International Journal for Innovative Engineering and Management Research
PEER REVIEWED OPEN ACCESS INTERNATIONAL JOURNAL
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A REVIEW PAPER ON STUDY ON RAINWATER FILTRATION SYSTEM BY USING CHARCOAL-BASED FILTRATION

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ABSTRACT

Rainwater harvesting is an effective and sustainable method of collecting and conserving rainwater for future use. However, collected rainwater may contain dust, suspended particles, organic impurities, and other contaminants, making filtration necessary before its reuse. This project presents a simple and economical rainwater harvesting and purification system using a charcoal-based PVC pipe filter. Rainwater is collected from the roof of a model house and directed through a PVC pipe containing layers of filtering materials such as gravel, sand, and charcoal. The charcoal helps reduce colour, odour, and certain organic impurities, while the other filter layers remove suspended particles and sediments. The filtered water is then collected in a storage tank and can be used for irrigation, gardening, cleaning, and other non-potable purposes. The proposed system is compact, low-cost, easy to construct, and requires minimal maintenance. It demonstrates how locally available materials can be used to conserve rainwater and improve its quality, particularly in areas where water availability is limited. The project promotes water conservation, sustainable resource management, and the reuse of rainwater through a simple filtration approach.

Keywords: Rainwater harvesting, Rainwater purification, Charcoal filtration, PVC pipe filter, Water conservation, Sustainable water management, Filtration, Reuse of rainwater, Irrigation, Low-cost water treatment

I. INTRODUCTION

Rainwater harvesting is an effective and eco-friendly method of [7] water and reducing water scarcity. However, collected rainwater may contain dust, suspended particles, and other impurities, making filtration necessary before use. Charcoal-based filtration is a simple, low-cost, and sustainable technique that helps improve rainwater quality by reducing impurities, colour, and unpleasant odour. This review paper examines the effectiveness of charcoal-based filtration, particularly in PVC pipe systems, and explores its potential for affordable and efficient rainwater purification. Additional disinfection and water-quality testing are necessary before drinking.

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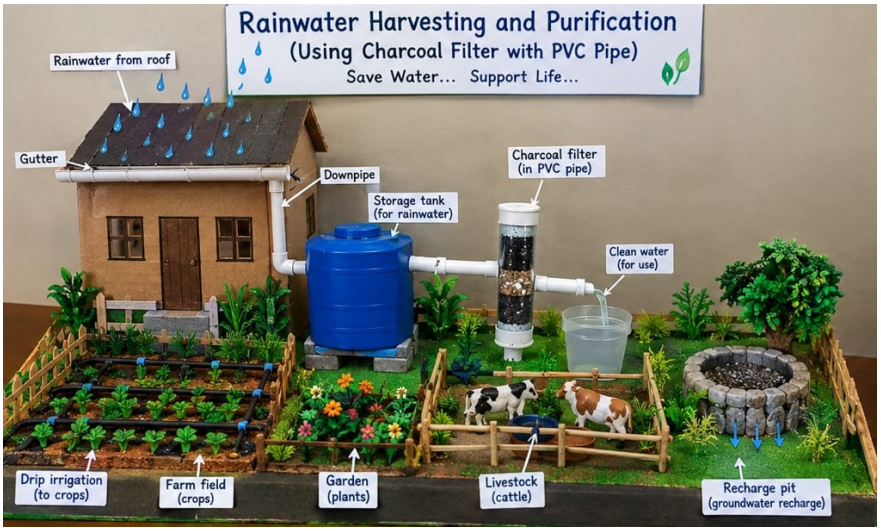


Fig. 1: Proposed model for purification of rainwater

II. OBJECTIVES

1. To study charcoal-based filtration for improving rainwater quality.
2. To remove impurities such as dust, dirt, and suspended particles from collected rainwater.
3. To reduce colour and odour using the adsorption properties of charcoal.
4. To develop a low-cost filter using charcoal and PVC pipes.
5. To evaluate filtration efficiency in improving the physical quality of rainwater.
6. To study advantages and limitations of charcoal-based filtration systems.
7. To promote water conservation through affordable and sustainable rainwater harvesting.

III. LITERATURE REVIEW

3.1. Santos, Duarte and Santos (2026): Authors reviewed different adsorbent materials used for rainwater treatment. Their research discussed carbon-based materials, modified minerals, and biosorbents for improving water quality. The authors explained that rainwater may contain organic and inorganic contaminants originating from the atmosphere and collection surfaces. They highlighted the importance of selecting suitable filter materials according to the type of pollutants present. Activated carbon was discussed as a promising material because of its porous structure and adsorption properties. The review also emphasized the influence of pH, filtration conditions, and material characteristics on treatment efficiency. Furthermore, the authors discussed the need for long-term testing and regeneration of filter materials. Their findings support the development of sustainable and economical rainwater treatment technologies. Relevance: This review provides a theoretical foundation for selecting charcoal-based filter media and evaluating its ability to improve the quality of harvested rainwater.

