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Review on Design of Rooftop Rainwater Harvesting in Nimgaon Village- A Case Study of Junnar Tahsil

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***Abstract*— Water is the most important resource on the earth. Which require water for various activities in our day-to- day life At the rate in which India's populace is expanding, it is said that India will without a doubt supplant China from its main position of most thickly populated nation of the world. This will prompt high rate of utilization of most significant characteristic asset "Water" bringing about expansion of weights on the allowed freshwater assets and supply of it is decreasing at a rapidly safe on this planet. Keeping in mind the end goal to ration and take care of our day by day demand of water prerequisite, we have to think for elective savvy and moderately simpler mechanical strategies of conserving water.**

The technical aspect of this project is rainwater harvesting collected from rooftop which is considered to be catchment areas Nimgaon Tarfe Mhalunge, Junnar, Pune. First of all, site is selected region of foot hill of sahyadri, where steep slope is present where runoff flows and the aim of this project is to collect and store that water and utilize the water by providing proper means of filtration. The project starts by collecting some important researches on rainwater Harvesting and studied them. After proper field planning work conducted to Nimgaon for proper visualize the situation of Nimagon village and to measure the dimension of roof catchment area. Then other required data are collected i.e. hydrological rainfall data, temperature. Then water is collected from different types of roofs will teste Physical, chemical as well as biological analysis of collected water was done experimentally in laboratory. The volume of water will calculate for determining to provide combined water tank for the people of Nimgaon village. Water harvesting potential for the village will calculate, and on the basis of tank capacity with suitable design will be consider. The key factor of this project is the filter unit which will be design efficient and economical and feasible to implement in the village or around the globe. Lastly this project is adopted for conserving the most important natural source on the earth. It is an initiative to preserve the water source. "*Save Water, Water will save us*".

Keywords*— *Rooftop harvesting, filter design, ground water recharge.

1. INTRODUCTION

1.1 Present water scenario in Maharashtra

In regions like Vidarbha and Marathwada faces water scarcity many a times. There are more than 5 districts in Maharashtra which are drought prone areas. Also some of the remaining districts face water problems every year. Pune district also face problems in summer season. By knowing this problem in Pune region the site is selected in Pune district for desertation. Roughly 40% of water utilized as a part of summer is utilized outside, which is when most territories confront water deficiencies and have water limitations. This water deficiency period is when plants and trees require water the most. As populace develops, water deficiencies happen. An ever increasing number of urban communities found a way to limit and to diminish the usage of water by doing water protection systems, as a method for observing and confining crisp water wastage. "Spare Water and Save Nation from Water Crisis and Saving Rainwater Saves Money", Helps the Environment. The more water is utilized, the less the need to utilize chlorinated or other synthetically treated faucet water. The more we utilize water, the less that will go into storm sewers where it is blended with oil and other harmful buildups from boulevards, parking areas and so forth taking into account more utilization of settling lakes to expel these poisons.

As per Times of India(TOI) Peak summer was yet to set in yet in excess of twelve areas over the state are reeling under intense lack of drinking water. The water level in the real dams in dry season inclined Vidarbha and a couple of locale in Marathwada has diminished radically.

"It's not a disturbing circumstance but rather still we should draft an activity get ready for handling deficiency of savoring water May and June," an administrator said. "We should use accessible water precisely. The central clergyman's yearning Jalyukta Shivar plot has acted the hero to keep up water level in specific locale."

On March 20 a year ago, the water supply division had conveyed 154 tankers. At 88, the most astounding number of tankers were conveyed in Marathwada, trailed by 40 in Pune district and 14 in Nashik division.

On March 19 this year, while no tankers had been conveyed in Nagpur division, in different parts 391 tankers had been sent to give drinking water to 401 towns and 10 villas. The vast majority of these tankers have been sent in Marathwada (252), trailed by Amravati (85) and Nashik (53) districts.

In Aurangabad alone, 206 tankers have been conveyed to supply consumable water to 169 towns. Aurangabad is trailed by Akola (46 tankers), Jalgaon (35) and Nanded (17).

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Rooftop Harvesting collecting/water reaping is the strategy through which rain water is caught from the rooftop catchments and water is put away in tanks, wells and stores. Collected rain water can be put away in sub-surface ground water repository by receiving manufactured energize strategies to meet the family unit needs through capacity in tanks. Ground water asset gets normally revived through permeation. Be that as it may, due to in separate improvement and fast urbanization, uncovered surface for soil has been decreased definitely with resultant diminishment in permeation of water, in this way draining ground water asset. Water reaping is the way toward expanding the normal filtration of water in to the underground development by some counterfeit strategies. "Cognizant gathering and capacity of water to take into account requests of water, for drinking, local reason and water system is named as Rainwater Harvesting."

