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Research Paper

Potential Roof Rain Water Harvesting In Pirwadi Village Of Kolhapur District, Maharashtra (India) - A Geospatial Approach

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ABSTRACT: *Water is scarce natural resource, even though 71% of land is covered by water. Out of total water on the earth near about 2.5% are fresh which is being utilized for various purposes viz. domestic, irrigation and industrial are common. Water scarcity has become a serious global threat due to hap hazardous population growth, frequent droughts and changing climate pattern (Carolina B. Mendez et.al). Now a day, the need of domestic water is magnifying tremendously in a developing country like India which has long tradition of rural culture. Here, an attempt has made to estimate the potential of roof rain water harvesting in a Pirwadi village of Kolhapur district (MS), India, with geospatial techniques. Google image of study area, global mapper and Arc Gis ver. 9.3 software were used to identify and calculate the various types of roof areas of houses and buildings located in the village. Rande's coefficient of runoff index for various types of roof and Gould and Nissen formula (1999) have been utilized for calculation of potential of roof rain water harvesting. Analysis reveals that, the total potential of roof rain water harvesting has estimated as 11457490.78 Lt. which would be more than enough to satisfy the total annual drinking and cooking requirement of the people in this village. Rain water harvesting techniques are proficiently useful to tackle down the water scarcity problem in rural areas.*

Keywords: *Water scarcity, Roof rainwater harvesting, Geospatial techniques, Runoff Coefficient*

I. INTRODUCTION

Water is scarce natural resource, even though 71% of land is covered by water. Out of total water on the earth near about 2.5% is fresh which is being utilized for various purposes viz. domestic, irrigation and industrial are common. Water scarcity has become a serious global threat due to hap hazardous population growth, frequent droughts and changing climate pattern (Carolina B. Mendez et.al). Now a day, the need of domestic water is magnifying tremendously in a developing country like India which has long history of rural culture. In India, the per capita per annum average availability of fresh water has been reduced from 5177 cubic meters from 1951 to 1820 cubic meters in 2001and it is estimated to further come down to 1341 cubic meters in 2025 and 1140 cubic meters in 2050 (Ministry of water recourses, GOI, 2003). According to Water resource department, the water scarcity will be reached to the zenith by 2050 which affects the socio-economic development of country. Fresh water availability is unequally distributed over space and time; on the other hand demand of the same is growing rapidly. With respect to that, rain water harvesting is proficient alternative to mitigate the severe problem of water sacristy. The term rain water harvesting refers to direct collection of precipitation falling on the roof or on the ground without passing through the stage of surface runoff on land (Athavale, 2003). The term of rain water harvesting is being frequently used these days, however, the concept of water harvesting is not new for India, and this technique had been evolved and developed centuries ago. The rain water harvesting practice is especially done in semiarid areas where the rain fall is inadequate and infrequent, but it also most applicable in hilly remote region and urban areas where rainfall is adequate but demand is severe. Rainwater is natural, reliable and least polluted source of water which could be harnessed through scientific techniques of rain water harvesting.

II. STUDY AREA

Pirwadi village of Kolhapur district (MS), India has been selected as study area for this work. This village extends from74^0 11' 01"E Longitude to 16^0 39' 17"N latitude, located in the Bhogawati river basin, specifically in the far eastern hilly flank of the Bhogawati river. The average height of the village is1965 feet above mean sea level and it experiences monsoon type of climate. The region receives rain from south west monsoon and average rainfall is 1025mm.

