Rainwater Harvesting

Partha Pratim Paul[1], Debjit Mondal[2], Shilpi Pal[3] and Sarbani Ganguly[4]

Student, Computer Science and Engineering, Narula Institute of Technology, Kolkata, India[1],[2]

Faculty, Department of Basic Science and Humanities, Narula Institute of Technology, Kolkata, India[3,4]

Abstract: Rainwater harvesting is a sustainable practice that involves collecting and storing rainwater for various uses. This process typically involves capturing rainwater from rooftops or other surfaces and directing it into storage systems such as tanks or reservoirs. The collected rainwater can then be utilized for purposes like irrigation, landscaping, flushing toilets, and even drinking after proper treatment.

Rainwater harvesting systems have gained increasing attention as sustainable water management solutions in urban and rural areas. These systems are designed to capture, store, and utilize rainwater runoff from rooftops or other surfaces for various purposes, such as irrigation, domestic use, and groundwater recharge. This abstract provides an overview of rainwater harvesting, including its components, benefits, and environmental significance.

It explores the principles of collection, storage, and distribution, highlighting their role in conserving freshwater resources and reducing the strain on centralized water supply systems. The abstract also discusses the potential challenges and considerations for implementing rainwater harvesting systems, emphasizing their adaptability to diverse geographical and climatic conditions. Overall, rainwater harvesting offers a sustainable approach to water resource management, contributing to water conservation and resilience in the face of changing climate patterns.

Keywords: Rainwater Storage, Catchment area, Rainwater Filtration, Water conservation

I. INTRODUCTION

Rain Water Harvesting is the process of collecting, storing, and utilizing rainwater that falls naturally from the sky. It is an ancient practice that has been used for centuries in various parts of the world to address water scarcity and provide a sustainable water source. Rain Water Harvesting offers numerous benefits, including water conservation, reducing reliance on conventional water sources, and mitigating the impact of storm water runoff. Rainwater harvesting is one of the most important purposes not in India whole world now thought about this process. Rainwater harvesting is an innovative and environmentally sustainable approach to address water scarcity challenges in various regions worldwide.

This practice involves the collection, storage, and utilization of rainwater, primarily for domestic, agricultural, and industrial purposes. As population growth and climate change put increasing pressure on traditional water sources, rainwater harvesting has gained prominence as a vital strategy for water resource management.

This paper provides an overview of the key aspects of rainwater harvesting, including its methods, benefits, and significance. It also highlights the role of rainwater harvesting in promoting water conservation, reducing reliance on centralized water supply systems, and contributing to the overall sustainability of communities and ecosystems. The paper also highlights the rainwater harvesting project in our college campus.

Our institute is Narula Institute Technology, which situated at 81, Niljung Road, Jagarata Polly, Deshpriya Nagar, Agarpara, Kolkata, WB-700109. The Institute is at the center of the campus and is surrounded by a residential area. The total strength of the campus including students and staff is more than 2000. Thus, with this present strength, there is a huge demand of water in the college campus along with the laboratories of Civil Engineering, Mechanical Engineering, Chemistry, Physics etc., requires a lot of water for experiments also for cleaning purposes. Hence, keeping in view all the above problems and the status of the campus in Narula Institute of Technology we tried to focus on the water scarcity problem. Therefore, in this situation, a rainwater harvesting system can be considered as the best solution for fighting against water scarcity on campus.

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
6th National Conference on Science, Technology and Communication Skills – NCSTCS 2K23
Narula Institute of Technology, Agarpara, Kolkata, India
Vol. 10, Special Issue 3, September 2023

Fig. 1 The Catchment Area of Narula Institute of Technology

II. OVERVIEW OF RAINWATER HARVESTING

Rainwater Harvesting is a technique that involves the collection and storage of rainwater for future use. It has been practiced for centuries in different parts of the world and is gaining popularity as a sustainable water management strategy. Rainwater harvesting is a sustainable water management practice that revolves around the collection, storage, and utilization of rainwater. It provides a valuable alternative or supplementary source of water for various purposes, thereby alleviating the stress on conventional water supply systems and contributing to environmental sustainability. This approach begins with the collection of rainwater from rooftops, catchment areas, or other surfaces, which is then channeled into storage tanks, reservoirs, or underground cisterns. This stored rainwater can be treated to meet potable water standards or used directly for non-potable applications, such as landscape irrigation, flushing toilets, and even industrial processes.

The advantages of rainwater harvesting are manifold. It helps reduce the demand for freshwater from conventional sources like rivers and aquifers, thereby conserving these precious resources. Additionally, it minimizes storm water runoff, which can carry pollutants and exacerbate flooding in urban areas. Rainwater harvesting systems are flexible and adaptable, making them suitable for both rural and urban settings. Furthermore, rainwater harvesting is an eco-friendly practice that reduces energy consumption and greenhouse gas emissions associated with the treatment and distribution of centralized water supplies. It encourages a decentralized approach to water supply, empowering individuals and communities to take charge of their water needs. In summary, rainwater harvesting represents a sustainable and practical solution to water scarcity and environmental challenges. It promotes water conservation, reduces environmental impact, and enhances resilience in the face of changing climate conditions, making it an essential strategy in the quest for sustainable water management.