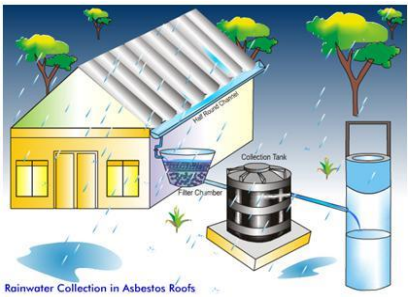

Fig. 1 Rooftop Rainwater Harvesting.

1.1 Components of rooftop rainwater harvesting:

Components of rooftop rainwater harvesting as shown in Fig. 2.

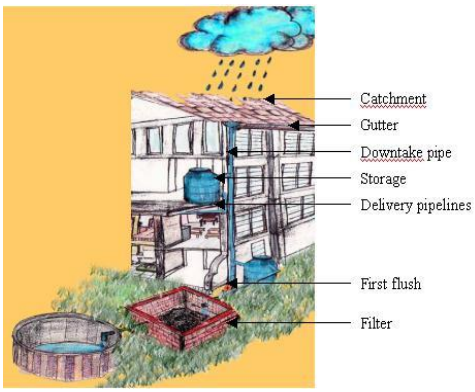

Fig. 2 Components of rooftop rainwater harvesting.

1) Roof catchment
2) Gutters
3) Down pipe
4) First flushing pipe
5) Filter Unit
6) Storage Tank

1.3 Benefits of rainwater harvesting system

After harvesting the rooftop water following benefits will gain:

1) Rainwater is a relatively spotless and absolutely free wellspring of water.
2) Rainwater is enhanced for landscape plants and gardens since it isn't chlorinated.
3) It can supplement other sources of water supply such as groundwater or municipal water connections.
4) It lower the water supply cost.
5) It can give a great move down wellspring of water for crises.
6) It is socially adequate and naturally capable.
7) It utilizations basic innovations that are economical and simple to keep up.
8) Reduced surge streams and topsoil misfortune.
9) It is free; the only cost is for collection and use.
10) It lessens the pollution of surface water with residue, composts and pesticides from water run-off outcome in cleaner lakes, waterways, seas and different recipients of tempest water.
11) It is utilized as a part of those regions which confront lacking water assets.
12) It can be utilized to energize groundwater.

1.4 Need for rainwater harvesting

In the todays condition the need of rain water activity is n eed of home. Its need is as given below:

1) As water is ending up rare, it is simply the need of the day to accomplish independence to satisfy the water needs.
2) As urban water supply system is under colossal weight for providing water to consistently expanding populace.
3) Groundwater is getting exhausted and contaminated.
4) Soil disintegration coming about because of the unchecked spillover.
5) Health perils because of utilization of contaminated water

2. LITERATURE REVIEW

Literature review related to the rainwater harvetsing was carried out. The Subjective research strategies were utilized to gather information on the utilization, task and support of water collecting systems. Initial, an investigation of auxiliary information, for example, different reports, papers, rules and strategies was completed to survey encounters from water reaping ventures that have just been actualized by different organizations everywhere throughout the world. Following papers are taken from websites such as Centre for Science and Environment, International Soil and Water

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Conservation Research, International Journal of Scientific & Engineering Research , Journal For Contemporary Research In Management, Tata Institute of Social Sciences, Journal Of Cleaner Production, Research Gate, Central Ground Water Board, Universal Journal of Environmental Research and Technology, Journal Of Environmental Management, African Journals Of Agricultural Research, Journal Of Hydrology, Water Science And Engineering.

According to Krishnaveni et.al. (2016) "Hydrologic design of rainwater harvesting system at Anna University, Chennai". This work is supportable system by planning a potential rain water reaping system in Anna university a basic spot of the city where a thousand populaces move in and out each day in the situation of the college water supply seems, by all accounts, to be in risk of occasional going away expanded water preservation will keep up a copious water supply later on. In this way computed the possible water to be harvest. Then dependable rainfall data was calculated. Then the demand calculations are done including net inflow and sump capacity, number of sumps. Also, they infer that this examination give valuable data to facilitate advancement of water reaping practice in Chennai and in addition for other parched and semi-dry areas of the world.[9]

