RAIN WATER HARVESTING A CASE STUDY FOR S. G. BALEKUNDRI INSTITUTE OF TECHNOLOGY CAMPUS BELAGAVI

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Abstract
Water is as important for survival of human being as much as food, air etc, but hardly any attention is paid for its economical use and conservation of this precious resource. Due to indiscriminate pumping of ground water, the water table is going down abnormally. Rains are the main source of water and if rain water is harvested, the scarcity of water can be eliminated altogether. Rain water is bacteriologically pure, free from organic matter and soft in nature. In this paper an attempt has been made to quantify the volume of water collected as 92, 14,360 litres annually and provision also made for ground water recharge. In this paper the estimation of the appropriate size of the water tanks to fulfil the annual drinking water demands through Domestic Rooftop Water Harvesting (DRWH) from rooftop of different areas are done. A mathematical equation expressing the relationship between the required size of water tank and different rooftop areas is developed. Rain water harvesting as a technique to preserve fresh water has been adopted for the study area of SGBIT campus located at Belagavi.

Keywords: Rain, water, harvesting, rooftop, analysis.

Introduction

India has a long tradition of water harvesting. Many of the traditional water harvesting systems have either fallen into disuse due to a variety of physical, social, economic, cultural and political factors which have caused their deterioration [1]. Water conservation has become the need of the day. Rainwater harvesting is a way to capture the rainwater at the time of downpour, store the water above the ground or charge the underground water and use it later [2]. This happens in open areas as well as in congested cities through the installation of required equipment. The collection and storage of rainwater from run-off areas such as roofs and other surfaces has been practiced since ancient times in India. It is particularly useful where water supply is inadequate.

Rainfall is the prime source of water and if rain water is harvested, the scarcity of water can be eliminated altogether. This is an ideal solution to overcome water problem where surface water sources are insufficient and inadequate groundwater supply quantitatively and qualitatively. Rooftop RWH is essential for making water available for future use and In fact India is blessed with adequate rainfall as a whole, yet there are large swathes of dry and drought prone area. In many places the quality of groundwater is not good. In such places rainwater harvesting may provide lifeline for survival. The reality of water crisis cannot be ignored. India has been notorious of being poor in its management of water resources. The demand for water is already outstripping the supply.

The rainwater harvesting system has been proven to conserve freshwater resource. However, it depends on many factors including amount of water that can be collected, non-potable use of water, economic feasibility and most importantly public perception of the system and its benefit in water conservation and ecosystem. The current study attempts to analyze the feasibility of a rainwater harvesting system for college campus. The objectives are to determine the optimal size of the cistern that will

collect and supply the water demand for various purposes. College usually have collection of large buildings which can potentially collect large quantity of rainwater, which can be used for many non-potable usages.

Scope of the Study

According to the Central Ground Water Board, the reservoir of underground waters will dry up entirely by 2025. As more than 50% of the Indian population is expected to shift to cities, consequently fresh drinking water is anticipated to become scarcer. To overcome the potential water scarcity and to become self-sufficient, better water management techniques need to be adopted. In this context application of rainwater harvesting can serve as one of the promising methods for conservation of water. Rain water harvesting is a process of capturing rainwater where it falls or capturing the runoff and taking measures to keep that water clean by not allowing pollution to take place in the catchments.

Objectives

1. This paper is carried out to cater the need of the water for the SGBIT campus; Belagavi. This study will not only be helpful to fulfil the need of water supply to this college but also to provide water to faculty residing in the Campus.
2. The water stored from the rainwater will also be of good quality i. e. free from impurities which might be there in groundwater of Belagavi as it is having large number of industries & e-waste.
3. Providing a Storage tank, Filtration tank and an Infiltration gallery for the ground water recharge from excess water.
4. Keeping in mind the increasing water demands, quality of water supply, variations in water availability and advantages of collection and storage of rainwater near the place of use etc, it was planned to design the rain water harvesting system for the SGBIT campus.

