Economic Aspects Of Rainwater Harvesting,A Case Study On D.Y.Patil Knowledge City

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Abstract - The proper plan and assessment of a water collecting framework is important to enhance framework execution and the soundness of the water supply. The principle plan parameters of a water gathering framework are precipitation, catchment range, accumulation proficiency, tank volume and water request. Its operational parameters incorporate water utilize effectiveness, water sparing proficiency and cycle number. The affectability examination of a housetop water collecting framework's outline parameters to its operational parameters uncovers that the proportion of tank volume to catchment region (V/A) for a water reaping framework. The suitable plan estimation of V/An is shifted with D/A. The additional tank volume up to V/An of 0.15~0.2 is likewise accessible, if important to secure more water. As needs, be, we ought to make sense of appropriate esteem or scope of outline parameters in view of the affectability examination to upgrade plan of a water gathering framework or enhance operation productivity.

Key Words: **Economic RWH, RWH, Roof top RWH, Estimate of RWH, Parameters of RWH, Design of RWH, Components of RWH.**

1.INTRODUCTION

Protection is a demonstration of saving assets from rot, misfortune or damage, generally to handle the assets with care and shield against pulverization. Water is one of the renewable assets. India with a normal precipitation of 1150 mm is the second wettest nation on the planet with great water assets. Be that as it may, the water assets are not equitably dispersed over the nation because of shifted hydro geographical conditions and high varieties in precipitation both in time and space. Indeed, even in high precipitation region, as Kerala in the South and Meghalaya in the east, water shortage is felt in the late spring months. As extensive amounts of precipitation are going to ocean as overflow, it is ideal to tackle this inefficient spillover by embracing legitimate logical preservation measures and building reasonable water collecting structures at fitting areas and falsely energize the exhausted aquifers through sub-surface dykes and revive tube wells. The preservation has two tenets (i) Wise advancement and (ii) Use without undue waste. The primary wellspring of energize to ground water body is precipitation.

1.1 Background

Conservation is an act of preserving resources from decay, loss or injury, otherwise to handle the resources with care and safeguard against destruction. Water is one of the renewable resources. India with an average rainfall of 1150 mm is the second wettest country in the world with good water resources. But the water resources are not evenly distributed over the country due to varied hydro geological conditions and high variations in precipitation both in time and space. Even in high rainfall area, like Kerala in the South and Meghalaya in the east, water scarcity is felt in the summer months. As large quantities of rainfall are going to sea as runoff, it is better to harness this wasteful runoff by adopting proper scientific conservation measures and constructing suitable rainwater harvesting structures at appropriate locations and artificially recharge the depleted aquifers through sub-surface dykes and recharge tube wells. The conservation has two doctrines (i) Wise development and (ii) Use without undue waste. The main source of recharge to ground water body is rainfall.

1.2 Status and necessity of harvesting

The truth of water emergency can't be disregarded. India has been infamous of being poor in its administration of water assets. The interest for water is now exceeding the supply. Lion's share of the populace in the urban areas today are groundwater subordinate. Despite the metropolitan water supply, it is not shocking to discover individuals utilizing private tube wells to supplement their every day water needs. Accordingly, the groundwater table is falling at a disturbing rate. Extraction of groundwater is being done spontaneous and uncontrolled hence this has brought about:
a. Hydrological lopsidedness
b. Weakening in water quality
c. Ascend in vitality prerequisites for pumping

Rain Water Harvesting, is a deep-rooted arrangement of gathering of water for future utilize. In any case, deliberate accumulation and energizing of ground water, is a late advancement and is picking up significance as a standout amongst the most practical and simple to execute solution for reestablish the hydrological lopsidedness and keep an emergency. Actually, water gathering implies a framework that gathers water from where it falls instead of permitting it to deplete away. It incorporates water that is gathered inside the limits of a property, from rooftops and encompassing surfaces. Specialists recommend different methods for collecting water.

2. THEROTICAL CONTAINTS

For calculation of discharge from roof top

Table -1: Runoff coefficient for various catchment surfaces.