According to Nawale et.al. (2015) The work carried out on rainwater harvesting systems in Pune city: The prime objective of this work was proper maintenance in will bring effective utilization of this system.. For conditions of rainwater harvesting system they interpret that it was evident that there was the existence of sources which would dilute the rainwater and what's more, in the meantime First flush redirection strategy which was of nearly significance to water gathering was not being used. For support of water reaping system they decipher that it was obviously clear that water collecting system are in great condition as the rooftop, drains, channels are appropriately kept up. For Frequency of cleaning water collecting system they decipher that cleaning ought to be accomplished more than once in a year. [3]

According to Patel et.al. (2014) The work carried out on Rooftop rainwater harvesting at SPSV Campus, Visanagar: Gujrat – A case Study. Their study majorly focuses on rooftop rainwater harvesting of the study area as Sankalchand Patel Sahakar Vidyadham (SPSV) Campus. The prime objectives of their work was to fulfill the scarcity of the water campus and then need to be use it for domestic and drinking water supply. In methodology they've determined some applications such as (1) what the captured water be used for (2) how much water can be captured(3) the collection Surface (4) Calculation of the volume of rainfall also (5) Rainfall data collection (6) Determination of catchment area (7) Hydrological analysis (8) Computation of volume of runoff per year. it was finally concluded that implementation of rainwater harvesting project to the campus of S.P.S.V. will be the best approach to fight with present scenario of water scarcity in all aspects, whether it is from financial point of view or from optimum utilization of land surface.[12]

According to Pawar et.al. (2014) The work carried out on rooftop rainwater harvesting of Renavi village in Sangli district of western Maharashtra: Article presents that the success story of rooftop rainwater harvesting. The potential assessment of the village revealed that, approximately 20 days, lakh liters of water collected from rooftops, will satisfy the demand of a population of 1300 for at least 78 days. This estimation was as per the united nation standards. A total of Rs. 6, 04,000 was invested as contribution by Government agencies and villagers for the Funding of rainwater harvesting program based on rainfall data is collected. Coefficient of runoff for the area is computed. The houses with and without roof top rainwater harvesting structures was been estimated and lastly ground water quality assessment from the open well and bore wells was calculated. From this work concluded that the rain water harvesting measures helps in fulfilling the domestic water need as well improving the ground water level by few meters. On the other hand, in some states of India such as Andhra Pradesh, Madhya Pradesh, Gujarat and Rajasthan the level of fluoride in ground water was above the permissible limit.[13]

According to Solanki et.al. (2015) The work carried out on rainwater harvesting in KJCOEMR at KJEI campus, Pune: In this research paper they have plot a planning of rainwater harvesting in K.J. Educational institute situated in Tal-Haveli, Dist-Pune, Maharashtra. Authors calculated the coefficient of runoff as per the areas such as urban area, single family residence, cultivated areas and forest. Then the volume of runoff in K.J. campus was been calculated. 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 K.J. campus receives torrential rains during monsoon season. Three underground tanks can be situated would be beneficial for the desired purpose as per schedule. And finally it was concluded that implemented the rainwater harvesting project to the K.J. building in the KJEI campus to fight with present scenario of water scarcity in all aspects, from financial as well as optimum utilization of land Resource.[15]

3. METHODOLOGY

3. 1 Problem statement

The present site is located on the high terrain, in mountainous region, foot hill of mountain. So the runoff from mountains to the steep slope. There is no facility to use or store that rainwater around the site. There is no use of that rainwater that the people from village can utilize it. So the main aim of this project is to stop that runoff, utilize the runoff or rainwater and arrest the ground water on that particular region.

3.2 Objectives

Present work is having following objectives:

1) To study the rainwater harvesting potential of Nimgaon village.
2) To understand the participatory approach of collective action of people in rooftop rainwater harvesting.
3) To conserve, preserve and use rainwater.
4) To identify suitable designin for harvesting system.
5) To use most efficient and effective rooftop rainwater harvesting system at Nimgaon village.

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6) To raise the underground water table by recharging the collected rooftop water.
7) To study the design of water tank and filter unit.
8) To augment ground water table and arrest ground water decline.
9) To beneficiate water quality in aquifers.

3.3 Study Area

The site is at Nimgaon Tarfe Mhaluge, Tal-Junnar, Dist-Pune. The site is lies an latitude of Junnar, Maharashtra, India is 19.209280, and the longitude is 73.872589Junnar, Maharashtra, India is located at India country in the cities place category with the GPS co-ordinates of 19° 12' 33.40" N and 73° 52' 21.32" E. It is situated 7km away from sub-district headquarter Junnar and 84km away from district headquarter Pune. It has an area of 3.18 km^2. Fig. No. 3.2 and 3.3 shows map of Nimgaon village.

