International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 03 | March-2016 www.irjet.net p-ISSN: 2395-0072

SUSTAINABLE WATER HARVESTING MANAGEMENT FOR SOUTHERN WEST PARVATI TERRAIN OF PUNE

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Abstract – *Due to rapid pace of urbanization many of the world's largest cities are facing problems with urban floods. The natural hydrological cycle manifests itself at different scales, depending upon climatic, geographic and biological factors. This study tries best to contribute to rising water problem in APCOE&R College in summer season by revealing students knowledge and natural behavior towards water harvesting. With continued population growth of students each year and increasing basic demands on water resources; natural harvesting has an increasing role for southern west Parvati terrain of Pune. Economizing on water use will be an important aspect of any effective response. Naturally recharge groundwater techniques offer possibilities for more extensive use of water within the campus area. Study will help to reduce over exploitation of water resources due to increase in demand. It is hoped that the information gathered through this project may be used to take inform decisions regarding water harvesting efforts for institution itself. Implementation of natural rain water collection system will help to increasing ground water table, which will very beneficial to fulfill the institutional water requirements in summer season.*

Key Words: Sustainable development, rainwater harvesting, watershed, natural ponds.

1. INTRODUCTION

Main aim of this research to study and implement a natural way to capture rainwater at the time of downpour, store that water above the ground or charge the underground water and use it in summer season. As there is scarcity of water in summer season some natural groundwater recharge techniques should be carried out. This can be practiced on hilly areas of Parvati region by collecting rainwater in ponds also by utilizing roof rainwater from college buildings located in Shahu College Campus and providing natural drainage system for the same. [1][8][9]

Thus the research focuses on naturally evolve appropriate guidelines for harvesting of water based on the existing water management practices and identify optimum recycle/ reuse options of water.

1.1 Scope of Study

Information gained from this work and implementation of it will allow maximum use of hilly region & rainwater in the benefit of mankind. This study will help to naturally collect, conserve and utilize rainwater for the future needs. By studying the past results of rainfall in Parvati Pune region water can be supplied even if municipalities cutoff the water supply which usually happens in summer season. [3]
Also this research will be beneficial for landscaping which will improve the aesthetics of surrounding area as well as fulfill the water demand.

2. LITERATURE REVIEW

2.1. Smart Controller Water Saving Studies Literature Review Of Water Saving Studies For Weather And Soil Moisture Based Landscape Irrigation Controlled Devices.

By:

- Southern California Area Office Temecula, California
- Technical Service Centre, Water Resources Planning And Operation Support Group Denver, Colorado

Published Year – APRIL 2008

This document summarizes the findings of a literature review of publicly available reports and articles for water savings studies that evaluated weather and soil moisture based ("smart") landscape irrigation control devices. It serves as a Supplemental document to the bureau of reclamation (2007) technical review report weather and soil moisture based landscape irrigation scheduling devices. The purpose of this document, and the Technical Review Report which it supplements, is to document the overall status of emerging weather and soil moisture based landscape irrigation controller technology with the intent to assist

water agencies in their efforts to promote this technology as a means of conserving water and reducing irrigation runoff induced pollution. These reports will be revised periodically in an effort to maintain up-to-date information.[2]

2.2 Sustainable Rain Water Harvesting, harvesting and management strategies for urban and rural sector, Nagpur

By:

- Dr.R.K.Sivanappan

Published Year : 11 November, 2006

Place	Rainfall in mm	Population	Availability of water/person/ year/M3/p/year
World	840	6 Billion	700
India	1150	1.0 Billion	2200

This report is based on different methods of rain water harvesting and harvesting systems. In this research they describe the three basic components of rainwater harvesting system:

1. Catchment Area i.e. the surface area utilized for capturing the rainwater.
2. Collection devices, like tanks or cisterns or percolation pits used for collection and holding the rainwater.
3. Conveyance system i.e. the system of pipe or percolation pits through the ground water is recharge and that water is collected by different sources like bore holes.

In this report they explained the different types of sources of rainwater harvesting and water harvesting systems in urban and rural areas Nagpur.[4]

2.3 Report on water harvesting method Ministry of agriculture and fisheries
Demand management of irrigation district water supplies

By:

- KEER WOOD Leidal Associates Ltd.

