Estimation of Roof Top Rainwater Harvesting Potential for Ground Water Recharging Considering Dominant Losses.

NIRAJ S. PATIL[1], HARSHITA S. SALUNKE[2], GAURAV M. MALI[3], SHITALKUMAR N. DESHMUKH[4]

[1] *Author Lecturer, Civil Engineering Department, SGDPJ, Maharashtra, INDIA*
[2] *Author Lecturer, Civil Engineering Department, SGDPJ, Maharashtra, INDIA*
[3] *Author Lecturer, Civil Engineering Department, SGDPJ, Maharashtra, INDIA*
[4] *Author HOD, Civil Engineering Department, SGDPJ, Maharashtra, INDIA*

ABSTRACT

Rainwater harvesting is a technique for collecting and storing rainwater for later use. This report examines the need for rainwater harvesting, explores various methods for its implementation, and analyzes existing research on the topic. Following a general introduction, the report reviews existing literature on rainwater harvesting. This includes the growing need for sustainable water management practices, the various methods of rainwater harvesting, and a summary of relevant research. The identified research gaps are then presented. The methodology used to analyze data related to rainwater harvesting is then explained. Finally, the report concludes with a data analysis and interpretation section, though the specific statistical methods employed are not detailed in the provided table of contents. This report delves into the critical aspect of rainwater harvesting, examining its necessity, methodologies, existing research, and identified gaps. Beginning with an overview of the topic and a delineation of the problem statement, it sets out the aims and objectives, followed by a delineation of the report's scope and structure. The literature review section explores the broader context, emphasizing the need for rainwater harvesting and various methods employed. Additionally, it summarizes relevant research papers and identifies existing research gaps. The subsequent section combines the problem statement with the methodology, outlining the approach taken to address the identified issues. Finally, the report delves into data analysis and interpretation, offering a comprehensive statistical examination to support the findings and conclusions drawn throughout the study. This report delves into Rainwater Harvesting (RWH) and its significance in achieving Sustainable Development Goals (SDGs). It focuses on Rainwater Harvesting and Storage Systems (RWHSS), utilizing Geographic Information Systems (GIS) and Remote Sensing (RS) technologies. The study employs Multi Influence Factor (MIF) analysis within Water Resources Information Systems (WRIS) to evaluate the effectiveness and feasibility of RWHSS implementation. Through a comprehensive approach, it aims to contribute to sustainable water management practices, aligning with global development agendas

Keyword: - *Sustainable Development Goals (SDGs), Rainwater Harvesting and Storage Systems (RWHSS), Multi Influence Factor (MIF), Resources Information Systems (WRIS).*

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1. INTRODUCTION

Water scarcity is a pressing global issue exacerbated by population growth, urbanization, and climate change. Traditional water sources such as rivers, lakes, and groundwater reservoirs are under increasing stress, necessitating innovative solutions to ensure water security. Rainwater harvesting (RWH) presents one such solution, offering a sustainable approach to augmenting water supply, particularly in regions facing water stress. Rainwater harvesting is the collection and storage of rainwater for later use, typically in domestic, agricultural, or industrial settings. It involves capturing rainfall from rooftops, surfaces, or catchment areas, then storing it in tanks, cisterns, or underground reservoirs. This ancient practice has gained renewed attention in recent years due to its environmental, economic, and social benefits. Beyond addressing water scarcity, rainwater harvesting contributes to environmental sustainability by reducing runoff and erosion, replenishing groundwater reserves, and minimizing the energy-intensive processes associated with centralized water distribution the context of climate change, rainwater harvesting holds particular promise as a climate adaptation strategy. With shifting precipitation patterns and increasing frequency of extreme weather events, RWH provides a flexible and adaptable water supply solution. By capturing rainfall when it occurs and storing it for future use, communities can better withstand periods of drought and erratic weather conditions. In conclusion, rainwater harvesting represents a promising approach to sustainable water management, offering a decentralized, adaptable, and environmentally friendly alternative to conventional water supply systems. As global water challenges persist and intensify, the importance of harnessing rainwater as a valuable resource cannot be overstated. This thesis aims to explore the principles, practices, and potential of rainwater harvesting in addressing water scarcity and advancing sustainability goals in diverse contexts.

