Sustainable Water Management for Jain Global Campus

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Abstract- **Over the years lakes and tanks dug out of rocks were used as rain water harvesting systems. With civilisation the structures were neglected and soon dried up and this lead to over exploitation of the available resources. Together with water pollution these have led to scarcity of fresh water in many parts of the world. In India maximum rainfall is experienced during monsoons. At this time rainwater can be captured and used during dry seasons to supplement that from BWSSB as well as for ground water recharge. India is among the countries of the world expected to face water stress by the year 2020 with Karnataka in particular being the second state with most exploited underground water. In this paper maximum water demand for Jain Global campus is estimated based on present and future population of the campus, standard consumption rates as well as the rate of consumption according to the monthly water bills for the campus. Water potential is computed based on the total catchment area of the Jain Global campus and rainfall pattern of Kanakapura area.**

Index Terms- **Jain Global Campus, Rainwater Harvesting System, Water Demand**

INTRODUCTION

Sustainable water management is use of water resources taking into account the present and future generation water needs. In UN 1998 projections it was said that by the year 2025, 48 countries including India will suffer water stress. Kaveri river which is over 100kms from Bangalore and 500kms below Bangalore is its only perennial source of water and the lakes that used to serve as storage and ground water recharge facilities have been neglected and used for city construction.

While charting 11^{th} mission road map for Karnataka, the former president of India has emphasized the implementation of rain water harvesting in Karnataka as one of the important elements of the road map. A number of institutions in India such as RV College, Teerthanker Mahaveer University, and IIT Kharagpur etc. have also taken initiatives towards sustainable water management through rain water harvesting as well as ground water recharge. However, these institutions have only used roof tops for rain water collection which leaves the large overland flow unutilised.

PROBLEM STATEMENT

It can be seen that the cost incurred in water bills as well as pumping of water through the campus is high. If rain water harvesting system is implemented in the campus water can be collected from the paved surface and from the unpaved surface saving water from WBSSB. This water can be used for bathing, flushing of toilets, bore well recharge and for irrigation. This will reduce the quantity of water from WBSSB thus reducing the costs incurred in water supply. It was also seen that 70% of the wells have dried up and this could be attributed to wrong location and overexploitation of ground water without recharging. If ground water prospect zones are analysed using ArcGIS the location of new bore wells can be decided.

LITERATURE REVIEW

Ramya et al. (2015) conducted a study on rain water harvesting as a technique to preserve fresh water for the study area of Vidya Vardhaka College of Engineering (V.V.C.E.), located top the west of Mysore. The study quantifies the extractable quantity of rooftop water to supplement public supply system. For the given rooftop area of $11107m^2$, about $706m^3$ of rainwater was found with a collection efficiency of 90%.

IIT Kharagpur (2014) implemented Green Initiative whose goal was to prevent wastage of water as well as to recycle and reuse the wastewater in the Institute and in the campus. A sustainable water management plan will be adopted based on the local water table and Geo-hydrological characteristics of the aquifer. Critical components of the plan will include: reduction of potable water usage by efficient monitoring, using efficient fixtures, and restricting usage for irrigation.

S Rehan et al. (2014) have done a paper where the focus was to design a tank to store rainwater for Teerthanker Mahaveer University, Moradabad. Here the water demand was calculated and found to be

$8*10^6$ litres per day. With catchment area of 4801.425m and average rainfall of 80mm a tank size 1200mm and height 20000mm was designed. The water is to serve a population of 2200 and to be used for non-drinking purpose.

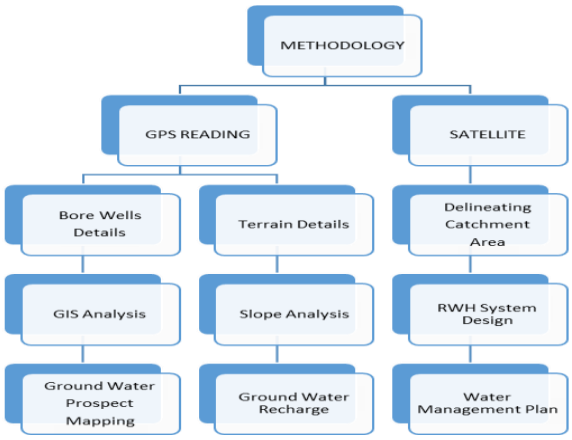
Ryan Currie et al. (2014) conducted a study and advised that 12500 gallons water harvesting and filtration system to supplement irrigation needs to be installed. Through the installations of rain water harvesting system the college system is expected to save approximately $953.19 with a return period of 11 years.