Technical working paper 1
Published year – FEB 1990

KEER WOOD leidal associates LTD (KWLA) have been retain by the ministry of agriculture and fisheries to undertake a comprehensive study that identified mechanism available to implement demand – side management, thereby encouraging better use of existing water resources through improved management and harvesting. The study is to be broad base, with consideration given to appropriate pricing and education.[5]

2.4 Potential For Water Harvesting & Harvesting Against Drought In Rajasthan, India

By:

- *Dr. Pratap narain*
- *Dr. M.A.Khan*
- *Dr.G.Singh*

Working Paper: 104
Drought Series: Paper – 7
Published year: 2005

This report is a part of research project, "Drought assessment & mitigation potential in south west Asian" Implemented by international water management institute. Rajasthan is a largest state in India covering an area of 34.22 million hectors, i.e., 10.5percent of country geographical area, but sharing only 1.15 percent of its water resource. In this state 70 percentage of people depends on agriculture based activities. This study examines the potential for water harvesting & harvesting against drought in Indian state of Rajasthan. It includes various water harvesting and harvesting techniques. The state still has significant potential for harvesting &harvesting of water, if an integrated water resources management approach is adopted & proper policies & investment action are implemented using recent technologies.[6]

3. STUDY AREA

In order to achieve the objectives of the present study an implementation is to be carried out at Anantrao Pawar College of engineering and research which is located at southern west region of parvati, pune, state of Maharashtra in India. The geographical campus area of college is 38 Acres which is located just beside parvati hills. This college is situated at latitude of 18.490802 south and longitude of 73.843787 west. The average elevation of parvati hill is 640meters (2100 feet's) above mean sea level.[14]

Fig. 1: Study Area

The study area of this project contains a mountainous hill region where rainwater can be collected. On which ample of trees are planted this prevents soil erosion. It also includes various institutes such as ITI College, Shahu College of Higher Education, law College and also primary-preprimary School. A Hostel facility building in the college campus can be studied deeply for smart and engineering way of water harvesting through this project. The Campus area where various studies can be carried out includes a playground below the said mountainous hill region.[3]

Some sloping hills (minor & major) can be understood and utilized properly for this project of water harvesting. Such a southern-west parvati terrene of pune city in Maharashtra state of India can be designed and planned effectively for usage of rainwater in study area. Following map shows total study area.

The main parameters studied were past results of rainfall, runoff calculation, volumetric capacity of ponds, roof rainwater capacity, and natural design of drainage system.

4. PROPOSED METHODOLOGY

4.1. Mapping of Study Area: Initial step of this project is of Mapping of Study Area which includes, Satellite mapping method by using the Global Positioning System device which can be seen by using internet on mobile device. This initial step also includes the topographical of Study Area in which we learn about the topography of our College i.e. hilly region. After this we grouped the Study Area in deeply which has made our goal specific to be studied on such a mountainous hilly region. Then we detected as well as found out the direction of runoff by using the GPS device. The catchment area of our study area has been decided by the same GPS device and has been identified so that the natural water harvesting system can be installed in this Parvati terrene region.

4.2 Identification of Storage Bodies within Study Area: We identified the depressions which were located in this study area. Then the process of selection of suitable depression were carried out which will fulfill the demands of the population within the study area. Depending upon the size of depression, availability of runoff water, under laying bed of the depression.

Fig. 2: Grouping/Zoning of Study Area

4.3 Calculation of expected runoff of Study Area:

Depending upon rainfall, runoff is calculated for this various formulae are used. These formulae's are based on actual field data wherein following parameters are considered,

- Catchment Area (Area Size)
- Rainfall (Total Receipt of Rainfall)
- Nature of Catchment(Relief type of Rocks, no. of streams)
- Average temperature (Rate of evaporation)[11]

Following formulae are used to calculate the rainfall-runoff relationship.

1) Sir Inglis Formula:

Ghats fed Catchment (i.e. the western slopes of western Ghats receiving heavy rain from the south west monsoon winds).

$$R = 0.85\,P - 30.5$$

Where in, R= Runoff (in mm)

P= Precipitation (in mm)

2) Khosla's Formula:

In this formula, Dr.Khosla has added one more aspect of temperature to see the effect of evaporation on the total water received through the precipitation.

$$R = P - 5\,T$$

Where in, R= Runoff (in mm)
P= Precipitation (in mm)
T= Average Temperature (in degree Celsius)

4.4 Identification of location of maximum storage within Study Area:

Depending upon maximum storage classification of depression is done as minor or major storage pond. Volume of minor pond varies from 10 to 30 cubic meters and capacity of pond above 30 cubic meters is considered as major storage pond.

Table -1: Classification of ponds as per study

Classification	
Minor ponds in Cubic meter	Major ponds in Cubic meter
10 to 30	Above 30

4.5 Demand Calculation:

Water required for dinking, toilet flushing, and canteen purpose is found out using data which includes population, per capita demand, by future prediction.[7]

4.6 Soil Permeability Test:

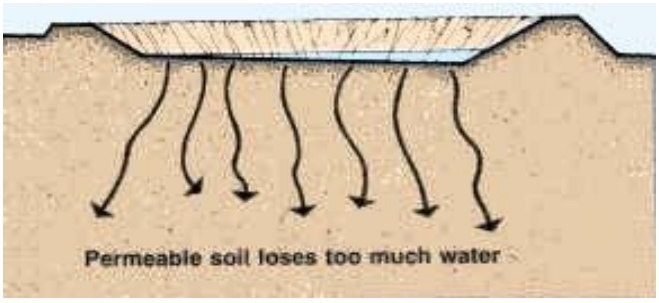

Fig. 3: Soil Permeability [11]

Soil Permeability is the property of soil to transmit water and air and is one of the most important qualities to consider fish culture.