III. COMPONENTS OF RAINWATER HARVESTING SYSTEMS

Rainwater Harvesting systems typically consist of several key components that work together to collect, store, and utilize rainwater efficiently. The specific components may vary depending on the scale and complexity of the system, but here are the common elements:

(1) Catchment Surface- The catchment surface is the area where rainwater is collected. It can be a rooftop, a paved area like a courtyard (or)parking lot,(or)even natural surfaces like open land (or)hillsides. The catchment surface should be clean and free from contaminants that could affect the quality of collected rainwater.
(2) Gutters and Downspouts- Gutters are channels installed along the edges of the roof along the edges of the roof to collect rainwater and direct it to downspouts. Downspouts are vertical pipes that carry rainwater from the gutters down to the storage (or) distribution system.
(3) Filtration System- A filtration system is essential to remove debris, leaves, sediment, and other particles from the collected rainwater. It helps ensure that the stored water is clean and free from contaminants. Filtration systems can include screens, mesh filters, sediment tanks (Or) other appropriate filtration mechanisms.

(4) First Flush Diversion System- A first flush diverter is a device used to divert the initial flow of rainwater, which may contain more pollutants from the catchment surface.
(5) Storage Tanks- Rainwater storage tanks are used to store the collected rainwater for later use. These containers can be made of various materials such as concreate, plastic, (or) metal. The size of the storage system depends on the water demand and the frequency of rainfall.
(6) Overflow system- An overflow system is designed to prevent excess rainwater from causing damage (or) flooding.
(7) Pumping System- In larger rainwater harvesting systems (Or) when a pressurized water supply is required, a pumping system may be installed. It helps distribute the collected rainwater to various points of use, such as irrigation systems, pumping fixtures, (or) industrial processes.
(8) Distribution System- The distribution system delivers the harvested rainwater to its intended uses. It may include pipes, valves, and outlets to supply water for non-potable purposes like gardening, toilet flushing, (or) industrial applications.
(9) Water Treatment- Depending on the desired use, additional treatment processes such as disinfection, sedimentation, (or) filtration may be required to ensure the collected rainwater meets the necessary quality standards.
(10) Monitoring &Maintenance- Regular Monitoring and maintenance of rainwater harvesting are crucial to ensure its proper functioning. This includes inspecting the catchment area, cleaning filters and storage tanks, checking for leaks (or) blockages, and addressing any necessary repairs (or) maintenance tasks.

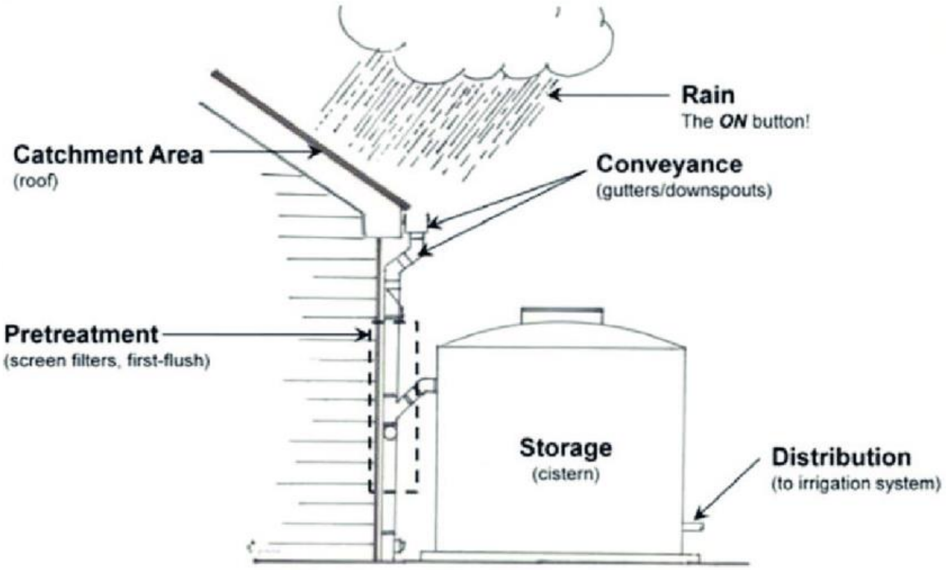

Fig. 2 Sketch of Rainwater Harvesting System

IV.MODEL DESCRIPTION

The study area of rainwater harvesting encompasses a multidisciplinary field focused on understanding, optimizing, and implementing rainwater collection and utilization systems. Researchers in this area explore various aspects, including hydrology, engineering, water quality, policy, and socio-economic factors.

They analyze the feasibility, design, and performance of rainwater harvesting systems in different geographical and climatic settings to promote sustainable water management practices and address water scarcity challenges. This research aids in developing guidelines, policies, and technologies that can enhance the adoption and effectiveness of rainwater harvesting worldwide'

CATCHMENT AREA
Calculations are for 1 storm, considering intensity of storm as 2cm\hr.