Fig. 3 Local map of study area of Nimgaon.

Fig. 4 Location map of study area of Nimagon.

3.4 Data Collection

The important Required data like annual rainfall intensity, temprature, humidity, runoff etc. In the visit we collected the ground data which is survey no. of the house, type of structure, dimensions of house, rooftop area and structure for harvesting etc.

The nearest raingauge station, vadaj dam which is located near the site to collect annual rainfall data of previous year which will help us to design an efficient Rooftop rainwater harvesting system.

Table 1 Measurement of area of houses

SR. NO.	HOUSE HOLDER NAME	TYPE OF STRUCTURE	DIMENSIONS			STRUCTURE FOR HARVESTING	REMARK
			L	W	H1		
1.	SHIVAJI NAMDEV WAGHULE	SLOPPING ROOF (MANGALORE)	18.40	6.93	3.26,4.23	UNDERGROUND TANK	N 19^{0}09.29' E 73^{0}52.35' 722M
2.	SHIVAJI NAMDEV WAGHULE	STEEL	12.23	6.15	2.67,2.35		N 19^{0}09.26' E 73^{0}52.35' 724M
3.	NITIN NATHA WAGHULE	LOAD BEARING	6.95	6.40	3.80,3.30	UNDERGROUND TANK	N 19^{0}09.28' E 73^{0}52.35' 721M
4.	PANDHARINATH BABURAO WAGHULE	STEEL SHADE	10.92	7.40	2.21,1.9	UNDERGROUND TANK	N 19^{0}09.28' E 73^{0}52.35' 721M
5.	SHARAD NAMDEV WAGHULE	STEEL SHADE	13.40	9.55	3.58,2.44	UNDERGROUND TANK	N 19^{0}09.27' E 73^{0}52.01' 723M
6.	SANTOSH BABAN WAGHULE	SLOPPING ROOF (MANGALORE)	9.10	3.50	2.75,2.25	UNDERGROUND TANK(500 LTR. AVAILABLE)	N 19^{0}09.254' E 73^{0}52.63' 719M
7.	SANTOSH BABAN WAGHULE	SLOPPING ROOF (MANGALORE)	9.1	6.85	4.25, 2.2	UNDERGROUND TANK(500 LTR. AVAILABLE)	N 19^{0}09.254' E 73^{0}52.63' 719M
8.	SHANKAR DHONDU WAGHULE	SLOPPING ROOF (MANGALORE)	7.1	6.7	3.80,2.35	UNDERGROUND TANK	N 19^{0}09.24' E 73^{0}52.63' 715M

Above Table No. 3.2 shows measurements of houses. The total catchment area will be calculating in this step and for that we have collected the data of the catchment roofs on which water is collected.

3.5 Annual Rainfall Data

For calculating annual rainfall precipitation previous five year rainfall data was collected. Rainfall from high-intensity, short duration rainfall events may be lost to overflow from storage tanks or splash out from the gutters. Although these intense rainfall events are considered part of the cumulative annual rainfall, the total available volume of such an event is rarely captured. Another consideration is that most rainfall occurs seasonally; annual rainfall is not evenly distributed throughout the 12 months of the year.

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Table 2 Previous 5 year annual rainfall data

Sr. no.	Year	Annual rainfall in mm
1	2013-2014	706.77
2	2014-2015	728
3	2015-2016	725
4	2016-2017	717
5	2017	870

The average five year annual rainfall will be 750mm.

Also the rooftop area and the amount of precipitation over the rooftops was caclculated.