Literature Review

M. Dinesh Kumar et al- The important points to make water harvesting efficacious: Developing a better understanding of catchment hydrology, developing basin water accounting and balance. [1] Arun Kumar Dwivedi et al- The size of the water tank required for fulfilling the drinking and cooking water demand of a family from DRWH from rooftop area of different sizes, as expressed by mathematical equations is exclusively for area of study. [3] S Rehan Ali et al- The Rainwater Harvesting will not only maintain the water level of the groundwater of the region but also save the water resources and power consumption for future use. [4] C. J. Khilare et al- Results obtained from the present study suggested that Rooftop RWH method is more applicable in campus which is located in drought prone zones of Maharashtra that would enable to solve the problem of water scarcity to certain extent. [5] Ramya et al- The harvested rainwater can be used for non-potable purposes after employing filtration from the designed composite rainwater harvesting unit. When the quality aspects of main source of drinking water is looked into, rainwater harvesting is an economical option to overcome dependency on water supply. [6] Sivaraman K.R. et al- Among the various measures suggested for improving the groundwater level were systematic execution of rainwater harvesting, diversion of excess rainfall to nearby tanks, provision of vegetable cover on soil for quick recharge, to adopt sustainable alternative methods such as desalination to balance demand and supply, create awareness of reuse of wastewater and dual water system to protect the existing water resources. [7] Manoj K. Jha et al- From this analysis, we can see that the rainwater harvesting technique would be most beneficial to a building that has large surface area and greater irrigation demand. Lowered water consumption along with lower hydrological footprint will contribute to sustainability. It will reduce water usage and energy consumption for the school. It will decrease storm water runoff and increase awareness of sustainability for students. [8] K S Umamani et al- To summarize, RWH is an essential and welcome initiative taken up by the BWSSB individually, as also by the various institutions involved in RWH. However, it is important that the process of implementation of RWH is strengthened further throughout the state. It is also important that the initiatives taken in respect of RWH across various institutions are coordinated so as to ensure better results. [9] Mrs. S.D. Khandagale et al- It is no denying that sustaining and recharging the groundwater along with judicious use of the limited fresh water resources is the need of the hour. If sufficient measures are not taken up immediately, we will face a crisis which will be detrimental to the very survival of mankind. Efficient management of water resources and education about judicious

utilization of water resources along with measures of harnessing, recharging and maintaining the quality of water and water bodies has to be taken up on war footing. [10]

Components of Rainwater Harvesting System

A Rainwater harvesting system comprises of components for pipes or drains, filtration, and tanks for storage of harvested water. The details of the components of rainwater harvesting system have shown in figure.

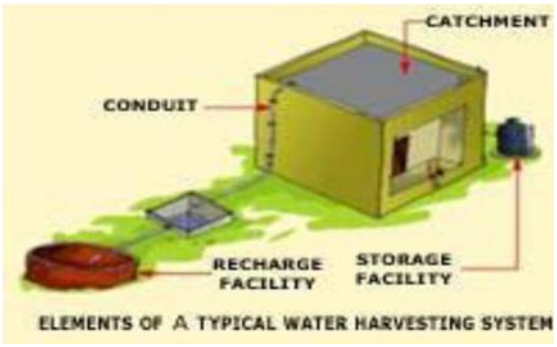

Fig2. Elements of a typical water Harvesting System

A rainwater harvesting system comprises components of various stages - transporting rainwater through pipes or drains, filtration, and storage in tanks for reuse or recharge. The common components of a rainwater harvesting system involved in these stages are illustrated here.

1. Catchments

The catchment of a water harvesting system is the surface which directly receives the rainfall and provides water to the system. It can be a paved area like a terrace or courtyard of a building, or an unpaved area like a lawn or open ground. A roof made of reinforced cement concrete (RCC), galvanised iron or corrugated sheets can also be used for water harvesting.