3.2. Mohammad Nur-E-Alam et al. (2025): Authors and colleagues investigated a granular filtration system for sustainable rainwater harvesting in urban Malaysia. Their research used activated carbon produced from coconut shells and palm oil fruit shells, together with coarse and fine sand. The main objective was to improve the physicochemical quality of harvested rainwater using sustainable filter materials. The researchers tested different filter configurations and examined various water-quality parameters, including pH, turbidity, and total dissolved solids. Their findings indicated improvements in several physicochemical characteristics after filtration. The study also considered the practical limitations of filter performance when treating larger volumes of water. The use of agricultural waste as a source of activated carbon offered an environmentally friendly approach to water treatment. The research demonstrated the potential of combining carbon materials with sand in a granular filter. Relevance: This study is directly related to the proposed charcoal-based rainwater filtration system because it demonstrates the usefulness of activated carbon and sand as combined filter media.

3.3. Lakshmi H. S., D. N. Shilpa, Surendra Prasad Maurya, Samarthya Ghimire and Unnat Kumar (2024): Authors and colleagues developed a sustainable rainwater filtration system using treated coconut coir and activated charcoal. The research aimed to improve rainwater quality through the use of affordable and locally available materials. The charcoal was activated using calcium chloride solution and prepared in different particle sizes. Coconut coir was treated using an aqueous sodium hydroxide solution before being used in the filter. The filtration system consisted of one coconut-coir layer and two activated-charcoal layers. The researchers analysed untreated and treated water samples to assess the system's performance. Their investigation included total solids, alkalinity, and acidity. The results indicated that combining natural fibres with activated charcoal could be a promising approach for domestic rainwater treatment. The research also demonstrated the potential of sustainable materials in developing simple filtration systems. Relevance: This study closely matches your project because it uses activated charcoal in a layered filter to improve harvested rainwater quality.

3.4. **So Yeon Yoon et al. (2024):**Yoon and colleagues developed a carbon-based rainwater filtration system designed to remove multiple pollutants. Their research investigated carbon filter media modified with magnesium, silicon, and silver. The objective was to improve the treatment performance of conventional carbon-based filtration materials. The researchers evaluated the removal of different contaminants, including heavy metals, organic pollutants, and microorganisms. The modified filter media were investigated for their ability to improve rainwater quality through adsorption and other treatment mechanisms. The study highlighted the importance of modifying filter materials to improve their effectiveness against specific contaminants. It also demonstrated the potential of carbon-based media in developing rainwater treatment systems. However, the performance of modified carbon cannot automatically be assumed for ordinary charcoal filters. Relevance: This study provides useful scientific evidence for carbon-based rainwater filtration and helps identify possible improvements for your proposed charcoal-based PVC pipe filter.

3.5. P. V. Nidheesh and colleagues (2024): Nidheesh and colleagues reviewed the conversion of locally available materials into biochar and activated carbon for water treatment. Their research discussed agricultural waste and other biomass materials that can be processed into carbon-based adsorbents. The authors explained how the properties of biochar and activated carbon influence the removal of organic and inorganic contaminants. The review covered mechanisms such as adsorption, complexation, co-precipitation, and ion exchange. It also examined the potential use of these materials in household water-treatment units. The authors highlighted the importance of producing effective filtration materials at a reasonable cost. Their work emphasized that the choice of raw material and preparation method affects treatment performance. The review also discussed challenges associated with the practical application of carbon-based materials. Relevance: This study supports the use of locally available charcoal and agricultural-waste-derived carbon in affordable filtration systems, including rainwater filters made from PVC pipes**.**

3.6. Bridget A. Ulrich, Karina Weelborg, Tadele M. Haile, Udai B. Singh and Joe Magner (2024): Ulrich and colleagues evaluated a biochar-amended stormwater filtration system for retaining nutrients, metals, and Escherichia coli. Their study compared sand filtration with biochar-amended sand and iron-enhanced sand under field conditions. The biochar was produced from red pine wood chips through pyrolysis. The researchers investigated how the different filter materials affected contaminant retention in parking-lot runoff. Their findings showed that biochar performance varied depending on the pollutant being treated. The research highlighted the importance of choosing suitable filter materials for specific water-quality objectives. It also demonstrated why filtration systems should be evaluated under realistic operating conditions. The study contributed to understanding the benefits and limitations of biochar in environmental water treatment. Relevance: Although this research focused on stormwater rather than harvested roof rainwater, it provides supporting evidence for investigating carbon-rich materials as part of a sustainable filtration system.