- Rooftop area=3560m^2
- Open area=10251m^2
- Runoff coefficient for roof-top area= 0.95
- Run off coefficient of rooftop area(open)=0.8
- Storm Duration =2hr.

FOR ROOF TOP AREA
Q= C.I.A\3.6 =0.95*20*3560*10^-6\3.6=0.1897 M^3/SEC
For Open Area
Q=C.I.A/3.6=0.8*20*10251*10^-6/3.6=0.2368M^3/SEC
Total Runoff= 0.01879+0.2368 =0.0425m^3/sec
Total Runoff Volume= peak runoff rate*storm duration =0.0425*2*3600 = 306000 lit.

WATER OBSTRUCTED IN A TANK
For this volume of water recharge tank dimensions (10m*10m*1.5m)
Water obstructed= volume of recharge tank/total runoff
=10m*10m*1.5m/306m^3=49.09%

SKETCH MAP OF RAINWATER HARVESTING IN NIT CAMPUS

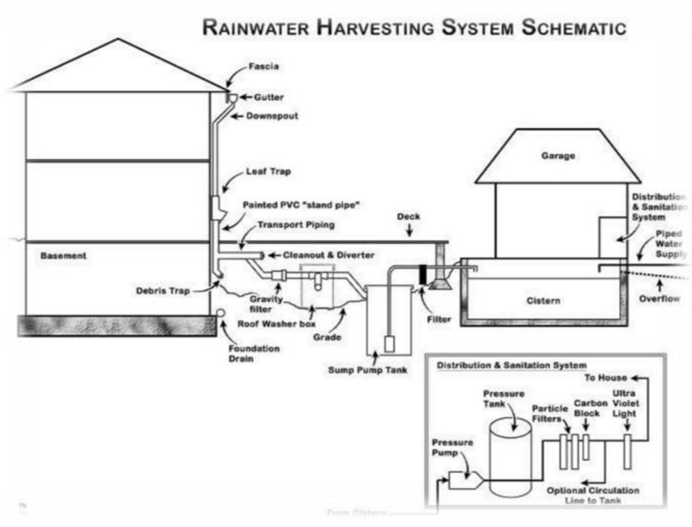

Fig.3 Rainwater harvesting system schematic.

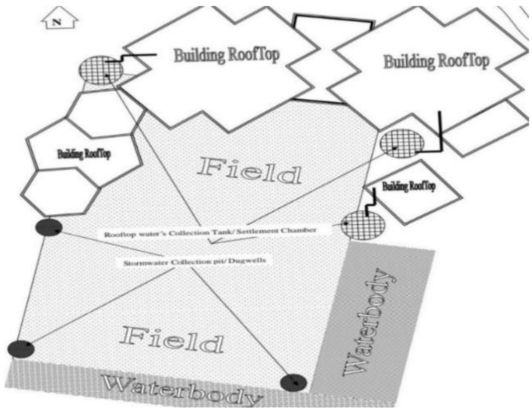

Fig.4 Sketch Map.

V. SMART RAINWATER HARVESTING SYSTEM WITH IOT INTEGRATION

A new idea for rainwater harvesting could be the integration of smart technology to optimize collection and usage. Rainwater Collection: Install a network of smart rainwater collection units on rooftops, connected to a central control system. These units would be equipped with sensors to detect rainfall intensity and adjust collection rates accordingly.

Filtration and Storage: The collected rainwater would pass through a filtration system to remove impurities and debris. The filtered water would then be stored in a smart storage tank capable of measuring water levels and quality.

Internet of Things (IoT) Connectivity: The entire system would be connected through IoT, allowing for real-time monitoring and control. Data from sensors, such as rainfall levels, water quality, and storage capacity, would be transmitted to a central control hub. Intelligent Water Management: The central control hub would be equipped with advanced algorithms to analyze the data received. It would make intelligent decisions based on factors like weather forecasts, water demand, and conservation goals. For example, it could adjust the storage capacity used for rainwater collection based on predicted rainfall patterns.

Water Distribution: The smart system would integrate with the existing water distribution network, providing a supplementary source of water during periods of low rainfall. It could automatically switch between rainwater and municipal supply based on water availability and demand.

User-Friendly Interface: A user-friendly interface, such as a mobile app or web portal, would allow users to monitor their rainwater harvesting system, track water usage, and receive alerts or recommendations for optimizing water conservation.

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

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Vol. 10, Special Issue 3, September 2023

VI. CONCLUSION

This experimental study has been done to find out the best combination of work piece and electrode which gives maximum MRR. Taguchi Method has been applied in this work for getting optimal setting of control parameters and ANOVA technique is used to identify the effect of control parameter on MRR. From the analysis of the results following conclusions can be drawn. In this experimental work it has been observed that the Material removal rate varies with each control parameter. From ANOVA analysis it can be concluded that Speed is the most influencing control parameter on MRR at 95% confidence level. Results obtained from both S/N Ratio and polynomial regression analysis are also bearing same trend.

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