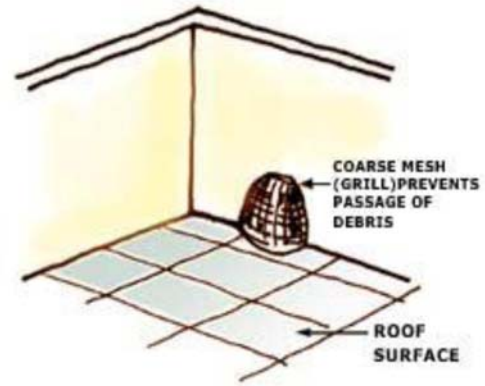

Fig3. Catchment & Coarse mesh

2. Coarse Mesh

Provided at the roof to prevent the passage of debris.

3. Gutters

Channels are provided all around the edge of a sloping roof to collect and transport rainwater to the storage tank. Gutters can be semi-circular or rectangular and could be made using:

- Locally available material such as plain galvanised iron sheet (20 to 22 gauge), folded to required shapes.
- Semi-circular gutters of PVC material can be readily prepared by cutting those pipes into two equal semi-circular channels.
- Bamboo or betel trunks cut vertically in half.

The size of the gutter should be according to the flow during the highest intensity rain. It is advisable to make them 10 to 15 per cent oversize.

Gutters need to be supported so they do not sag or fall off when loaded with water.

4. Conduits

Conduits are pipelines or drains that carry rainwater from the catchment or rooftop area to the harvesting system. Conduits can be of any material like polyvinyl chloride (PVC) or galvanized iron (GI), materials that are commonly available.

The following table gives an idea about the diameter of pipe required for draining out rainwater based on rainfall intensity and roof area.

Study Area Location

SGBIT campus is located in the Belagavi, state of the Karnataka, in India, has been undertaken for the present investigation. The geographical area of the Belagavi is 94 sq. Km. the city is situated in western ghat in Karnataka between 15^0 51' North to 74^0 30' East Latitude. It has an average elevation of 784 meters (2572 ft). The total population of the city is 6, 43,862 as per 2011 Census.

Extent of the study area

SGBIT Campus comprised with 10.08 acres of campus with 11971m^2 built up area. Population of college is about 2000 including students, teaching and non-teaching staff and daily visitors.

There is great demand of water in college mainly for laboratories used in Civil Engineering, Mechanical Engineering, Chemistry, Physics etc., for use in cleaning the building floors, labs as well as classes.

The reasons for collecting and using rainwater for domestic use are plentiful and varied. The use of rainwater is a useful alternative to provide continuous flow of water for the students and Laboratories.

Fig1. Location Map of SGBIT Campus, Belagavi

Climate of Study Area

Belagavi is known for its pleasant climate all round the year. Summer season is considered as humid as the temperature goes up to 38^0 Celsius. And is coldest in winter (Temperature is dropping to 12^0 Celsius). And it experiences almost continuous monsoon rains from June to September. Belagavi sometimes receives hail storms during April. The annual average rainfall is about 1200mm.

Methodology

Rainwater harvesting techniques may be defined as the process of augmenting the natural infiltration of rainwater or surface run off into the underground formation by some artificial methods. The methods suggested are water spreading, recharge through pits, recharge wells, chambers, trenches, bore wells, open used well cum charged wells, shafts and directly diverting runoff water into the existing wells or in the defunct irrigation or drinking water wells.

If appropriate methods were not adopted, the purpose of rainwater harvesting gets defeated. Following steps are commonly followed in rainwater harvesting from roofs. They are: Collection of rain water, separation of first rain flush, filtration of rain water, storage of rain water and distribution of rain water.

Domestic, Office & Educational Complexes & Industries:

Collection through roof top for individual and multi-storey houses, percolation pits, pebble bed, ponds, ditch and furrow storage, well-cum-canal-cum-percolation pit, utilisation of existing functioning and defunct wells & bore wells, dug-cum-bore well, service-cum-recharge well, broken brick / pebbles, recharge wells, storm water drains and stopping of rain water gushing out of the gate and from compound by dwarf wall in housing complexes.