3.7. Corrêa et al. (2023): Studied the physicochemical characteristics of rainwater filtered using activated carbon produced from seeds, sand, and a combination of both materials. Their research investigated the changes in rainwater quality after filtration. The study is relevant to the present project because it demonstrates the potential of combining carbon-based materials with sand to improve rainwater quality. A similar combination of charcoal and sand can be incorporated into a PVC pipe filter to develop an economical rainwater filtration system.

3.8. Molla Jamal et al. (2023): Investigated a fabricated first-flush rainwater harvesting technology to address freshwater scarcity in Dhaka, Bangladesh. The system included a first-flush arrangement and activated carbon filtration to improve the quality of harvested rainwater. The research highlighted the importance of removing initial roof runoff and using filtration to reduce contaminants. This study is relevant to the proposed project because a first-flush mechanism combined with a charcoal-based PVC pipe filter may improve the quality of collected rainwater.

3.9. Ahmad, Anak Jose, Iskandar, and Abdul Kadir (2022) : Studied the effectiveness of rainwater harvesting filters using natural resources. Their research examined rainwater collected from a rooftop and assessed its characteristics before and after filtration. The study considered natural materials such as activated carbon and coconut husk for developing a simple filtration system. The findings provide useful guidance for designing a low-cost filter using locally available materials. This research is relevant to the present project because charcoal, sand, and gravel can be arranged inside a PVC pipe to reduce suspended impurities and improve the physical quality of rainwater.

3.10. He et al. (2022): Reviewed the use of waste-derived biochar for water pollution control and sustainable development. The authors discussed how biochar produced from biomass waste can help remove pollutants from water through adsorption and other surface interactions. Their review highlighted the environmental benefits of converting waste materials into useful treatment media. This research is relevant to the proposed charcoal-rainwater filtration system because carbon-rich materials may provide an affordable and sustainable option for improving water quality.

3.11. Liang et al. (2021) : Reviewed the removal of organic and inorganic pollutants using biochar and biochar-based composites. Their research discussed the importance of surface area, pore structure, and the properties of carbon-based materials in contaminant removal. The review indicated that biochar has potential as a low-cost material for water treatment. This study supports the use of charcoal as a filtration medium in the proposed rainwater harvesting system, where it can help adsorb certain dissolved impurities and organic contaminants. However, its effectiveness depends on the type of charcoal and the properties of the water being treated.

3.12. Xiong et al. (2021) : Investigated the removal of heavy metal ions from rainwater runoff using a bioretention cell modified with biochar. The researchers examined how biochar could improve the treatment of runoff contaminated with heavy metals. Their study demonstrated the relevance of carbon-based filtration media in stormwater treatment. This research is useful for the present project because charcoal may help reduce certain contaminants in collected rainwater when incorporated into a properly designed filter. The proposed PVC pipe system can use charcoal along with sand and gravel for preliminary treatment, although laboratory testing is necessary to establish its actual removal efficiency.

3.13. Zhang et al. (2021): Studied the influence of rainfall characteristics on bioretention systems modified with activated carbon and biochar. Their research evaluated the systems' ability to retain stormwater and remove pollutants under different rainfall conditions. The study showed that treatment performance depends on rainfall characteristics and the properties of the filtration media. This research is relevant to the proposed project because rainwater flow rate and contact time with charcoal may influence filtration performance. Therefore, the PVC pipe filter should be designed to provide adequate contact with the filter media while maintaining a suitable flow rate.

3.15. Boehm et al. (2020): Boehm and colleagues reviewed the effectiveness of biochar-amended biofilters for removing pollutants from stormwater. Their study found that adding biochar could improve the removal of microbial pollutants and trace organic contaminants compared with conventional filter media in the reviewed experiments. However, improvements in removing suspended solids and nutrients were not consistent across all studies. This research is relevant to the proposed rainwater filtration system because it supports combining charcoal-based media with sand and other filtration materials to improve water quality.

3.16. Rahman, Nachabe, and Ergas (2020): The researchers investigated biochar-amended stormwater filtration systems for removing nitrogen and E. coli. They examined how hydraulic loading rates and the time between rainfall events affected filtration performance. Their findings indicated that biochar properties and operating conditions influence the removal of contaminants. This study is relevant to the proposed charcoal-based PVC pipe filter because it highlights the importance of selecting suitable charcoal and controlling the rate at which rainwater passes through the filter.

