.

7. CONCLUSION

The present study shows the total water demand and supply gap is -7272 liters daily and -2654280 liters annually. It has also been increased from 8,000 to 12,000 liters per day in every summer season which leads to severe problem of water scarcity in the college campus. Both concrete and metal sheets type of roof surfaces in the college is more suitable for rainwater harvesting because of its collection efficiency is 70 per cent. Estimated annual rooftop rain water potential of these roof surfaces is about 48.75 per cent and 50.56 per cent respectively. Rooftop rainwater harvesting estimated annual potential is about 1818844 liters and it can mitigate 56.80 per cent water requirement of drinking and 47.45 per cent of domestic demand annually. If the college has used harvested water in dry days only then 77.53 per cent of drinking water demand or domestic water demand fulfilled. The total water demand of the

college is about 7034280 liters out of which annually 25.85 per cent and in dry days 33.34 per cent completed through Rooftop RWH method.

Highest rooftop rain water harvesting potential is exist in Indoor Sport Complex and Wing - 'B' Buildings. High potential exist in buildings such as MCVC and Canteen building , Auditorium and Ladies hostel and Golden Jubilee building also medium but good potential was found in as many as 6 buildings like Chemistry & Zoology Laboratory, Wing - 'A', Principal Cabin & Office, Wing - 'C' Building, Library, Car & Motor Cycle Parking and Gents and Ladies Toilet buildings in the college campus. Thus, the Rooftop rain water harvesting would be a good solution for drinking and domestic water sustainability of the college in some extent. Results obtained from the present study suggested that Rooftop rain water harvesting method is more applicable on college campus located in drought prone-zones of Maharashtra.

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