How much water can be harvested?

The total amount of water that is received in the form of rainfall over an area is called the rainwater endowment of that area. Out of this, the amount that can be effectively harvested is called the water harvesting potential.

Compiled from various sources total amount of rain water harvested = Rainfall in mm(R) x Area of catchment in m^2 (A) x Runoff coefficient(C)

Result and Discussions

Rain Water Harvesting system is designed to the college campus and the results are presented and discussed.

Table 1 Rainfall Data of Belagavi City

Year	1991	1992	1993	1994	1995
Rainfall(mm)	1261.6	1197.8	1307.5	1993.2	775.8
Year	1996	1997	1998	1999	2000
Rainfall(mm)	1052.3	2017.3	1101.2	1310.2	1097.4
Year	2001	2002	2003	2004	2005
Rainfall(mm)	774	1030.6	575	989	2095.1
Year	2006	2007	2008	2009	2010
Rainfall(mm)	1772.9	1430.2	1255.3	1497.7	1264.9
Year	2011	2012	2013	2014	2015
Rainfall(mm)	1273.1	859.7	942	1341.8	716.3

One of the specimen calculations shown for Civil Engineering Department

Total roof area of main building = 1056.51 m^2

Average annual rainfall of Belagavi city = 1245 mm

Potential rainwater from roof =A * R * C

= 1056.51 X 1.245 X 0.85

= 1118.05 m^3/ year

= 1118050 Litres/year

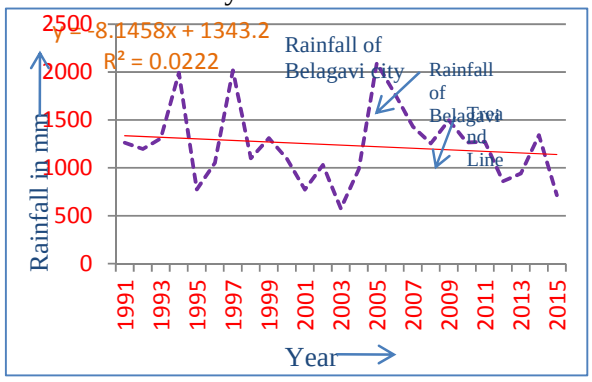

Fig.2 Rainfall of Belagavi City

Table 2 Calculation of Roof area and Volume of water

Building type	Roof area(m^2)	Volume of water in litres
Administrative Building	684.34	724200
Main Building	3184.93	3370450
Auditorium	645.74	683350
Chemistry and physics lab	635.54	672560
Machine shop block	163	172490
Machine and Energy lab	92.22	97590
New Mechanical Department	397.28	420420
Civil Department	1056.51	1118050
Girls hostel 1	1400.77	1482360
Girls Hostel 2	254.4	269210
Mess Building	130.79	138400

Design a rainwater harvesting system:

Main steps to be followed in designing a RWH system are

a) Determine the total amount of required and available rainwater

b) Design of Storage Tank

c) Design of Filtration Tank

d) Design of Infiltration Gallery

a) Total amount of required and available rainwater: To estimate water demand the following equation can be used

Demand= Water Use x Number of Persons x 365 days

If the average water use per person is 10 litres per day and the Institute has 2000 members,

Then Demand = 10 litres x 2000 member x 365 days=7300000 litre per year.

b) Design of Storage Tank: From the Drawing of Terrace Floors,

Catchment area:

Total Roof water from Civil Department, Mechanical Department, Energy lab, Machine shop Block, Mess Building, Girls Hostel 1, Girls Hostel 2

Amount of Rain Water Harvested Annually=3698520 Litres

Amount of rain water harvested daily=this is based on the dry period, i.e. the period between the two consecutive rainy seasons. From the rainfall data the dry session is of 245 days, Therefore Amount of rain water harvested daily=3698520/120

=30821 Litres

For this volume of water storage tank of dimensions 5m x 5m x 3m can be constructed.