R Patel et al. (2014) did a case study on Rooftop Rainwater Harvesting (RRWH) at Sankalchand Patel Sahakar Vidhyadham (S.P.S.V.) campus, Visanagar. The water is to be used for domestic and drinking purposes. With total catchment of $31342m^2$, total rainfall of $26671.37m^3$, a total of 0.62 gallons of water is expected.

Zain M. Al-Houri et al. (2014) conducted a study potential of roof top rain water harvesting as a water resource in Jordan. In this work, Google earth and ArcGIS were used to identify the roof tops that can be used for rain water harvesting. Rooftops were traced on Goggle earth 2012 images and the area was automatically calculated using ArcGIS. Harvesting rain water from roof top, building condensates and foundation dewatering, store in clean water cistern reuse for toilet flushing in the future buildings. Excess water overflows to an irrigation cistern. The irrigation cistern supplies for irrigation and other surface water feature. The approach is to save over $220,000 of college funds.

B. L. Shiva Kumar (2006) conservation of ground water through artificial recharge using roof top rainwater in RV College of engineering campus. The impermeable area contributes for a maximum yield rainfall falling over it which is available for harvesting 52.20 million litres. There are seven bore wells and one open well in the campus area with water level ranging from 20m to 25m below ground level. Harvested rainwater from rooftops of Administrative and R&D blocks of RVCE campus rooftops rainwater is channelled into the well and recharges under gravity flow condition through gravity head recharge settling tank. Water level recorded continuously. It is observed that about 2.39 million litres of water have been harvested. The Benefit cost ratio is found to be 1.55.

METHODOLOGY



OBJECTIVES

The project "Sustainable Water Management for Jain Global campus" objectives are as follows:

- To design roof top rain water harvesting system.
- To locate groundwater-recharge structures.
- To analyse Groundwater prospects zones and groundwater potential sites for new bore wells.
- To calculate water demand for current and future scenario.
- To propose sustainable water management practices for Campus.

STUDY AREA

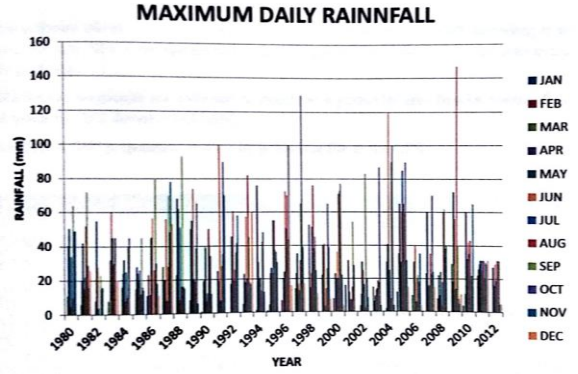
Jain Global campus is located at coordinates 12°38'18"N 77°26'27"E and encloses an area of $1.2km^2$. Total population of the campus is 7750 with 1850 people staying in campus and 5900 staying outside the campus as show in appendix table 1. The main water source for the campus is BWSSB at the rate of R60 per kl, and bore wells are used as supplementary source. The water from BWSSB is pumped from the main gate and then stored in four tanks from where it is distributed throughout the campus. Approximately 30000 kl of water is consumed every month. 12 bore wells have been dug in the past 15 years but only 4 are functional.

Fig.: Jain Global Campus (Source : Google Maps)

DATA PRODUCTS

Rainfall Data for Kanakapura rain gauge station

Average annual rainfall for Kanakapura is 818.15. Data for average annual and maximum daily rainfall as obtained from Indian Meteorological department. Figure: Shows Maximum Daily Rainfall in Kanakapura.