A Pond Build in impermeable soil will lose little water through seepage. The more permeable soil, the greater the seepage. Some soil is so permeable and seepage so great that is not possible to built a pond without special construction techniques.

Soils are generally made up of layers and soil quality often varies greatly from one layer to another. Before pond construction, it is important to determine the relative position of permeable and impermeable layers. The design of pond should be planned to avoid having a permeable layer at the bottom to prevent excessive water loss into the subsoil by seepage.

The constant head permeability test involves flow of water through a column of cylindrical soil sample under the constant pressure difference. The test is carried out in the permeability cell, or permeameter, which can vary in size depending on the grain size of the tested material. The soil sample has a cylindrical form with its diameter being large enough in order to be representative of the tested soil. As a rule of thumb, the ratio of the cell diameter to the largest grain size diameter should be higher than 12 (Head 1982). The usual size of the cell often used for testing common sands is 75 mm diameter and 260 mm height between perforated plates. The testing apparatus is equipped with a adjustable constant head reservoir and an outlet reservoir which allows maintaining a constant head during the test. Water used for testing is de-aired water at constant temperature. The permeability cell is also equipped with a loading piston that can be used to apply constant axial stress to the sample during the test. Before starting the flow measurements, however, the soil sample is saturated. During the test, the amount of water flowing through the soil column is measured for given time intervals.[13]

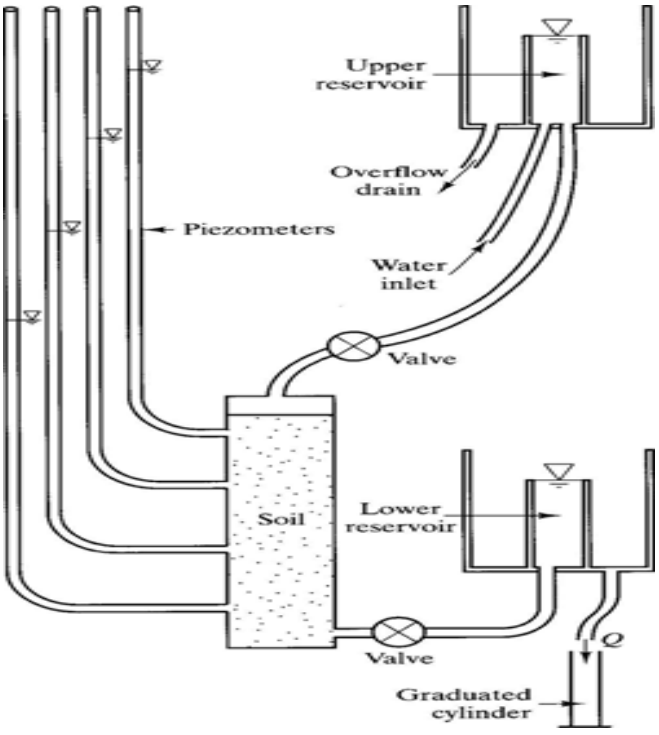

Fig. 4: Soil Permeability Test[13]

Knowing the height of the soil sample column L, the sample cross section A, and the constant pressure difference Δh, the volume of passing water Q, and the time interval ΔT, one can calculate the permeability of the sample as:

$$K=QL / (A.\Delta h.\Delta t)$$

4.7 Calculation of surface area of roof & amount of water available by roof:

In this Planning, surface area of roof top is calculated and depending on it amount of water available is calculated. This available water is much cleaner when compared to sloping rainwater collected in the pond. This rooftop water can be used after some primary treatment hence minimizing the cost of treatment. And this collected and treated rooftop water can be used for toilet flushing.

