Assessment of Rain Water Harvesting in Ray Nagar, Kumbhari, Solapur, Maharashtra, India

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Abstract

The availability of water is extremely uneven both in space, time and depth. So will it be the case in groundwater now and in future. The uneven distribution of groundwater in an area is mainly attributed to highly heterogeneous lithology and variability of rainfall. Therefore, an integrated approach is mandatory to view multi-dimensional problems be set in a watershed. The resistivity survey was carried out for rock type identification. wenner configuration was used during resistivity survey.

The harvesting of rainwater simply involves the collection of water from surfaces on which rain falls, and subsequently storing this water for later use. Normally water is collected from the roofs of buildings and stored in rainwater tanks. Rainwater harvesting is the accumulation and deposition of rainwater for reuse before it reaches the underground. Rain water harvesting is a technique of collection and storage of rainwater into natural reservoirs or tanks, or the infiltration of surface water into subsurface aquifers (before it is lost as surface runoff). Uses of this water include water for drinking, garden, water for livestock, etc. As a humble effort, yet benefitting to the present day requirement has been envisaged by the authors in this work. The present work gives the detailed study of the area in which vesicular and amygdaloidal igneous structures observed in basalt rock. Ground water is available in unconfined and confined aquifer. Pre monsoon water level is 8 to 11 meter below ground level. Post monsoon water level is 4 to 6 meter below ground level. Total number of recharge pit cum bore wells -10 nos. Dimension of recharge pit cum recharge bore well – 2m x 2m x 2m.Diameter of recharge bore wells= 180 mm and depth of Bore well – 30 meter. The paper deals with total rain water harvesting and its management.

Keywords: Hydrogeology, Rainwater harvesting, Electrical resistivity, Rain fall, Housing project

Introduction

Water plays a significant role in our lives since it is a precious natural resource. Over the past few years, there has been an increase of water shortages in several parts of the world. It is vital that ideal measures are put in place to help to reduce the high rate of water loss. With the change in climate patterns, people need to be aware of the alarming water shortage that we face currently and the imminent danger of severe shortage in the future. Various methods can be implemented to address the water problem in the most area. Rainwater harvesting is one of the methods that can be used for water conservation.

Rain water harvesting is a technique of collection and storage of rainwater into natural reservoirs or tanks, or the infiltration of surface water into subsurface aquifers (before it is lost as surface runoff). The harvesting of rainwater simply involves the collection of water from surfaces on which rain falls, and subsequently storing this water for later use. Normally water is collected from the roofs of buildings and stored in rainwater tanks. Rainwater harvesting is the

accumulation and deposition of rainwater for reuse before it reaches the underground. Generally water collects from rooftops, the land surface or rock catchments using simple techniques such as containers and pots . Uses of this water include water for drinking, garden, water for livestock, etc. In many places the water collected is just redirected to a deep pit with percolation. Commonly used systems are constructed with three principal components; namely, the catchment area, the collection device, and the conveyance system. It is a technique or strategy for the collection of rainwater and storing it in the right way for future use. The water can be collected from various surfaces and platforms and stored for later use. In most cases, the water is usually collected from rooftops and other hard surfaces. Rainwater harvesting is considered as a very reliable way to conserve water.

Study area

The study area is Ray nagar federation housing society, Gat no. 728,A/P. Kumbhari,Tal. South Solapur.Dist- Solapur,Maharashtra. 413006 situated 14 km from Solapur city, Maharashtra. In forms parts of Survey of India topographic sheets 47 O/ 13, 47 O/14, 56 C/1 and 56 C/2. The area is bound by north latitudes 17^{o} 42' and 17^{o} 46' and east longitudes 75^{o} 16' and 75^{o} 56'. The annual rainfall is about 550mm to 650mm which is mainly received during the monsoon months of July to September. Groundwater occurrences in the area are controlled by the weathered and fractured part of the basaltic rock formation.

Geology of the study area

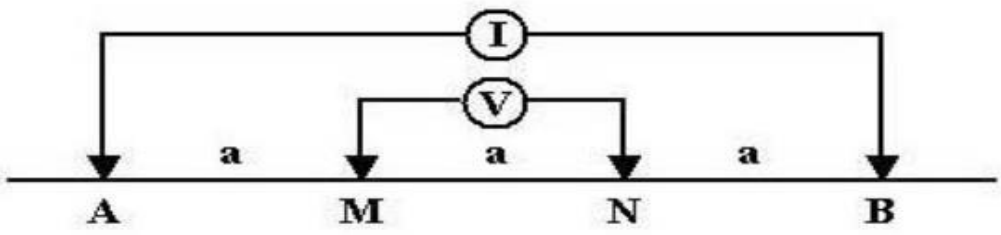
Study area forms parts of the famous Deccan Traps, The lava assemblage in Solapur district belongs to Sahyadri Group and consists of Indrayani, Karla, Diveghat, Purandargarh and Mahabaleshwar formations. Each of these formation have "AA" and "Pa hoe hoe" lava flows and may consist of simple and compound flows and of the formation has more than couple of flow units.The flow units can be distinguished from one another on the basis of lithological character such as vesicularity, amygdaloidal, zeolites and compactness of the basalts. The top of the flow has been demarcated by vesicularity, flow breccias or red bole layer. The flow units have been laterally traced and correlated with the observations in the dug wells which are unlined. The lower most flow and the top most flow units are partial. This is because the base of the lower flow is not noticed and the top of the uppermost flow is not exposed in this region.