Type of Catchment	Coefficients
Roof Catchments Tiles Corrugated metal sheets	0.8-0.9 0.7-0.9
Ground surface coverings Concrete Brick pavement	0.6-0.8 0.5-0.6
Untreated ground catchments Soil on slopes less than 10 per cent Rocky natural catchments	0.0-0.3 0.2-0.5

Table 2: 90mm PVC Pipe Storage Volume

Length: feet (meters)	Volume: gallons (liters)
3 (.9)	2.0 (7.6)
5 (4.6)	3.3 (12.5)
10 (3.0)	6.7 (25.4)
15 (4.6)	15 (56.8)

Table 3:Sizing of rainwater pipe for roof drainage

Diameter Of pipe (mm)	Average rate of rainfall in mm/h					
	50	**75**	**100**	**125**	**150**	**200**
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
75	40.8	27.0	20.4	16.3	13.6	10.2
100	85.4	57.0	42.7	34.2	28.5	21.3
125	-	-	80.5	64.3	53.5	40.0
150	-	-	-	-	83.6	62.7

3. DESIGN AND MATHEMATICAL FORMULATION

$Q = K \times R \times A$

Where:

•*R* is the Avg. rainfall in mm per year = 1294 mm for Pune region with considering factor of safety.

•*A* is the roof area in square metres = 3420 sq. mt.

•K is a 'run-off coefficient' = 0.80 (For a hard roof.)

The quantity of runoff is calculated Q = 3541 m3 (Say 3540384 liters) has used and managed for the purpose of rain water harvesting. Out of which some is used for storage purpose and the remaining for the recharging the ground water table with the help of existing sources.

3.1 CONVEYANCE SYSTEM

Out of the various conveyance systems studied before in the chapter 3 of the thesis work, the conveyance system of PVC conduct has been adopted for the rainwater harvesting system of the college campus. The maximum rainfall intensity for Pune is= 397 mm per day Maximum rainfall for that intensity for roof area 3420 sq.mt. is 1357.74m3/day. There for calculating the diameter of pipe is $d2 = 1357740/(24x15x0.785)$ ....15 outlets

d =69.31mm say 90mm.

3.2 FILTER DESIGN

Filter is to be designed for a catchment area of 3420 sq.m. Peak rainfall intensity of area is 397 mm/day. Runoff coefficient of the catchment is 0.8
First calculate the peak runoff rate from the catchment

Peak runoff rate = peak intensity of rain fall x catchment area x runoff coefficient
Therefore,
Peak runoff rate = (3420 x 0.397 x 0.8)/24 = 45.26 m3/hour
Assuming, Rate of filtration = 5 m3/hour
Area of filter bed required = Peak runoff / Rate of filtration
= 45.26/ 5 = 9.052 m2 = 10m2
Provide filter bed of 3.5m x 2.85 m size
Provide depth 1.2m and free float 0.3
Total depth = 1.5m.

3.3 Design of storage tank

Total amount of water collected in one year =3542cu.m
Taking height of tank=5m
Area of the base=3542/5=708.4sq.m
We can take square base each of side =30x24 or rectangular base as per land availability. So our tank will be of dimensions30x24x5 m (taking rectangular tank) which is not economical and also space needed for construction is very large As water is stored on monthly basis, Size of the tank will be equal to the excess amount of water left over after consumption. Hence, mostly excess amount of water assumed to be collected during the period of maximum rainfall – June, July and August.
Assume No. of users in campus 4000
Assume use of water 10 lit/capita/day
Amount of water consumed per month =1200cu.m
Amount of water collected during July and August =1086.73+720.78 m3
Amount of water collected during one month = 1807.21 m3.
Hence, total amount of water to be stored =1820-1200=620m3 say 620000lit
Fixing the height of tank to be 4 m
Area of the base =620/4=155m2
•Total Run off used for the RWH work. = 3540384 liters.

•The storage tank capacity to be constructed = 620000liters.

•The size of the proposed storage tank is = 4x10x16m.

