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"Watershed Management"- A Smart Water Management for Smart Campus

Gaurank Patil[1], Soniya Kharasamble[2], Nikhil Shete[3], Sandesh Dhamane[4], Dipak Pali[5]

Student, Department of Civil Engineering, Trinity College of Engineering & Research, Pune, India[1,5]
Student, Department of Civil Engineering, Vishwaniketan Institute of Management Entrepreneurship Engineering Technology, Khalapur, Mumbai[2,3,4.]

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Abstract: At the rate in which Indian population is increasing, it is said that India will surely replace china from its number 1 position of most densely populated country of the world after 2030. These will lead to high rate of consumption of most valuable natural resource "Water" resulting in augmenting of pressures on the permitted freshwater resources. Ancient method of damming river and transporting water to urban area has its own issues of eternal troubles of social and political. In order to conserve & meet the daily demand of water requirement & increase ground water table, Watershed management is one of the best method fulfilling these requirements.

In future, everyday about 10,000 persons including Students, Staff – Members will come to KJEI Campus. In this campus, the intensity of rainfall is moderate, but there is no exact method use for storing this rainwater, so because of this summer season the campus needs to get water from outside sources like water tankers. The technical aspect of this paper is watershed management which collected from rooftop all buildings of KJEI Campus, all area of KJEI campus & surrounding hills of KJEI campus which is considered to be catchment area. First of all, we require following data to be collected to progress the imitation of our paper area is to be calculated, and the storage capacity with suitable design is to be considered. Volume of storage has to be calculated with suitable design is to be considered. Volume of storage has to be calculated with the most appropriate method of estimation. Locations of storage on the basis of hydrological analysis & Geographic Information System analysis is to be define in the campus.

Keywords: Indian Population, natural resources, KJEI campus, Watershed Management, rooftop, Catchment Area, Hydrological Analysis, Geographic Information.

Introduction

Watershed Management means the process of creating & implementing plans, programs & project to sustain & enhance watershed functions that affect the plant, animal & human communities within watershed management boundary. Watershed management is not so much about managing & mitigating human environmental interaction. Because human activity includes actions by government, municipalities, industries & landowners, watershed management must be cooperatives efforts. Effective watershed management can be prevent community water shortages, poor water quality, flooding & erosion. The expense of undertaking watershed management far less than the cost of future remediation. These are various points includes in watershed management & discuss briefly such as concept of augmenting groundwater reservoir.

Human activities on land have a direct & cumulative impact on water and other natural resources within a watershed. Upstream activities influence river flows and water quality downstream. Channelizing rivers, removing riparian vegetation along watercourses, paving recharge areas, filling in wetlands & consuming groundwater at rates faster than it can be replenished can have severe & in some cases, irreversible effects on natural systems. These effects in turn usually impair water quality, degrade aquatic & terrestrial habitat, contribute to a loss of biodiversity, contaminate underground aquifers & increase risks of flooding & erosion damage.

At the heart of watershed management is the underlying philosophy that **"Everything is connected to everything else".** Watershed components are interrelated & interdependent, like the links of a chin or the spokes of a wheel. Damage to any one watershed component runs of damage to all. The health of upstream components directly determines the health and function of areas downstream. If the headwaters of Duffins Creek & Carruthers Creek are healthy, areas downstream will benefit. If the headwaters of Duffins Creek & Camuthers Creek Watersheds are well managed then lake Ontario and the St Lawrence River Basin will benefit.