Table 3 Rooftop Area and Precipitation

Serial no.	Name of house holder	Rooftop Area	Rainfall collected water
		Sq.m	Liters
1	Jalindar balaji waghule	115.78	86835
2	Ashok balaji waghule	132.57	99427.5
3	Sakharam balaji waghule	46.27	34702.5
		134.5	100875
		166.59	124942.5
4	Santosh murlidhar waghule	90.14	67605
		64.53	483975.5
5	Dattatray dhondhu waghule.	103.32	77490
6	Shripat dhondhu waghule	63.86	47895
		87.96	65970
7	Murlidhar dhondhu waghule	103.32	77490
8	Ganpat dhondhu waghule	103.32	77490
9	Sampat dhondhu waghule	103.32	77490
10	Keshav haribhau waghule	126.15	94612.5
11	Natha Baban Waghule	88.06	66045
12	Sachin vitthal waghule	270.6	202950
13	Lakshman Ranuji waghule	173.61	130207.5
14	Sant Savata Maharaj Temple	91.29	68467.5
		84.27	63202.5
15	Dnyaneshwar Lakshman Waghule	107.26	80445
16	Ramdas Ganpat Waghule	150.61	112957.5
17	Sukhdev Savleram Waghule	159.14	119355
18	sharad Namdev Waghule	159.14	119355
19	Tukaram Bhaguji Waghule	111.66	83745
20	Hemant Krushnaji Waghule	83.68	62760
21	Shivaji Namdev Waghule	132.41	99307.5
22	sharad Namdev Waghule	96.23	72172.5
		127.97	95977.5
23	Nitin Natha Waghule	44.48	33360
24	Santosh Baban Waghule	33.12	24840
		72.64	54480
25	Shankar Dhondhu Waghule	47.57	35677.5
		13.7	10275
26	Sachin Natha Waghule	107.48	80610
27	Tukaram Savleram Waghule	75.32	56490
		96.19	72142.5
28	Dashrath Dhondhu Waghule	102.04	76530
		84.55	63412.5
29	Pandharinath Baburao Waghule	80.808	60606
		194.87	146152.5
30	Pravin Kisan Waghule	133.75	100312.5
		51.83	38872.5
31	Avinash Namdev Waghule	51.85	38872.5
32	Sonai Poultry Farm	692.67	519502.5

3.6 *Test on water sample:*

Experimental values of parameters of water sample collected from rooftop area are to calculate to determine the quality of the rainwater before and after filtration. The parameters of water calculated are:

1) Turbidity
2) PH
3) Chloride Contents
4) Total hardness
5) Alkalinity

The water sample harvested from different types roof such as sloping roof (Mangalore tile), slab, tap water and bore well water. This sample from different places contains different parameters of water. Experimental values of parameters of harvested are derived and utilize the harvested water as per the standards.

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Table 4 Experimental Values of Parameters of Water Sample before Filtration

Sample No.	Ph	Chloride Content (Mg/L)	Turbidity (Ntu)	Total Hardenss (Mg/L)	Alkalinity (Mg/L)
Sample 1	7.5	120.53	1	424	178
Sample 2	7.5	110.6	0	478	162
Sample 3	7.5	129.04	26	272	161
Sample 4	7.5	87.92	5	350	143

These values will be checked in the standard values of water in Bureau of Indian Standards (BIS) standard specification for potable water (BIS-10500-1991). Based on those results the type and amount of treatment need for the water will be given in the form of filtration. And after filtration all the parameters will be calculated, and based on those values the use of the water will be specified.

3.7 Filter Unit

Filter unit will be design by taking the values of those parameters of water before filtration into consideration. This will specify the water to be used for varios purposes.

The key component of this design is the filter media, where the better result through filter will make this project in good direction. Since the site is in rural area the natural organic material will easily available to utilize it for the purpose of filter unit. Material such as dry grass, coal, fine sand etc. So an efficient and economical filter can be design which is feasible to implement anywhere as filter media.

To design an efficient filter system, materials which we are using for the filter are as follows:

1) Sand
2) Gravel
3) Aggregates
4) Charcoal(activated carbon)
5) Wire mesh
6) Seashore sand

Seashore sand is the main ingredient we are looking forward to make use of it in the filter. We will take a test on the sand and take out the characteristics and properties of that sand. To utilize seashore sand we must have to treat it to remove its alkaline nature. This will help to decide to implement it in the design.

4. RESULT AND DISCUSSION

In the present context, the different methods were employed of rainwater harvesting from the recent researches all over the world. As we have selected our region in Maharashtra state Pune district, the research from Maharashtra and Pune guides us a lot. All the necessary data which is important for our project was available in those research papers

The main and best source at the present time of pure water is rain. If more awareness showed towards this then it will make rainwater harvesting a success. Rainwater harvesting system provides water for various purposes including bathing dish washing, cooking, drinking also flushing toilets, washing floors, fish tanks, gardening and for this purposes the rainwater must be treated to remove heavy metals and contaminants and needs disinfection and filtration treatment required..

By studying all the techniques, design, maintenance and discipline, we are going to design an efficient rooftop rainwater system. This rooftop rainwater harvesting system contents are ground water recharge, to mitigate the water problem in summer season, design of filter medium would be efficient rainwater harvesting which can implement in a simple manner anywhere across the world.

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