Lithology of the area

Resistivity survey for rock identification

The resistivity survey was carried out for rock type identification. wenner configuration was used during resistivity survey. Wenner array consists of four collinear, equally spaced electrodes. The outer two electrodes are typically the current (source) electrodes and the inner two electrodes are the potential (receiver) electrodes. The array spacing expands about the array midpoint while maintaining an equivalent spacing between each electrode. The advantages of the Wenner array are that the apparent resistivity is easily calculated in the field and the instrument sensitivity is not as crucial as with other array geometries. Relatively small current magnitudes are needed to produce measurable potential differences. The disadvantages are that for each sounding, all of the electrodes have to be moved to a new position. In order to image deep into

the earth, it is necessary to use longer current cables. The Wenner array is also very sensitive to near surface in homogeneities which may skew deeper electrical responses.Wenner electrode array geometry and apparent resistivity.(table 1,photo1)



$$\rho_A = 2\pi\ a \frac{V}{I}$$

Fig.no.1: Shows wenner electrode array

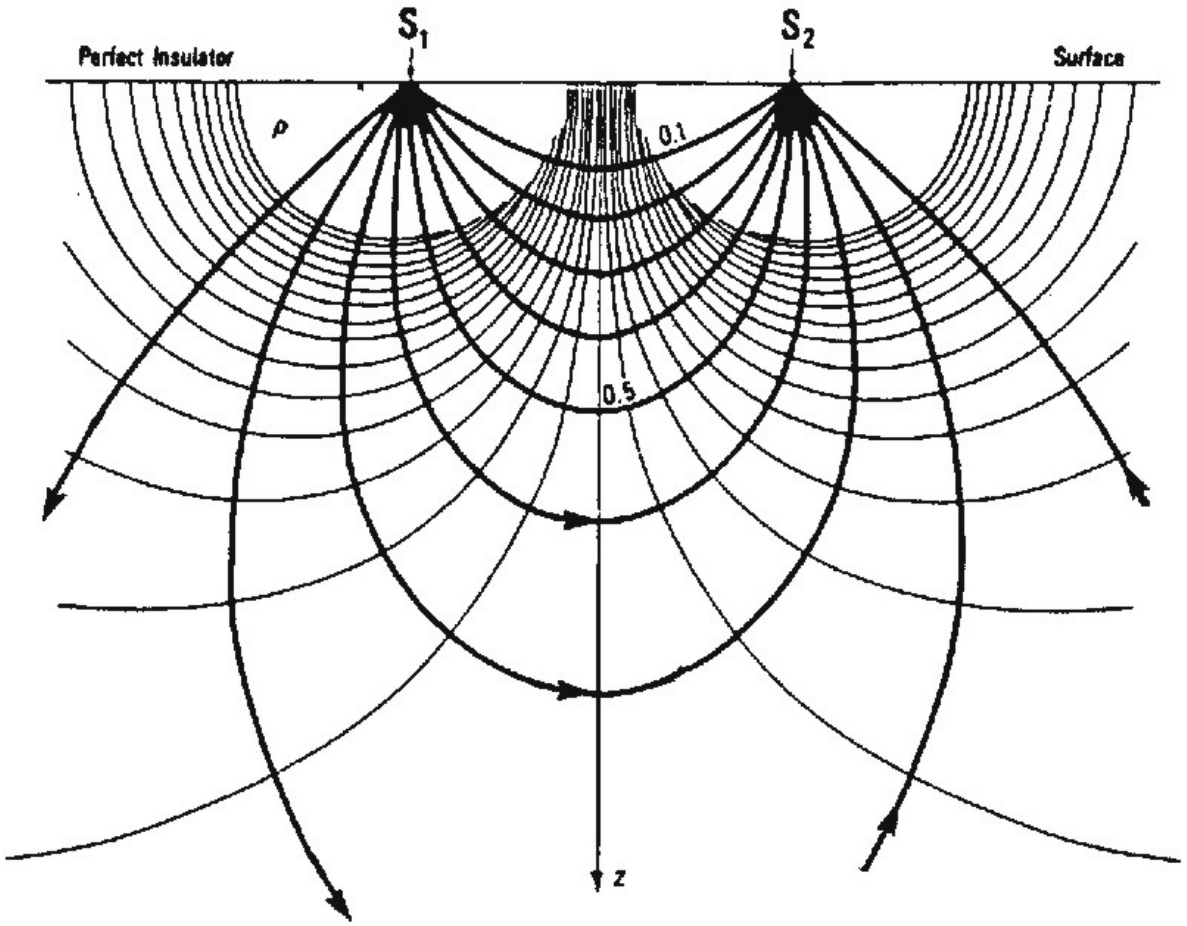


Fig. no. 2: Showing current flow lines

Photo 1 : Shows resistivity survey for subsurface rock identification

Table no.1: Illustrates the rock types of the area

Sr,no.	Depth in meters	Rock Types
1	0 - 5 mts	Soil and Weathered Basalt
2	5 - 30mts	Zeolitic Basalt
3	30 - 70mts	Tightly fractured Basalt
4	70 - 85mts	Red bole mixed zeolitic Basalt
5	85 - 95mts	Zeolitic Basalt
6	95 -100mts	Hard and Compact Basalt

Concept of rainwater harvesting

Tapping the rainwater from where it falls – Techniques of rainwater harvesting involve Catch the rainwater from localized catchment surfaces such as roof of a house, plain and sloping ground surfaces etc. It is easy process to collect Rainwater and diverted into ponds, vessels or underground tanks to store for longer periods and to recharge by construction of RWH Structures in a suitable sites.

Advantage of Rain water harvesting

Reduces flooding and erosion

Harvesting rainwater can help the environment in a number of ways. For starters, it can reduce erosion around downspouts and in gardens. It can also control storm water run-off. Rainwater doesn't produce scale and corrosion as hard water does. The collection of rainwater may reduce flooding in certain areas as well.

Reduces water bill

Rainwater harvesting will not only help individuals save on their water bills but can cut costs for entire communities. The cost to supply mains and overall water services can be substantially reduced when many people in one community use rainwater. Having a source of water can also reduce dependence on municipal sources in case the water becomes contaminated. Rainwater can be used as the primary source of water or as a backup source when needed.

Can be used for non drinking purpose

The majority of the water we need is used for non-drinking. Everything from washing clothes and dishes to bathing and flushing toilets require large amounts of water. Rainwater can be used for all of these things. Rainwater is soft and can lessen the need for detergents when washing clothes and dishes. Rainwater can also be used for washing vehicles, bathing pets, and nearly all cleaning that uses water.