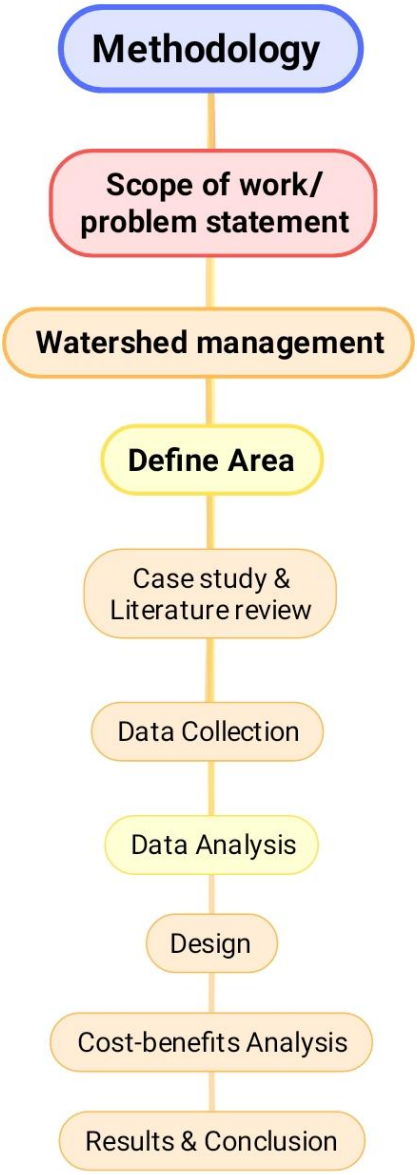
Literature Review

1] Mr. Pandurang D. Jankar & Dr. Mrs.Sushma. S. Kulkarni carried out **" A Case Study of Watershed Management For Madgyal Village":** It started that in the madgyal some measures have been adopted to recharge the ground water resources, but it has been found that these measures don't work with full capacity in some cases. In the madgyal watershed area, Demand for water for agriculture & drinking purpose is increasing rapidly deplecting water resources coupled with overpopulation. Efforts are made to divert large amount of rainwater to recharge ground water resources.
Conclusion: By disucssion with local peoples & technical experts, they collected information about past & present situation of water & water demand . They also collected information from social mapping, GIS survey including contour map, natural stream map & water delineation map. They designed bunds for the water storage.

2] Mr. Suhas P. Wani & Kaushal K. Garg worked on **" WATERSHED MANAGEMENT CONCEPT & PRINCIPLES"** and concluded that, watershed is not only simply the hydrological unit but also socio-political- ecological entity which plays crucial role in determining food, social & economical security & provides life support services to rural people. The criteria for selecting watershed size also depends on the objectives of the development \& terrain slope. A large watershed size also depends on the objectives of the development & terrain slope. A large watershed management can be achieved in Plain valley areas or where forest or pasture development is the main objective.
Conclusion: They studied on history of watershed development programs in India. We got information about delineation of watershed, we also came to know about components of watershed management. They focused on various approaches in watershed management.

Methodology

Flow Chart



Quality of Water**:** 1] Water being a good carrier for disease germs, should be well treated so as to avoid the dangerous water born disease. Therefore, impure water should be treated into pure water, which is potable one.

2] The treated water controls the various water born disease & makes it possible to safe guard the health of the people & reduce costly repairs of various machines & also raises the standard of living of the community.

3] The water supplied to consumers should be pure.

4] The term pure dose not means that it should be physically or chemically pure, but it should be potable. Domestic water should be free from impurities & bacteria.

Sr. No	Parameter	Limits	Remarks
1.	Colour	5	May be extended up to 50 if toxic substances are suspected.
2.	Turbidity	10	May be relaxed up to 25 in the absence of alternate
3.	pH	6.5 to 8.5	May be relaxed up to 9.2 in the absence
4.	Total Hardness	300	May be extended up to 600
5.	Calcium as Ca	75	May be extended up to 200
6.	Magnesium as Mg	30	May be extended up to 300
7.	Copper as Cu	0.05	May be relaxed up to 1.5
8.	Iron	0.3	May be extended up to 1
9.	Manganese	0.1	May be extended up to 0.5
10.	Chlorides	250	May be extended up to 1000
11.	Sulphates	150	May be extended up to 400
12.	Nitrates	45	No relaxation
13.	Fluorides	0.6 to 1.2	If limit is below 0.6 water should be rejected. Limit is extended to 1.5
14.	Phenols	0.001	May be relaxed up to 0.002
15.	Mercury	0.001	No Relaxation.
16.	Cadmium	0.01	No Relaxation.
17.	Arsenic	0.05	No Relaxation.