4.8.1 Indian Standard Guidelines for Rain Water Harvesting in Hilly Areas by roof water collection system:

Rain water may be harvested in areas, having rainfall of considerable intensity, spread over the larger part of the year, that is, in the hilly areas. Roof water collection is an ideal solution for water problem where there is inadequate ground water supply and surface sources are either lacking or insignificant. Rain water is bacteriological pure, free from organic matter and soft in nature.[10]

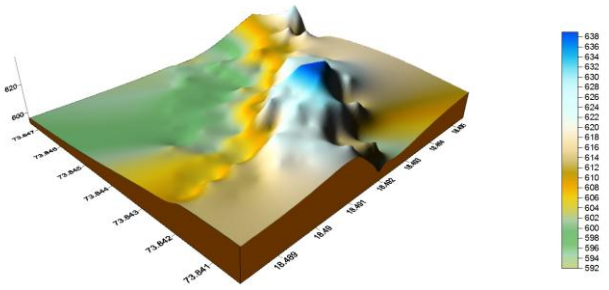

Fig.3 Topography of Study Area

ROOF WATER COLLECTION SYSTEM

4.8.1.1 In this system roof top forms the catchment.

4.8.1.2 Materials: Although suitable locally available materials of non-corroding, non-rusting, non-absorbent nature are permissible, for longer life, materials indicated below are recommended.

4.8.1.3 Roofing: Galvanized iron sheet , aluminimum sheet , deleterious glass fibre sheet, concrete clay tiles, slates and other roofing materials. Thatched roof may be used provided it is covered by water proof sheeting like food grade low density polyethlene films.If the roof is painted, only non-toxic paints be used for painting the roof. Water collected from roofs painted with toxic paints should not be used for drinking purposes.[8]

4.8.1.4 Drain *(Gutter):* Galvanized iron sheet , wood, bamboo or reinforced cement concrete gutters.

4.8.1.5 Down Pipe: Galvanized mild steel pipe, cast iron pipe , high density polyethylene pipe .

4.8.1.6 Storage Ponds:

Underground—Masonry or reinforced cement concrete structure suitably lined with water proofing materials, high density polyethylene tanks.

Over Ground/Surface—Galvanized iron sheet, reinforced cement concrete, plastic/high density polyethylene or ferro-cement sheet.

4.9 Design of Collection System: To collect the rain water design of collection system is done. On the basis of above data we can successfully install various natural collection systems. These collection systems include underground drainage system. Side drains can also be provided to effectively collection of rain water. Nature friendly ponds are used as rain water collection system.[9]

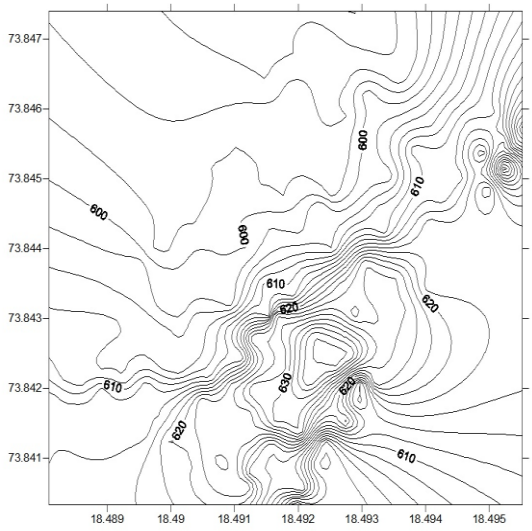

Fig. 4 Contour Map of Study Area

5. DISCUSSION AND PLANNING:

Parvati terrene is receiving ample of rainfall in Pune region, but experienced acute water shortage as a result of extensive deforestation and due to non-harvesting of water from different resources. Free flow of water along the slopes of hills has caused heavy erosion of top soil. There are now many stretches devoid of trees and greenery. Our college spends large amount of money for water, if effective water harvesting is implemented in our college, the things would have been different.

There is great demand of water in our college mainly for laboratories used in civil engineering, mechanical engineering and physics and chemistry laboratories etc. And also for use in cleaning the building floors labs and horticulture purpose also, for sprinkling the water in dry land of college is especially in summer season for preventing the dust particles in the air etc.

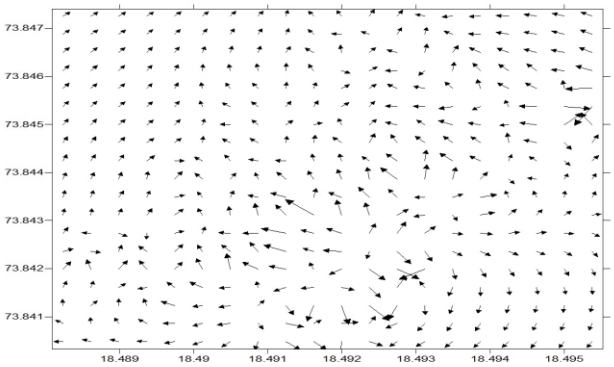

Fig.5: Analysis of Topography of Study Area

6. CONCUSION AND FUTURE WORK IN APCOE&R:

The 100% use of natural resources and percolation of the water is studied Various water harvesting systems Positive possibilities for collecting and using rainwater for Institutional demands. The use of rain water is alternative to provide continuous flow of water for students and laboratories in APCOE&R.

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