Improve plant growth

Rainwater harvesting can also be used to improve plants and gardens. Using harvested water can flush the salt buildup from plants and soil. Harvested rainwater is generally free from several types of pollutants and man-made contaminants. Rain is also free from chlorination. Using water that is this clean and healthy for plants and trees can save money on overall property maintenance and landscaping needs.

While regular maintenance is required, simple collection systems can be constructed that most people can easily build and maintain. Rainwater harvesting and storage can be incorporated in both rural and urban areas and provides many benefits to individuals, communities, and the environment.

Road water Harvesting:-

Road runoff water is often speeding down the drain, quickly concentrating into erosion gullies taking the soils along. Instead of giving it a speeding ticket, it can also redirect the water away from the road, within the adjacent area. Not letting it go, but also not letting it affect your road and landscape a new type of road water management. The concentrated water along roads and road catchment can be harvested. This harvesting can be done with simple structures on and along the road. Trenches,drains, cross-culverts, etc. A combination of techniques can channel water from roads into retention/infiltration areas. Benefits include groundwater recharge, landscape restoration, increased road infrastructure longevity, and increased water availability for agricultural and domestic use. Road water is to be recharged through trenches along the road

Rain water availability

Total annual availability of rain water at site

Based on assuming annual rainfall is 550mm (from district HQ data Solapur)
However, annual rainwater sources are available on present study is as follow

Table no. 2: Shows estimation of runoff before project completion

. Type of surface	Area sq. m	Runoff Coefficient	Average annual rainfall(m)	Annual potential for RWH(m3)
Non agriculture	50000	5.00	0.55	137500

Table no. 2: Shows estimation of runoff after project completion

Type of surface	Area sq. m	Runoff Coefficient	Average annual rainfall(m)	Annual potential for RWH(m3)
Roof top area	13894.98	1.39	0.55	10622.71

Annual intake or absorbing capacity of aquifer

Based on assuming specific yield of aquifer in basaltic terrain 0.02 and resistivity data and hydrogeological data, water can be stored in the aquifer.
Area of aquifer x Thickness of aquifer (from resistivity data) x Specific yield of aquifer
=50000.m x 25m x 0.02=25000 m3
The rainwater harvested from terrace will be recharged and stored in the aquifer the rest of water will be flow near to tributaries
Area of recharge x Thickness of aquifer x Specific yield of aquifer
= 13894.98 x 25m x 0.02 =6947.49 m3 per bore per year

Water harvesting potential of the area:-

Area of catchment in 13894.98 sq.m x Amount of minimum rainfall 550 mm= 7642239 cu.m

Influencing factor

Among the several factors that influence the rainwater harvesting potential of a site, eco-climatic conditions and the catchment characteristics are considered to be the most important.