1.1 General

Rainwater harvesting (RWH) is a centuries-old practice that involves collecting, storing, and using rainwater for various purposes. It has gained renewed attention in recent years due to increasing water scarcity, population growth, and environmental concerns. Here is some general information about rainwater harvesting Rainwater may contain pollutants from rooftops, air pollution, or other contaminants, requiring proper filtration and treatment. Installation costs for RWH systems can be significant, although long-term savings and benefits often outweigh upfront expenses. Lack of supportive policies, regulations, and incentives may hinder the widespread adoption of rainwater harvesting, particularly in urban areas. Advances in RWH technology, such as improved filtration systems, smart monitoring devices, and modular designs, are making rainwater harvesting more efficient, affordable, and accessible to a wider range of users.

1.2Problem Statement:

Water Quality Concerns Rainwater may contain contaminants, such as pollutants from rooftops, debris, and microbial pathogens, which can compromise its suitability for various uses, including potable water supply. storage and Treatment: Effective storage and treatment solutions are needed to maintain water quality and prevent microbial growth, sedimentation, and contamination during storage and distribution. System Design and Integration Designing efficient and cost-effective rainwater harvesting systems requires careful consideration of factors such as catchment area size, storage capacity, conveyance infrastructure, and filtration methods. Initial Investment Costs: The upfront costs associated with installing rainwater harvesting systems, including equipment, infrastructure, and maintenance, can be prohibitive for individuals, communities, and businesses, particularly in low-income or resource constrained settings .Cost Benefit Assessing the long-term economic viability and return on investment of rainwater harvesting projects compared to conventional water supply sources requires comprehensive cost-benefit analyses, taking into account factors such as water savings, utility costs, and potential revenue streams. Awareness and Education Limited awareness and understanding of rainwater harvesting benefits, techniques, and best practices among the general public, policymakers, and stakeholders may impede its acceptance and uptake.

1.3 Aims and Objectives:

Aim: To determine the RAIN WATER HARVESTING considering potential losses and water demand of various building in Jalgaon district.

Objectives:

a) To study methods of RAIN WATER HARVESTING and affecting parameters
b) To determine the RAIN WATER HARVESTING potential of various building
c) To compare the harvesting potential of different buildings.

