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Design and Implementation Of Water Conservation System For Southern West Parvati Terrain Of Pune

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Abstract – *When faced with a water shortage, a community or a country must either develop new water resources or reduce demand. 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 conservation. With continued population growth of students each year and increasing basic demands on water resources; natural conservation 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 conservation 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.*

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 rain falls over time and seeps underground to become ground water, it feeds submerged natural ponds, lakes and rivers. Also 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][7]

Thus the research focuses on naturally evolve appropriate guidelines for conservation 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. [2]
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 Indigenous Water Conservation System:

Himachal Pradesh Krishi Vishva Vidyalay, College Of Home Science, Palampur176 062, Himachal Pradesh [Vol-8(4)]
By :

- Mrs. Neetu Sharma
- Mrs. Promila Kanwar

Published Year: October 2009

Water is essential commodity for development & survival. But the ever-increasing the population, technological modernization, changing life pattern & erratic monsoon are likely to lead to water crisis. In this study they explain the different water conservation systems of Himachal Pradesh. The villagers had developed different techniques/structure in such a way that the ground water as well as the rain water could be utilized properly. The 100% use of natural resources and percolation of the water is studied. Various water conservation systems found in himachal Pradesh state like baudi, nawn, chhrudu, khatri, khad, nala, etc have been described.[4]

2.2 Rainwater Harvesting System :- For College Of Engineering, Teerthanker
Mahaveer University, Moradabad, Vol.3 (ISO 3297:2007)
By:

- S.Rehan Ali
- R.K.Jain

Published year: 3rd August 2014

Over the years, the raising population, growing industries and expanding agricultural practices have raised the demand of water supply. Rain is still main hope and source of our agriculture. By rain water harvesting ground water can be recharge but due to increasing in demand rate of depletion of ground water resources is high. Hence only rainwater harvesting will not be helpful to meet water demand.
In this project the focused is to design of tank to store rainwater from roof top of building to cater the need of water requirement for college of engineering Teerthanker, mahaveer university, Moradabad.

In this project rainfall characteristics are studied from year 2008 to 2012. Roof slab is of dome shape because dome shape is economical. Hence on the basis of water demand, ground condition and rain water data, it is proposed to develop the rainwater harvesting system which will not only maintain ground water level (GWL) but also saves water resources from depletion and reduce power consumption.[5]

2.3 Water Conservation & Sustainability : Shirpur Pattern
By:

- Mr. Amrishbhai Patel
- Mr. Suresh Khanapurkar

Published Year: 2012

The present research paper is based on the basic research of water conservation at Arunavati, Tapi River& at the southern footage in Shirpur Tehsil Dhule district. The main vision of the project to recharging the ground water by using different techniques like dry dug well near the river bank. The project officer Mr. Suresh Khanapurkar is a geologist of government of Maharashtra. The upper layer of alluvial soil can be removed and the problem is the lower yellowish layer of soil it can't percolate the water for this they are planning for the Shirpur pattern. This project is run in 100sq km area around the catchment of river Arunavati & Tapi. This pattern is also call as Amrishbhai Patel pattern all over Maharashtra.[6]

2.4 The Contribution Of Soil And Water Conservation To Sustainable Livelihoods In Semi-Arid Areas Of Sub-Saharan Africa
By:

- Charlotte Boyd

Paper No 102
Published Year-January 2000

This paper discusses the role of soil and water conservation (SWC) practices in sustainable livelihood and presents preliminary finding from case studies conducted in Tanzania and Uganda. In this research paper they told about the different activities included in this region for the availability of the policies for their conservation system in sub-Saharan Africa. The case study of this area Tanzania and Uganda like local soil classification , texture and cropping suitability.SWC plays an important role in the farming system of villages both macro-level; and micro-level factors have been an important influence on the extent to which households practice SWC.[9]

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.

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 conservation 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 conservation. 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, 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 conservation system can be installed in this Parvati terrene region.

Fig. 2: Grouping/Zoning of Study Area

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.

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)[7]

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.

4.6 Soil Permeability Test:

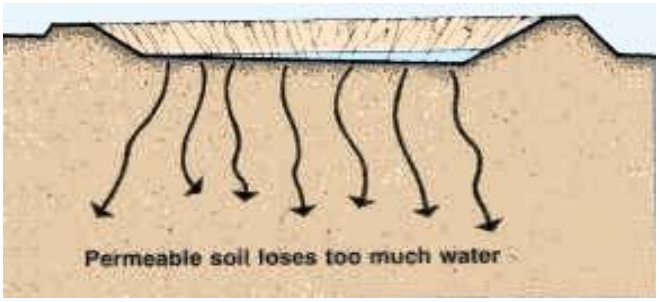

Fig. 3: Study of Soil Permeability [10]

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]