Catchment area charactristics

Runoff depends upon the area and type of the catchment over which it falls as well as surface features.All calculations relating to the performance of rainwater catchment systems involve the use of runoff coefficient to account for losses due to spillage, leakage, infiltration, catchment surface wetting and evaporation, which will all contribute to reducing the amount of runoff.

Catchment area characteristics Runoff depends upon the area and type of the catchment over which it falls as well as surface features. As mentioned earlier rainfall measured in depth and it is the point rainfall. In order to get the volume of water i.e. the rainwater endowment of that area we have to multiply the depth of the rainfall with the catchment area. For the Roof Top Rain Water Harvesting catchment area is the roof surface. The effective area of roof used for computing volume of water is called roof foot print. For plane horizontal rectangular or other shape roof, roof foot print is same as the roof and thus effective area is same.

Results and Discussion

Rainwater harvesting is in two ways

A. Direct Use: The process of collecting and storing the rainwater by construction of sump through filters for future productive use

B. Artificial recharge to groundwater: Recharge the rainwater in a scientifically planned way by construction of rain / roof top water harvesting structures to augment the groundwater. Groundwater aquifers can be recharged by various kinds of structures to ensure percolation of rainwater in the ground instead of draining away from the surface. We are adopting commonly used recharging methods

Recharging Subsurface aquifers

Rain / Roof Top Water Harvesting: Water is essential for life and place a major role in earth's climate. By modifying land use, the proportion of the different pathways, evaporation, percolation and run off change. The never ending exchange of water from the atmosphere to the oceans and back again is known Hydrological Cycle. In the present day world, rapid urbanization coupled with industrialization has become the order of the day. Added to urbanization, scanty and erratic rainfall is often resulting in reduction in water levels indicating depletion in storage in the surface reservoirs. Dependence on ground water is increasing rapidly over the past two decades. The demand is so high that indiscriminate use of groundwater resulting in steep fall of the ground water levels and there is also reduction in yields.

Recharging of bore wells

Recharge pits with bore well:-

Rainwater collected from rooftop of the building is diverted through drain pipes to settlement or filtration tank. After settlement filtered water is diverted to bore wells to recharge deep aquifers. Abandoned bore wells can also be used for recharge. Optimum capacity of settlement tank/filtration tank designed on the basis of area of catchment, intensity of rainfall and recharge rate. While recharging, entry of floating matter and silt should be restricted because it may clog the recharge structure. First one or two shower should be flushed out through rain separator to avoid contamination.

Groundwater recharge or deep drainage or deep percolation is a hydrologic process where water moves downward from surface water to groundwater. Recharge is the primary method through which water enters an aquifer. This process usually occurs in the vadose zone below plant roots and is often expressed as a flux to the water table surface. Recharge occurs both naturally (through the water cycle) and through anthropogenic processes (i.e., "artificial groundwater recharge"), where rainwater and or reclaimed water is routed to the subsurface

Conclusion

Size of recharge pits	2m Length X 2m Breadth X 2m Deep with 30m depth Borewell

Water is essential for survival and has no substitute Demographic growth has led to the problems of water poverty and war for water. In the present investigation an attempt has been made to study the distribution of rain water for the benefit of proposed housing project.In he area of investigation rocks are not exposed on the surface of site. The bore wells in and around site are more than 60 meter deep most of bore wells around site are medium to low yielding in summer. The zeolitic basalt is a porous and permeable rock formation in site area and Vesicular and amygdaloidal igneous structures observed in basalt rock.ground water is available in unconfined and confined aquifer. Pre monsoon water level is 8 to 11 meter below ground level.Post monsoon water level is 4 to 6 meter below ground level.Average annual roof top terrace rain water resources is = 10622.71cu.m. Absorbing capacity of aquifer approximately=25000 m3per year.Total number of recharge pit cum bore wells -10 nos,dimension of recharge pit cum recharge bore well – 2m x 2m x 2m,diameter of recharge bore wells= 180 mm.Depth of Bore well – 30 meter and depth of perforated or slotted casing 6m.Not recommending water harvesting tank.

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