Software Used:

1. Map Source (Downloading the GPS records)
2. Google Earth
3. AUTOCAD Civil 3D (Digitization)
4. AUTOCAD Map 3D (Digitization)
5. Arc GIS (Importing GPS records and processing)

1.Borewell infront of Swimming pool GPS no. 346 | 2.Delineation of JGI campus using Google Earth | 4. Refined Satellite Image of JGI Campus | 5. Satellite image of Jain Global Campus on GIS

3. Refining of an image in AUTOCAD civil 3D

DATA ANALYSIS:

Population and water consumption in Jain Global campus are shown in table 3.21 and table 3.22 respectively. Presently total population of the campus is 7750 with 1850 people staying in campus and 5900 staying outside the campus. But population is expected to change as the college grows. Therefore RWH system is designed for a design period of 20 years.

Design Population in 2035: There are a number of factors that affect population growth. In case of Jain global campus some of them are explained below

1.Opportunities: This include availability of funds, growing demand as well as increasing number of international students will increase in increase in population growth rate.

2.Threads and Weakness: The high rate at which engineers are produced in the country as well as the new colleges advancing in the vicinity are threads that could have negative impact on campus.

3.Other Factors: All the campuses of Jain University are to be moved into Jain Global campus in two years. The metro is to be brought to Harohalli. Both the factors will result in increase in population of Jain Global campus.

Considering all the factors population at the end of design period of 20 years can be estimated to be 5 times the present population.

Water Demand Calculation:

From table 3.22 total consumption for inmates and day scholars are 135lpc and 50lpc respectively. According to monthly water bill from WBSSB water consumption in Jain global campus is 30000kl per month. To accommodate variations in demand maximum daily demand will be considered and taken as 210% of average demand.

Table: 1 Jain Global Campus Population in 2015:

Description	Population	Demand
Inmates	1,850	=2.1 (1,850*135+7,750*50) =1.14MLD
Day Scholars	5,900	
Total	7,750	

Table: 2 Jain Global campus population in 2035:

Description	Population	Demand
Inmates	9,250	=2.1 (9,250*135+38,750*50) =5.72MLD
Day Scholars	29,500	
Total	38,750	

DESIGN OF RAINWATER HARVESTING SYSTEM:

The calculations for the storage tank are made based on the monthly rainfall data collected and the monthly demand of water. In order to get the accurate quantity of water to be stored by the tank, the runoff coefficients have to be considered. Runoff coefficient

represents the catchment losses and it depends on the nature of the surface and intensity of rainfall. The table below shows runoff coefficients for different surfaces.

DESIGN OF THE PIPES:

Table: 3 Maximum Rainfall

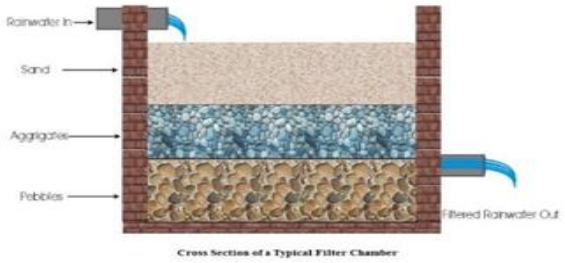
Description	Rainfall
Minimum	0
25^{th} percentile	14
Median	24
75^{th} percentile	43.3
Maximum	147

Table: 4 Design of the pipe, For example the diameter of the pipe of the sub staff quarters is calculated as follows:

Description	Value
Area of the sub staff quarters	156 m^2
Rainfall	50 mm
Diameter of the pipe	50mm

FILTERS:

Water collected from the roof or any paved surface has some contaminants (leaves, dust, bird droppings etc.), these contaminants can be removed by filtration process. Filtration can be done with the help of sand filters which is cheap and easy to install. The Sand filter is shown in the figure below:



Cross Section of a Typical Filter Chamber

MAXIMUM DAILY RAINFALL FOR KANAKAPURA:

From the above information the pipes are designed for a rainfall of 50mm. This rainfall is used with the respective areas of individual houses in order to design the diameter of the pipes. Table: 5 Sizing of the rainwater down take pipe:

Pipe Diameter (mm)	AVERAGE RATE OF RAINFALL (mm/hr)					
	50	75	100	125	150	200
	AREA IN m^2					
50	13.4	8.9	6.6	5.3	4.4	3.3
65	24.1	16.0	12.0	9.6	8.0	6.0
70	40.8	27	20.4	16.3	13.6	10.2
100	85.4	57.0	42.7	34.2	28.5	21.3
125	159.71	106.73	80.50	64.3	53.5	40.0
150	249.60	166.82	125.27	100.0	83.6	62.7