3.4 DESIGN OF TOP SLAB

L/B = (16/10) = 1.6 (< 2) i.e. two way slab
Let live load on top slab = 2 kN/m2
Assuming thickness of 200mm including finishing, etc.
Self weight = 0.2 X 1X1X 25 = 5 KN/m 2
Total weight = 2+5 = 7 kN/m2
Mx =ax X wlx2
=0.107x7x100
=74.9kn.m
My=ay X wlx2
=0.0424x7x100
=29.68kn.m
Astx=16 mm @ 170mm c/c

Asty=10mm @ 180mm c/c

As it is not possible to construct large volume tank for the water storage and also it is not economical. Therefore, in this alternative plan, it is possible to use the underground storage tank for college premises, which is also having capacity of 6.2 lakh liters as needed by design. For the preliminary storage purpose the existing tank in the premises of the college can be used, which is constructed back side of fluid mechanics lab. This tank is having size and after inspection it is found in good condition also. The pipe line of is needed to lay from the existing tank to the underground sump of hostel which is having length of meter. This option also helps to cut the cost of the project and time duration of the construction of project.

3.5 DESIGN OF PUMP

For Design 1

Capacity of tank = 620000 liters

Rate of pumping = 25833.33 Lit/hrs

=7.17lps

Static head = 29

Frictional loss of head 6kh/cm2

Pipe dia mm = 90mm

C value for PVC pipe = 140

Total length = 28m

Pump discharge = 0.5 MLD

Rate of frictional loss:
Q= 7.43x10-9 x C x D2.63 x (Hf)0.54
Hf= 14.29 m/km

Add 10 % more for valves and fitting = 0.028x14.29

= 0.40m

Margin over residual haed = 1.5

Total = 1.9m

Head on pump = 29+1.9

= 30.90 m

BHP of motors (Considering 60 % efficiency)

= Q x H x1.3/(75x0.6)

= 7.17x29x1.3/(75x0.6)

Say = 6.00 HP

Hence the pump used for lifting the water from proposed storage tank is 6 HP.

4 WATER DISTRIBUTION

Technically, there are two types of methods for distributing the harvested rainwater:-

- RATIONING METHOD (RM)

- RAPID DEPLETION METHOD (RDM)

To explain these both methods, let us first apply it on any building. The detail calculation is carried out to get the valuable steps. Later on, these crucial steps are again applied to all other building and number of days for consumption of stored water is calculated by using both of these methods.

4.1 Rational method (RM)

The Rationing method (RM) distributes stored rainwater to target public in such a way that the rainwater tank is able to service water requirement to maximum period of time. This can be done by limiting the amount of use of water demand per person. Suppose in this method, for example the amount of water supplied to student is limited which is equal to say, 100 lt/day per capita water demand.

Again, suppose number of students in hostel = 300

Then, Total amount of water consumption per day = 300x0.1 = 30 m3/day

Total no. of days we can utilize preserved water = stored water/water demand

For building (Sample), volume of water stored in tank was taken approx.

= 6200 m3

Hence finally, no of days = 6200/30 = 206 days (or 7 months)

For long term storage of preserved water in good condition, preserving chemical should be added.

4.2 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 in this method is considered to be only source of water for the consumer, and alternate source of water has to be used till next rains, if it runs dries.

For example if we assume per capita water demand = 150 lt/day = 0.15 m3/day

Total amount of water consumption per day = 300 x 0.15= 45m3/day

Total no. of days, preserved water can be utilize = stored water/water demand

= 6200/45

= 137 days (4.5 months)

Hence, finally it is observed that, if the amount of water stored is equal to 6200 m3, then applying

1. RDM, consumer can only utilize the preserved stored water for about 137 days (4.5 months),

2. Whereas in RM, preserved stored water can be utilized for a period of 206 days (7 months).

As per the requirement and the convenience any of the method of distribution can be used from above.

5 CONCLUSION

It concluded from above findings that rainwater harvesting, if conserved and utilized using the rainwater harvesting technology, can be an effective tool of replenishing ground water resources.

Rainwater harvesting is a coping strategy in variable rainfall areas. In the future climate change, will increase rainfall variability and evaporation, and population growth will increase demand on ecosystem services, in particular for water. Rainwater harvesting will become a key intervention in adaptation and reducing vulnerabilities.

Realize that rainwater harvesting is not a 'silver bullet', but can be effective as a complementary and viable alternative to large-scale water withdrawals, and as a way of reducing the negative impacts on ecosystem services, not least in emerging water stressed basins.

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