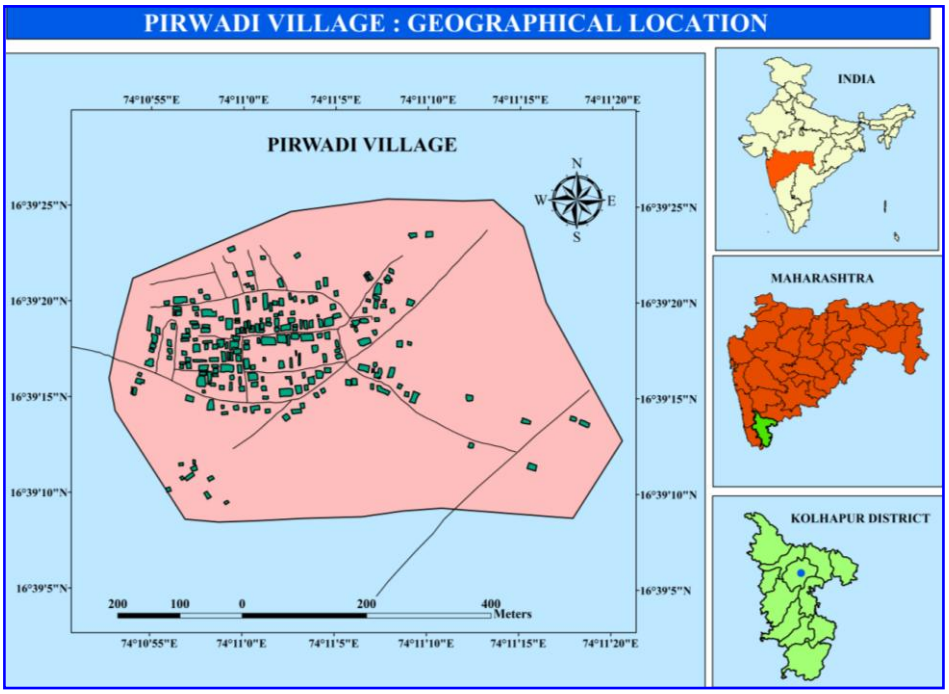

Figure: 1. Location map

III. OBJECTIVES

In view of the above, the specific objectives for present study are to assess the potential of roof rain water harvesting in Pirwadi village of Kolhapur district (MS), India.

IV. DATA BASE AND METHODS

The present research work is based on primary as well as secondary data sources viz. intensive field work in which well organized schedule has attempted to gather the data regarding to daily, monthly and cumulative requirement and scarcity of water, as well as to know the available water resources in the study area. The data concerned to population, households, climate, rainfall, temperature were collected from relative departments. It is very tedious work to assess the catchments available for roof top rainwater harvesting, here the roof tops are the catchments and with respect to that GIS approach were utilized to calculate the area of various types of roofs in the study area. Google satellite image has been downloaded and different types of roof catchments and roads were digitized. The concerned folders saved in kml file format and the same has exported in Global mapper software and converted in to the shape file format. The shape files have been exported in Arc Gis 9.3 and calculated the area of each type of roof available in the study area in order to find out the total rain water harvesting potential of the study area. Runoff coefficient is the factor which accounts for the fact that all the rainfall falling on catchments cannot be collected (Satya Raj, 2011). Collection efficiency varies with the size and texture of the roof. Rande's collection efficiency method for various types of roof has been taken in to consideration for calculating the coefficient of runoff. Gould and Nissen formula (1999) were utilized for calculation of potential of roof rain water harvesting in the study area. Further that, the economic value of water which would be harnessed has been assessed.