Table 3 Estimation of Storage tank

SN	Description of work	Unit	No	Length (m)	Breadth (m)	Depth (m)	Quantity (m^3)
1	Earthwork	m^3	1	6.6	6.6	3.5	152.46
2	P. C. C. Bed	m^3	1	6.6	6.6	0.5	21.78
3	BBM	m^3	4	6.6	0.3	3	23.76
4	R. C. C. Slab	m^3	1	7	7	0.15	7.35
5	Ventilation pipe	No's	1	-	-	-	1
6	Cover	No's	1	-	-	-	1

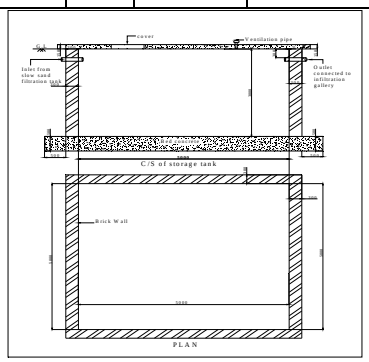

Fig 3 Storage Tank

c) Design of Filtration tank: Sand filters have commonly available sand as filter media. Therefore providing a slow sand filter.

Therefore providing 1 Filter unit with dimensions of 6m x 3m x 2.6m

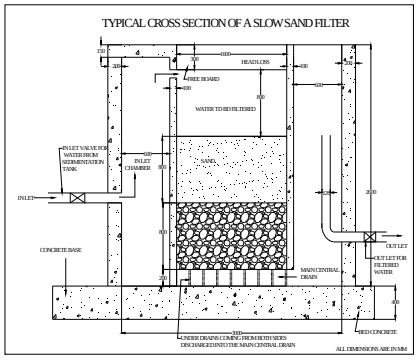

Fig4. Filtration Tank

d) Design of Infiltration Gallery: Providing a Circular infiltration gallery with diameter of 2.6m and depth of 3m

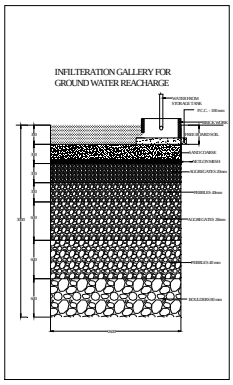

Fig5. Infiltration Gallery

Quality of Stored Water:

Rainwater collected from rooftops is free of mineral pollutants like fluoride and calcium salts that are generally found in groundwater. But, it is likely that to be contaminated with these types of pollutants:

1. Air Pollutants
2. Surface contamination (e.g., silt, dust)

Such contaminations can be prevented to a large extent by flushing off the first rainfall. A grill at the terrace outlet for rainwater can arrest leaves, plastic bags and paper pieces carried by water. Other contamination can be removed by sedimentation and filtration. Disinfectants can remove biological contamination.

Conclusion

Analysis reveals that the quantity of water available depends on intensity of rainfall and the surface of the roof, and additional sources of water are always needed. For long periods of drought, it is necessary to store excessively large volumes of water. In areas with significant variations in the annual rainfall pattern, the matching of water supply and water demand may be difficult. However, institution has a crucial role to play.

Rainwater in many cases is the easiest way to access, most reliable, and least polluted source, especially in drought prone areas or where the groundwater is saline.

1. It is concluded that implementation of RWH system for SGBIT campus would result in the form of the best approach to deal with present scenario of water scarcity.
2. Huge quantity of water as 9214360 litres can be collected in a year in college campus.
3. Providing a main storage tank of dimensions 5m X5m X3m
4. Providing a Filtration tank as slow sand filter with dimensions 6m X 3m X 2.6m
5. Providing a circular Infiltration gallery for the ground water recharge of dimensions of depth 3m with a diameter of 2.6m

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