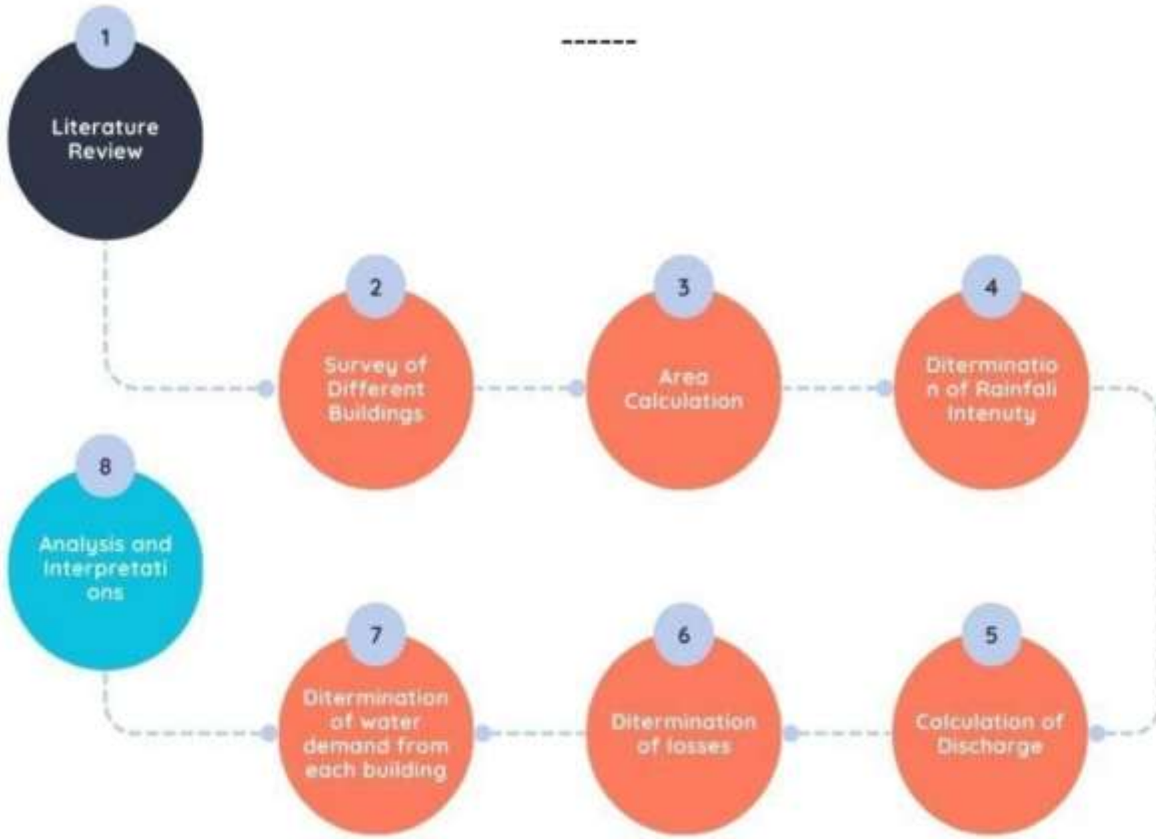
1.4 Scope: -

The scope of rainwater harvesting is quite broad and encompasses various aspects related to the collection, storage, treatment, and utilization of rainwater. Here are some key points that illustrate the scope of rainwater harvesting: Rainwater harvesting extends beyond single-family homes. It's used in Agriculture: Rainwater provides irrigation for crops, particularly valuable in drought-prone regions. Industries: Industries can utilize rainwater for various processes that don't require potable water Urban Areas: In cities, rainwater harvesting can help manage storm water runoff and reduce the risk of flooding. Reduced Dependence on Municipal Supplies: Rainwater harvesting lessens the strain on municipal water supplies, especially during dry periods. By collecting rainwater for purposes like flushing toilets or watering gardens, you rely less on treated city water. Environmental Benefits: Rainwater harvesting contributes to environmental well-being in several ways: Groundwater Collected rainwater can be directed to recharge groundwater aquifers, mitigating depletion. Reduced Strain on Water Sources: Less reliance on freshwater sources like rivers and lakes helps maintain their health. Erosion Control: By reducing storm water runoff, rainwater harvesting helps prevent soil erosion. Cost Effectiveness: While there's an initial investment in setting up a rainwater harvesting system, it can pay off in the long run by lowering water bills. Groundwater Recharge: By capturing rainwater and allowing it to percolate into the ground, rainwater harvesting contributes to and bore holes. Overall, the scope of rainwater harvesting is multifaceted, encompassing water management, environmental stewardship, making it a valuable tool for sustainable development. Rain water harvesting presents a sustainable approach to water management, offering a reliable source for various uses and promoting water conservation.

2. METHODOLOGY

2.1 INTRODUCTION

As a way to combat water scarcity and become more water-conscious, rainwater harvesting has emerged as a simple yet impactful solution. This method captures the rainwater that naturally falls on rooftops, ground surfaces, or any designated area. Instead of letting it run off unused, the collected water is then channeled into storage tanks or cisterns for later use. This not only conserves a valuable resource but also provides a source of soft water ideal for gardens and even some household applications with proper treatment. From watering plants to supplementing Information to consider when surveying different building types, specifically focusing on their suitability for rainwater harvesting (RWH) systems Building Type: Residential (single-family, multi-family), Commercial (office buildings, retail stores), Industrial (warehouses, factories), Institutional (schools, hospitals), Government Buildings, etc. Size: Square footage, number of floors, building footprint (all influence collection potential Location: Urban, suburban, rural (impacts rainfall patterns and regulations The area you need to calculate for rainwater harvesting is the catchment area, which is typically the surface area of your roof: Measure the roof: If your roof is rectangular, simply multiply the length by the width to get the area in square feet (ft²) or square meters (m²).Consider complex shapes: For more complex roof shapes, you might need to divide it into simpler shapes (rectangles, triangles) and calculate the area of each section separately. Then, add all the areas to get the total catchment area. Rainfall intensity is definitely important for rain water harvesting: More water collection: During heavy downpours (high intensity rainfall), you have the potential to collect a larger volume of rainwater from irrigation needs, rainwater harvesting offers a sustainable approach to water management. your catchment area (roof, ground surface etc.). This can be beneficial if your storage capacity allows. Runoff coefficient: This value indicates what percentage of rainfall actually converts to runoff that can be collected. Knowing this along with rainfall intensity helps estimate the amount of rainwater you can realistically harvest. Rainwater harvesting typically focuses on collecting rainwater, not discharging it. However, there are calculations involved in estimating how much rainwater you can collect Catchment Area: This is the surface area that collects rainwater, usually your roof. Find the area in square feet (ft²) or square meters (m²). Rain fall Depth: This is the amount of rain in a specific period. Look for average annual rainfall data for your location in inches (in) or millimeters (mm). Rain water harvesting isn't perfect, and there are some losses to consider. These losses are typically accounted for by a value called the runoff coefficient Absorption: The collection surface itself, like your roof, might absorb a small amount of rainwater. This is more common with porous materials like concrete or asphalt compared to metal roofs. Spillage: During heavy rainfall, your collection system might overflow, leading to some loss. Leakage: Cracks or improper connections in your rainwater harvesting system can cause leaks.