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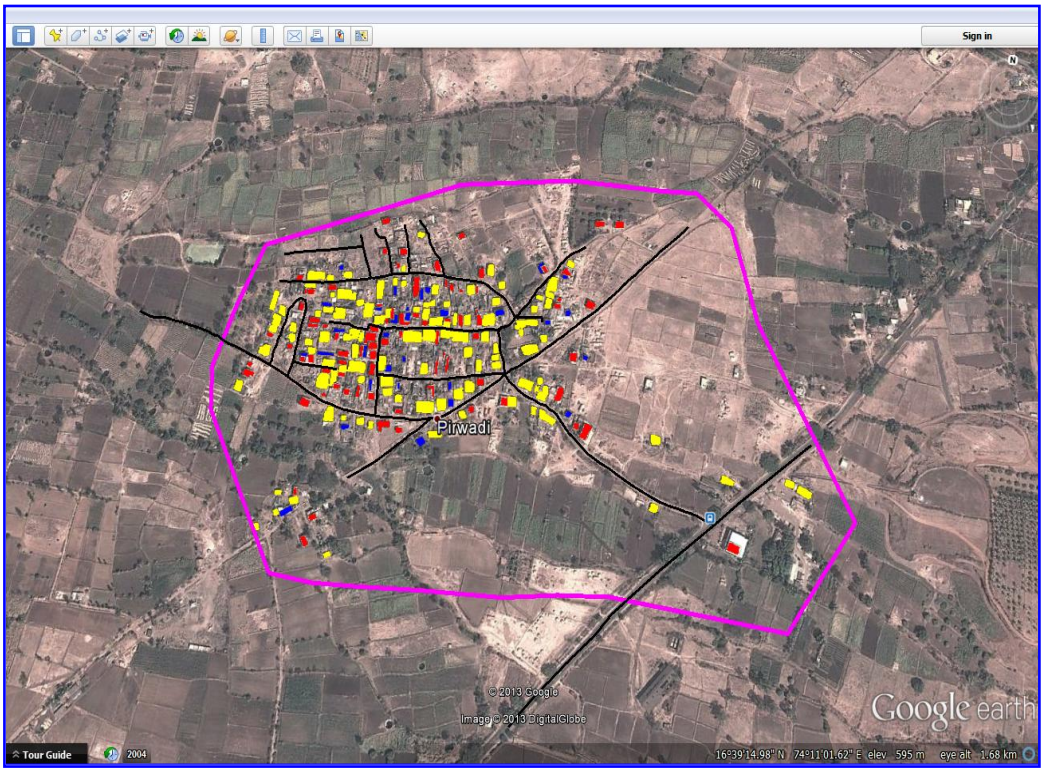