Methods for Calculation of Runoff:

A] Analytical Method –

1] Hydrological Analysis. - As this discharge was directly proportional to head loss(H) and the area of cross section (A) of the soil, and inversely proportional to the length of soil sample (L). In other words, here H/L represents the head loss or hydraulic gradient (I), K is the Coefficient of Permeability. Hence Q= K.I.A. Similarly based on the above principle the water harvesting potential of catchment area can be calculated.

2] Rationing Method (RM): The Rationing method (RM) distributes the stored rainwater to target public in such a way that the rainwater tank is able to serve water requirement to maximum period of time. This can be done by limiting the amount of use of water demand per person. The factors consider in this method are a) Catchment Area, b) Impermeability factor & c) Intensity of rainfall. Formula: **Q= K.I.A> Ri** where K= factor taken as 1/360, A= Catchment Area in hectare, Ri= Rainfall Intensity in mm/hr.

3] Rapid Depletion Method (RDM): In Rapid Depletion Method, there is no restriction on the use of harvested Rainwater by consumer. Consumer is allowed to use the preserved rain water up to their maximum requirement,

resulting in less number of days of utilization of preserved water. The rainwater tank is considered the only source of water for the consumer, and alternate source of water has to be till next rains, if it turns dries.

B] By Runoff Formulae & Tables-

1] Runoff Coefficient: **R= K*P** where K= Runoff Coefficient, P= Rainfall, R= Runoff.

2] Strange's Tables: Strange gave tables and curves for runoff resulting from rainfall in the plain of south India. Strange's table is based on daily rainfall & three types of catchment (Dry, Wet, Damp)

3] Lacy's Formula: **R= P/ (304.8f/1+P*S)** Where, S= Catchment Factor, F= Monsoon duration factor.

Methods for Cost Analysis:

Using Revit Software – Built for Building Information Modeling (BIM), Autodesk Revit Software combines features for architectural design, MEP & Structural Engineering & Construction in a single comprehensive application. The 2016 release Continues to support user productivity with improved Revit Software Performance & usability enhancements. New Features includes MEP fabrication detailing within Revit, improved structure reinforcement detailing & improved workflows specific to steel connection design & detailing. In our Project, by using revit software developing models of earthen reservoir including design data such as size of reservoir, Capacity of required water demand etc.

Data Collection Survey

Preliminary Survey:

We defined catchment area, carried out contour survey by using prismatic level, we determined ridge line, and we studied soil condition of the campus. We define slopes from analysis of contour survey. Found out reduce level of hilly area of KJEI Campus.

Rainfall Data Collection: The rainfall data of KJEI Campus is given below in tabular form

Months	Avg. Annual Rainfall in mm	Rainy Days
January	1.7`	0.2
February	1.5	`0.1
March	0.6	0.1
April	9.8	0.9
May	30.0	2.2
June	171.4	9.6
July	171.0	12.2
August	139.5	9.8
September	141.7	7.9
October	85.8	4.7
November	21.5	1.2

December	7.4	0.4
TOTAL	781.9	49.4

Calculation Survey of Population in Campus: The Calculation of Population of campus is given below in tabular form

Types of Buildings	Population (Nos.)	Water Req. BLD
T.C.O.E.R	2060	82400
K.J.E.I.M.R	2560	102400
T.A.E	1120	44800
ARCHITECTURE	0075	3000
POLYTECHNIC	0135	5400
SCHOOL	0110	4400
JR.COLLEGE	0380	15200
CANTEEN	-	5000
CANTEEN	-	3000
HOSTEL	0250	31030
TOTAL	6605	296630li/day.

Quantity of water required for Institute= **0.296MLD.**

Analysis & Design

Determination of Catchment Area: The KJEI Campus surface area is nothing but the catchment area which receives rainfall. Catchment area of KJEI campus is measured. This measurement was done by available AutoCAD drawings.