3. General: -

This chapter highlights the data analysis and corresponding interpretations. it covers the details of rainfall taken from WRIS site survey of various buildings along Jalgaon district. and its area determination using satellite information. The buildings include various public buildings hospital and residential buildings in an around the region. In Jalgaon district have semi-arid climatic conditions having prominent amount of rainfall during the monsoon period and very uneven during the other period climatic conditions.so our project deals only with the rainfall data of monsoon period covering the period from June to September. we have taken rainfall data from the year 2015- 2020.

3.1 Statistical Analysis of data: -

3.2.1 Determination of discharge: Discharge is equivalent to the rooftop rainwater harvesting potentials. The term "discharge" in this context refers to the release or outflow of this collected rainwater from the storage system, either for immediate use or for diversion to other purposes such as irrigation, groundwater recharge, or stormwater management. We have analyzed the total monsoon period to calculate the discharge. Then we have taken four months of June, July, August, September, that is, we have calculated the discharge of 122 days. The formula of discharge is = Rainfall intensity*area of rooftop*coefficient of friction.

3.2.2 Determination of losses:

Three potential losses occur in close conduit. 1. Entrance loss and exit loss 2. Bend loss 3. frictional loss.

Entrance loss and exit loss: Entrance / Exit Losses Entrance losses come from when liquid enters a pipe from a much larger pipe or tank of some sort. Exit losses are opposite and come from liquid leaving a pipe and entering a much larger pipe or tank. When entering a pipe, the losses depend on the shape of the entrance.

hi =Ki*v^2/2g

Bend loss: The additional loss of head (apart from that due to usual friction) in flow through pipe bends is known as bend loss and is usually expressed as a fraction of the velocity head as, where V is the average velocity of flow through the pipe.

h bend = Kb v^2/ 2g

Were,
Kb = co-efficient of bend.
V= velocity of fluid. (m/s)

frictional loss: Friction loss affects flow rate and fluid pressure within the piping system and must be considered during system design. Fittings, bends, valves, expansion joints and any change in direction can also create friction that causes pressure loss and can result in operational challenges.

Formula: h L major = f*(L) (V^2)/ 2(g) (D)

Where,

H L major = head loss in ft or m.

F= Darcy- Weisbach friction factor

D= Diameter of pipe

L= Length of pipe

V= Flow velocity

g = gravitational acceleration

Considering both of these losses we got the values in the range of 0.5 to 2% only so there is not much reduction in this discharge. Still, we have used to consider the discharge deducting these losses. We have calculated both of these losses and the cumulative loss was in range of o.5 to 2%. Hence there is not was a significant effect of losses only total rainwater harvesting potential as its amount of significantly higher. Still, we have considered the final data of discharge deducing the losses.

3.2.3. Determination of cumulative discharge and water demand for entire monsoon period: June, July, August, September have been added for cumulative discharge. We have drawn standard criteria to calculate water demand. Which are provided for IS standard. How much for public building, residential building, hospital? With that calculation, we calculated the water demand. With that calculation we took all the water demand. Multiply that by number of individuals. Water demand has been divided into 3 categories: residential building, public building, and hospital.

Residential building we took 135 liters per day for those 4 months.

Formula = 135*number of individuals*122.

Public building: Public buildings do not have as such other usage, so we did not apply the factor.

Formula= 45*number of individuals *122.