Figure: 2. Google Image & Digitization work of Pirwadi Village

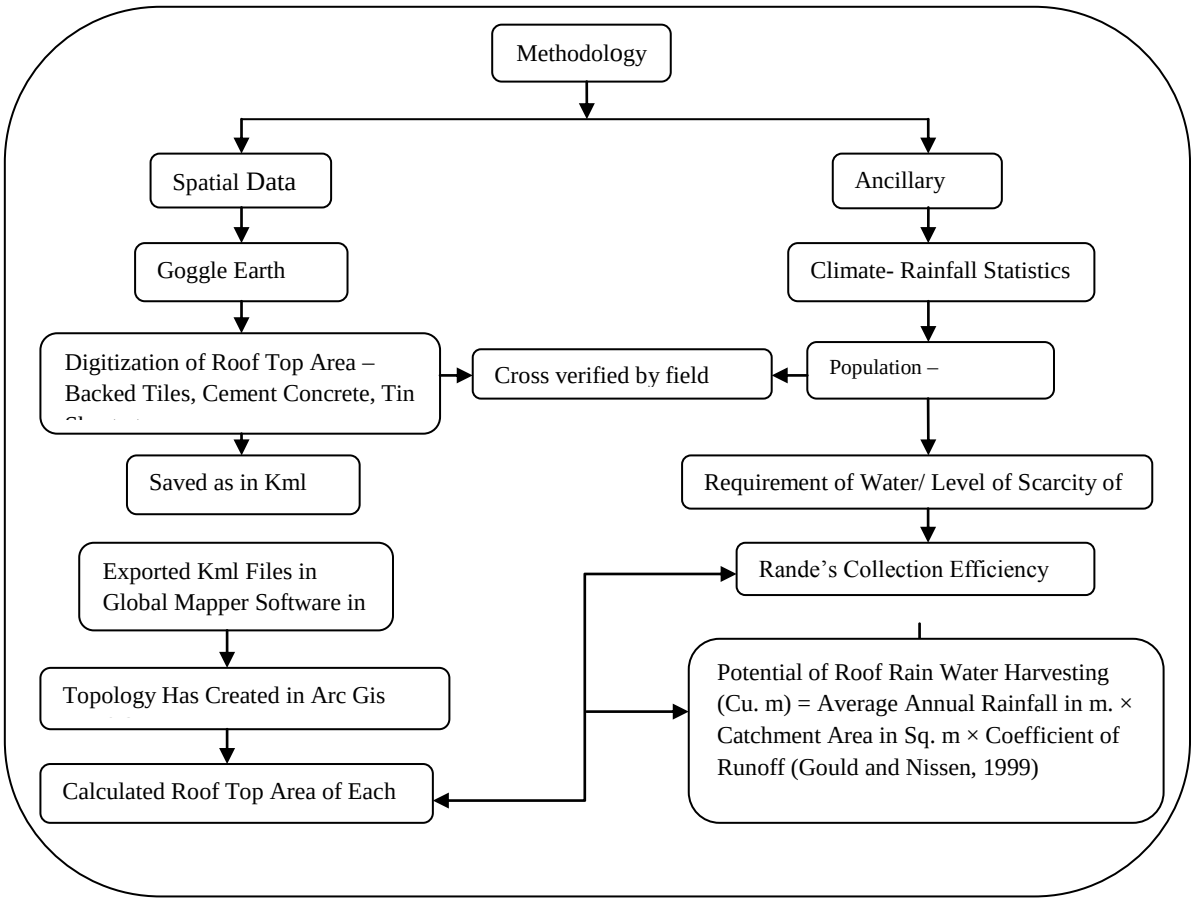

Figure: 3. Research Methodology

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V. ROOF RAINWATER HARVESTING SYSTEM

Roof becomes the catchment which is the crucial factor in the RRWH system and collected water from roof of the house's or buildings can either be utilized for day to day domestic purposes or for artificial recharge of ground water. This method is less expensive and very effective and if implemented properly helps in augmenting the ground water level of the area (Panhalkar, 2011). The ideal roof rain water harvesting and conservation system encompasses following basic components.

- Catchment Area/Roof: Surface upon which rain falls
- Gutters and Downspouts: System of transport channel from catchment surface to storage.
- Leaf screens and Roof Washers: Systems that remove contamination and debris.
- Cistern or Storage Tanks: Where collected rain water is stored.
- Conveying: The delivery system for treated Rain Water, either by gravity or pump.
- Water Treatment: Filters and equipment and additives to settle, filter and disinfect the water.

Among the above mentioned components of RRWH system filters and storage tanks are important which ensures the availability and purity of harvested water.

VI. POTENTIAL OF ROOF RAINWATER HARVESTING

Potential of roof rainwater harvesting refers to the capacity of an individual roof to harness the water falls on that roof in a particular year covering all rainy days. The annual yield of water which is probably measured in unit of liters is the product of roof type and annual average rainfall of an area. Rain water yield varies with the size and texture of the catchment area. A smoother, cleaner and impervious roofing material contributes to better water quality and greater quantity (R.W.H.C.M., 2002). Potential of roof rainwater harvesting in a study area has evaluated by using following formula

Gould and Nissen Formula (1999): S = R*A*Cr

Where, S = Potential of roof rainwater harvesting (In cu. m.)

R = Average annual rain fall in m.

A = Roof area in Sq. m.

Cr = Coefficient of Runoff.

Here, to assess the coefficient of runoff for different types of house roofs Rande's coefficient efficiency index were used as follows

Table No: 1. Coefficient of Runoff

Roof type	Estimated collection Efficiency (as % Precipitation)
Cement Concrete	**85**
Tin Sheets	**75**
Backed Tiles	**60**

Source: Rande (2002)