Total Catchment Area = 1.5km^2

Determination of water demand & Capacity: The campus population includes no of staff, no of students was collected from account department of each college.

Total population of KJEI Campus = 6605

Calculations:

Per Capita Demand of Water= **Q / (P x 365) lit/capita/day.**

Total Water Demand per Day= **296630.**

Demand of water per year **= 296630*365= 108.27 x 10^3 Cu.M**

Determination of Runoff: The Formula for calculation or runoff produced is given below

Volume of Water Received (m^3) = Area of Catchment (m2) x Amount of Rainfall (M)

= (1.5 x 10^6) x 0.750

= **1125* 10^3 Cu.M**

Design of Percolation Tank: A study was planned to design a percolation pit to harvest rain water and recharge ground water aquifers so as to improve or maintain the ground water quality of well located in our campus. K.J Campus receives torrential rains during monsoon season but now days, good quality water is rare available.

Current dimensions of percolation tank which is available in our college campus, = (20 x 20 x 15) = **6000Cu.M**

But the current demand of water in our campus is more than capacity of percolation tank already available in campus.

We have modified the current percolation tank available near K.J College building. The design data is as follows

Total water Demand: 296630 lit/Day

Total water demand per year= 296630 * 365 = **108.270* 10^3Cu.M**

Total required water demand including evaporation losses and other losses = 108270 + 32481 = **140751Cu.M**

We assumed that the depth of tank is 20m,

Therefore, 108270/20 = 5413.5 per sq.m

A^2 = 5413.5 therefore A = 75m where A= length or width of tank.

Therefore dimensions of tank is **75 x 75 x 20m.** but it is not satisfied as per demand, so we again modified the design of tank. We assumed the depth of tank as 20m therefore we took dimensions of percolation tank as **85 x 85x 20m** which is satisfied as per need.

Result

Dimension of Tank & Cost of Construction:

Sr. No	Description	Volume m^3	Rate / unit m^3	Cost
1.	Excavation in hard soil	144500	200	28900000.00

Cost of Excavation.

Sr. No	Description	Volume	Rate / unit (Brass)	Cost
1.	Salable Murum assume the depth of 15m	108375 m^3 in brass = 38295.053	500	19147527.00

Estimation of Percolation Tank

The initial cost of excavated percolation tank was Rs 28900000.00

Salable cost of excavated soil is about Rs 1,91,47,527.00

Total Estimated Cost of Percolation Tank is = initial cost – salable cost

= 2,89,00,000.00 – 1,91,47,527.00

= Rs 97,52,473.00

Consider 5% maintenance cost every year = Rs 4,87,623.00.

Cost analysis of Water Tankers: Cost per water tank = Rs 1000.00

No of water tanks required per day = 20 (March to june)

Total cost of tankers = 20x1000x120 days = Rs 24,00,000.00

No of Years	Cost of Water Tankers	Cost of Percolation Tank
One Year	Rs 24,00,000.00	97,52,473.00
Two Year	Rs 48,00,000.00	1,02,40,096.00
Third Year	Rs 72,00,000.00	1,07,27,719.00
Fourth Year	Rs 98,00,000.00	1,12,15,342.00
Five Year	Rs 1,22,000.00	1,17,02,965.00

Conclusion

This project dealt with all aspect of improving the water scarcity problem in the K.J.E.I Campus by implementing ancient old technique of watershed management. From above analysis, it was concluded that a huge amount of water got collected from the K.J.E.I Campus and surrounding hills. This percolation tank should have to built for the storage of 1404751 $m^3$of water. Hence this tank has huge capacity of getting rainwater and on proper storage, this tank can supply almost throughout the year for about 6605 consumer having a consuming rate of 40lit/day as calculated by rational depletion method.

Hence it was finally concluded that implementation of WATERSHED MANAGEMENT OF KJEI CAMPUS will be the best approach to fight with present and future water related problems from financial as well as optimum utilization of land resources.

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