Hospital needs water for doctors, nurses, and other cleaning purposes, except for patients; so we have put a factor of 0.5 there.

Formula= 350*Number of individuals *122 (f) *0.5.

3.2.4. Graph Interpretation:

have you can see the graphs of rainwater harvesting potentials and water demand for the year of 2015 the bar in the blue color represents the total rainwater harvesting potential during monsoon period while the orange portion indicates the water demand for the period. in the same way different graphs have been drawn for the year 2016 to 2020. with a view to represent the entire district of the all categories in a same picture we took the annual average potential for all the buildings. in order to compare the potential of three categories that is (residential, Public, and Hospitals) buildings we simply to the cumulative average of RWH potential from 2015 to 2020 and made the graph.

4.1 Result and discussion

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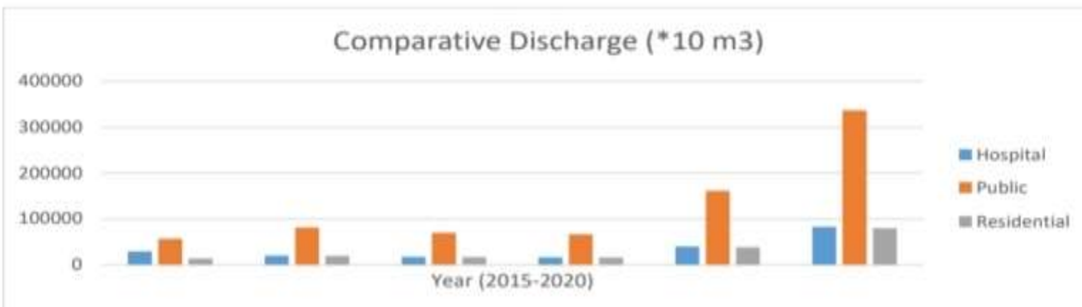
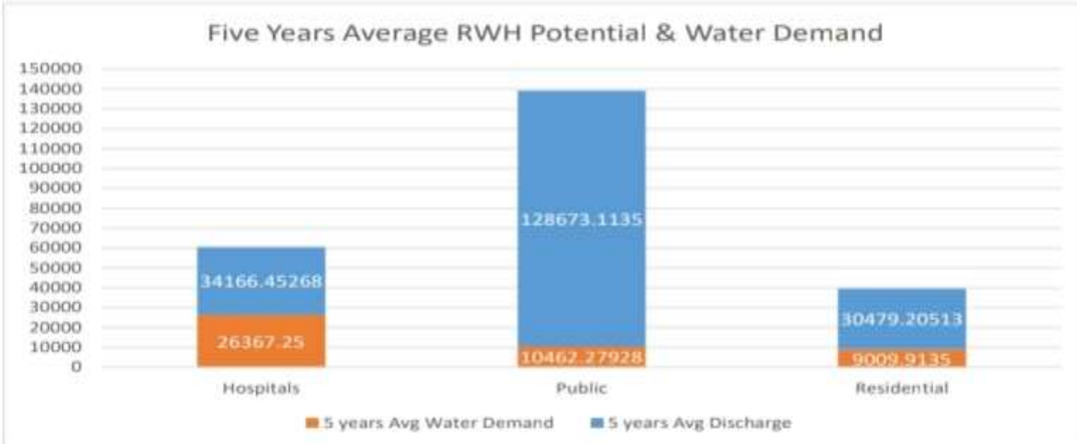


Comparative Discharge

Year	Hospital	Public	Residential
2015	29163.84	57019.5	13506.38
2016	20058.96	81361.13	19272.27
2017	17189.65	69923.26	16562.94
2018	16232.26	66028.85	15640.46
2019	39611.37	161129.3	38167.2
2020	82742.64	336576.7	79725.98
AVG	34166.45	128673.1	30479.21



	5 years Avg Discharge	5 years Avg Water Demand
Hospitals	34166.45	26367.25
Public	128673.1	10462.28
Residential	30479.21	9009.914

5. Conclusion:

Here it can be observed that public building has the highest rainwater harvesting potential provide that water demand is laser as compared to others. Ever after considering the water losses there is not much deduction in rainwater harvesting potential as losses equals to L 1.5% only

Public	50 thousand-5 lakh cumecs
Hospital	15 thousand-90 lakh cumecs
Residential	10 thousand80lakh cumecs

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