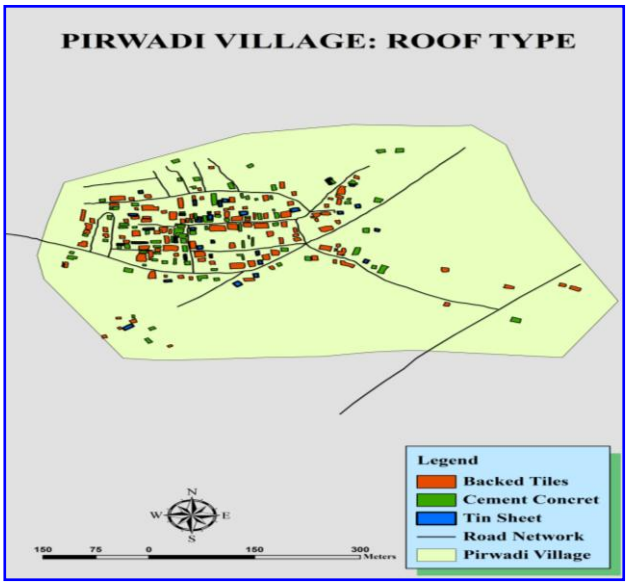

Figure: 4. Roof classes of Pirwadi Village

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VII. RESULT AND DISCUSSION

The Pirwadi village is spread over 279 hectare of an area with total population of 1893 dwelling in about 378 households (Census Report, 2001). Domestic water supply in this village is done especially by means of tube wells and wells. The village is located nearest to the Kolhapur city, so average annual rainfall of the city i.e. 1025mm is used for the calculation. The fruitful statistics of roof area exhibits that most of the roofs have been comprised by backed tiles having an area of 9629.987 sq. meter, followed by cement concrete(5010.858 sq. m.) and tin sheets(1519.987 sq. m.) respectively. The water collection efficiency varies with roof type, though cement concrete roof is having maximum collection efficiency, but here the people mostly preferred to construct roofs of backed tiles. So, maximum yield of water could be harvested is observed from backed tiles (5916.29 cu. m.) followed by cement concrete roof (4365.71cu.m.) and tin sheets (1175.49 cu. m.) respectively. The cumulative potential of water harvesting from roofs in this village is 11457.49 cu. m.

Table No.2 Potential of RRWH in Pirwadi Village

Roof Type	**Area in Sq. m.**	**Potential of Water Harvesting in Liters**	**Potential of Water Harvesting in cu. m.**
Backed Tiles	9629.987	5916292.00	5916.29
Tin Sheets	1519.753	1175488.75	1175.49
Cement Concrete	5010.858	4365710.03	4365.71
Cumulative Potential of water harvesting		11457490.78	11457.49

(Source: Compiled and computed by researcher)

In developing countries particularly in rural areas, it is assumed that 20 liters of water/capita/ day is required to fulfill the basic domestic needs including hygiene and health (UNO, 1990). If we consider this UNO's minimum threshold of domestic water use, then in Pirwadi village the cumulative annual demand of water for total population would be 13818900 liters. If we assume that out of these 20 liters of water/capita/day, 10Lt. /capita/day is necessary for cooking and drinking purpose, then in this village the total cumulative annual demand of water would be 6909450liters.

Table No.3 in Pirwadi Village

Total Population (2001)	No. of Households (2001)	Total Annual RRWH Potential (in Liters)	Total LPCPD Annual Demand of Water (@ 20 Liters)	Total LPCPD Annual Demand of Water (@ 10 Liters)
1893	378	11457490.78	13818900	6909450

(Source: District Census Hand Book, 2001 & computations made by researcher)

It means that out of total potential of RRWH, about 60% of water could be essential to properly satisfy the basic need of drinking and cooking in this village.

VIII. CONCLUSION

In Pirwadi village, the water deficiency situation in hot season can be change in to water adequate situation by adopting the roof rain water harvesting techniques. The total potential of roof rain water harvesting has estimated as 11457490.78 Lt. which would be more than enough to satisfy the total annual drinking and cooking requirement of the people in this village. The aforesaid discussion emphasizes that the rain water harvesting techniques are proficiently useful to tackle down the water scarcity problem in rural areas.

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