Table: 6 Runoff coefficients for various surfaces of the catchment:

Types of Catchments	Co-efficient
Roof Catchment	
Tiles	0.8-0.9
Corrugated metal sheets	0.7-0.69
Ground surface covering	
Concrete	0.6-0.8
Brick pavement	0.5-0.6
Untreated ground catchment	
Soil on slopes less than 10%	0.1-0.3
Rocky natural catchment	0.2-0.5

Table: 7 Design of Dimensions of a tank

Description	Value
Rainfall	0.1773 m
Rooftop area SET college	6,476.5m^2
Runoff coefficient	0.8
Volume of collected water	0.1773 m *6,476.5*0.8 = 803.86cum
Area of SET skylight	2,127.15 m^2
Volume of collected water (SET skylight)	0.1773*2,127.15*0.8 = 264cum
Total volume of water collected	1,064.86cum
Dimensions of the tank	5m*16 m*16 m

DESIGN OF THE TANK:

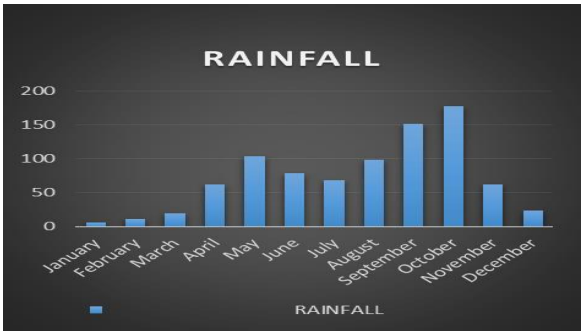
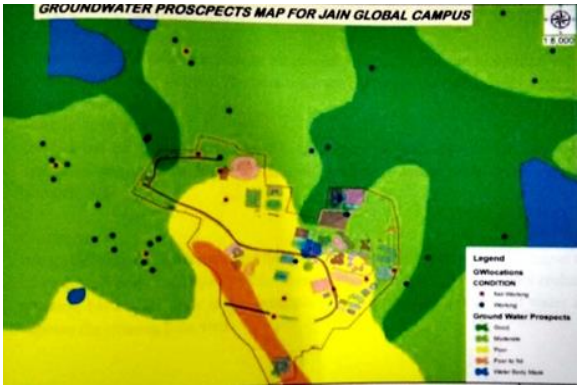


Table: 8 Monthly average rainfalls for Kanakapura

MONTH	RAINFALL
January	5.32
February	10.65
March	18.97
April	61.65
May	103.23
June	78.36
July	68.58
August	98.58
September	151.63
October	177.27
November	62.33
December	23.08

GROUND WATER PROSPECTS FOR JAIN GLOBAL CAMPUS:

A study and mapping of ground water potential zones is essential in selecting the proper location of the bore well points and the prevention of bore wells failure. However, the bore wells will continue working only if there is a balance between the ground water withdrawal and ground water recharge. Overexploitation of ground water will lead to bore well failure. The mapping of ground water potential zones can be done with the help of the existing bore wells in an area and the use of Geographic Information System (GIS). The ground water prospects map of Jain Global campus is shown.



CONCLUSION

From the study made, it is observed that high costs are incurred in supplying water for Jain global campus and it was concluded that implementation of rainwater harvesting system as well as recycled water can reduce the quantity of BWSSB water by 69% for present population water demand and 33% for future demand (20 years design period) thus reducing the costs. A Survey was carried out in Jain global campus as well as the area surrounding the campus (within 2kms radius from the campus). It was observed that only 4 out of 12 bore wells are working in the campus whereas only 4 out of 30 bore wells are not working outside the campus. With the help of GIS, under-ground water prospect zones were analysed and it was observed that Jain global campus is located on the ridge with very little underground water. Therefore it is concluded that artificial ground water recharge be done.

FURTHER SCOPE

The area surrounding Jain global campus has good water potential, there are more than 50 bore wells within a radius of 2kms from the global campus. It is evident from this statistic that in the near future the ground water will be depleted if proper ground water recharge measures are not implemented. The global campus will also be affected, so ground water recharge should not only be practiced inside the campus but even in the surrounding area. The ground water recharge in the surrounding. The ground water recharge in the surrounding area can be done by check dam/nala bund, recharge wells, bore well recharge and recharge shaft.

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