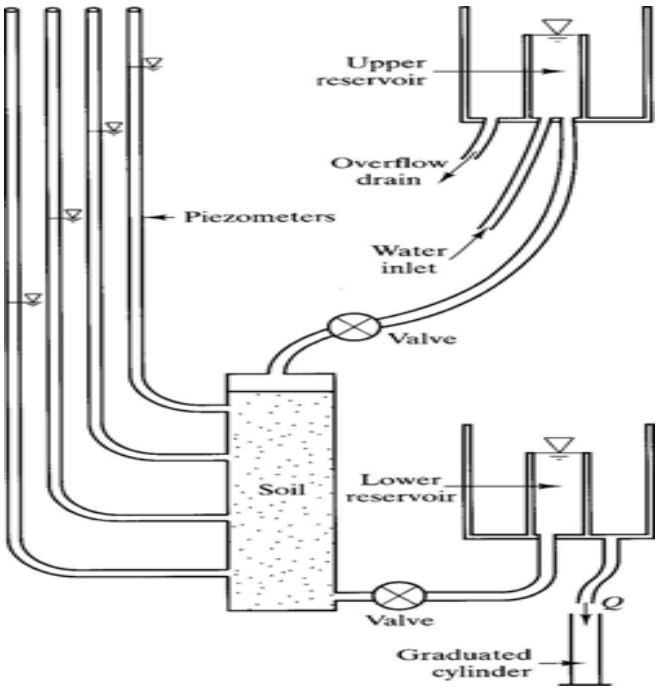

Fig. 4: Soil Permeability Test[13]

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.

4.7.1 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.[8]

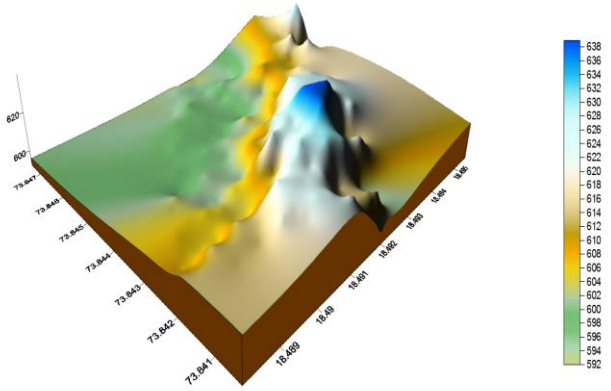

Fig.3 Topography of Study Area

ROOF WATER COLLECTION SYSTEM

4.7.1.1 In this system roof top forms the catchment.

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

4.7.1.3 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.

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

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

4.7.1.6 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.

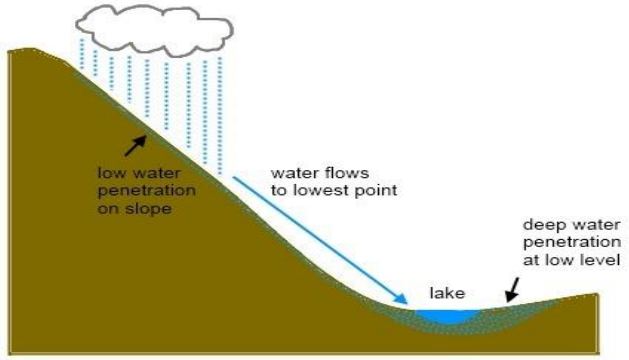

Fig. 3: Rain Water Collection [14]

4.8 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.[10]

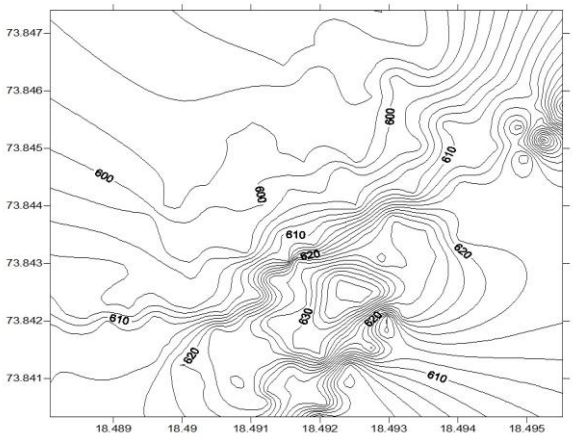

Fig. 4 Contour Map of Study Area

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-conservation 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 conservation 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.

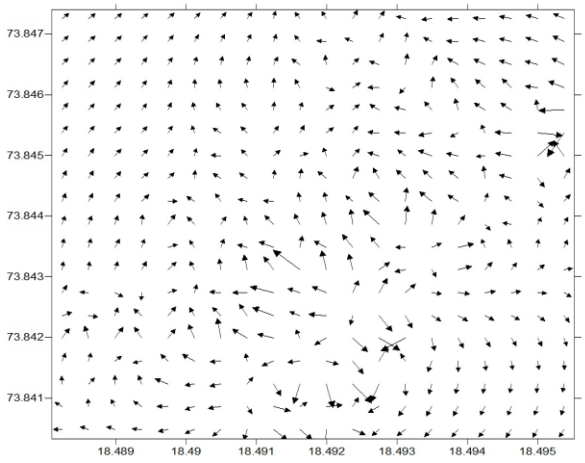

Fig.5: Analysis of Topography of Study Area

6. CONCUSION AND FUTURE WORK IN APCOE&R:

The 100% use of natural resources and percolation of the water is studied with various water conservation 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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Currently working at Anantrao Pawar College of Engineering and Research (APCOER), Pune India where he is Head of the Department since 2013. He completed his degree in Civil Engineering and Masters Degree in Environmental Engineering to focus and address the environmental issues and respective advance research. His area of research includes Water and Wastewater Treatment, Solid waste Management, Climate change. Sagar Gawande is a Life Member of the Indian Water Works Association (IWWA), Life Member of the Indian Society for Technical Education (ISTE), and Life Member of Institution of Public Health Engineering (IPHE). He effectively contributed in addressing the environmental issues through National and International journals since 2007.