3.17. **Sang et al. (2019):** Sang and colleagues investigated a pilot-scale bioretention system containing commercial activated carbon and river sediment-derived biochar for treating stormwater. The study evaluated the removal of nutrients, including nitrogen and phosphorus. The researchers found that activated carbon and biochar performed differently depending on the pollutant being treated. This research is relevant to the proposed project because it demonstrates that carbon-based materials can improve stormwater treatment, although the filtration medium must be selected according to the required water-quality improvement.

3.18. Xiong et al. (2019): Xiong and colleagues studied a bioretention cell containing iron-modified biochar and saturated zones to improve stormwater runoff treatment. Their research evaluated the removal of chemical oxygen demand, nitrogen, and phosphorus. The results showed that the composition and arrangement of filtration media influenced treatment efficiency. This study is relevant to the proposed rainwater filtration system because it supports the use of suitable carbon-based materials in layered filtration arrangements. A charcoal, sand, and gravel filter inside a PVC pipe can be investigated using a similar principle, with its performance verified experimentally.

3.19. Tian et al. (2019): Tian and colleagues investigated a pilot-scale, two-layer bioretention system containing biochar and zero-valent iron for nitrate removal from stormwater. Their study found that biochar increased water retention time and improved nitrate removal compared with the control system. This research is relevant to the proposed project because it highlights the importance of contact time between water and filtration media. In a charcoal-based PVC pipe filter, an appropriate flow rate and filter-layer arrangement may improve treatment performance.

3.20. Afrooz et al. (2018): Afrooz and colleagues investigated the removal of bacterial pathogens and viral indicators using biochar-modified stormwater biofilters. They compared

biochar-amended filters with conventional sand filters and observed better removal of the tested microorganisms in the biochar-amended systems. The study also examined the mechanisms responsible for retaining microorganisms during filtration. This research is relevant to the proposed rainwater filtration project because it suggests that carbon-based materials may contribute to reducing microbial contamination. However, ordinary charcoal filtration cannot guarantee safe drinking water, so disinfection and microbiological testing are necessary before consumption. Hogen's and viral indicators using biochar-modified stormwater biofilters. They compared biochar-amended filters with conventional sand filters and observed better removal of the tested microorganisms in the biochar-amended systems. The study also examined the mechanisms responsible for retaining microorganisms during filtration. This research is relevant to the proposed rainwater filtration project because it suggests that carbon-based materials may contribute to reducing microbial contamination. However, ordinary charcoal filtration cannot guarantee safe drinking water, so disinfection and microbiological testing are necessary before consumption.

3.21. Stratigea, D., & Makropoulos, C. (2017): Balancing water demand reduction and rainfall runoff minimisation: modelling green roofs, rainwater harvesting and greywater reuse systems* - Stratigea and Makropoulos studied combined performance of green roofs, RWH and greywater reuse for balancing water demand And runoff minimisation. The study modelled systems in Athens, Greece using Water Science and Technology framework. The filtration system combined natural media including sand, soil and granular activated carbon using biological and physical filtration. The results showed that combined RWH and green roof reduces water demand by 30% and runoff by 45%. The study demonstrated that hybrid systems are More sustainable than single systems.

3.22. Ayog, J. L., Bolong, N., & Makinda, J. (2017): Feasibility Study of Rainwater Harvesting in Universiti Malaysia Sabah's Residential Colleges* - Ayog et al. conducted a feasibility study of RWH in residential colleges of Universiti Malaysia Sabah to support Eco-Campus initiative. The study focused on rooftop rainwater harvesting from college buildings with average annual rainfall of 2500mm. The filtration system used composite filter with sand, activated carbon and mesh screen using filtration and adsorption processes. The results showed that the campus can harvest 2.01 million litres annually and filtration improves pH and reduces TDS and EC to safe levels. The study demonstrated cost-benefit ratio of 1.53 indicating viability.

3.23 Sanches Fernandes, L. F., Terencio, D. P. S., & Pacheco, F. A. L. (2015) : Rainwater Harvesting systems for low demanding applications* - Fernandes et al. studied the Potential of rainwater harvesting systems for low demanding applications like toilet. Flushing, washing and irrigation. The study was conducted in Portugal and focused on Single-family residences using continuous simulation of rainfall and water demand. The results showed that RWH can save 30% to 50% of potable water and is economically viable with a payback period of 3-5 years. The study demonstrated that RWH is a sustainable alternative for non-potable water supply.

3.24 Campisano, A., & Modica, C. (2015): Appropriate resolution timescale to evaluate Water saving and retention potential of rainwater harvesting for toilet flushing in single Houses* - Campisano and Modica studied the importance of time resolution in evaluating RWH performance for toilet flushing in single houses. The study compared daily vs hourly rainfall data and water demand data from 6 experimental households in Southern Italy. The filtration system used first-flush diverter and granular media filters to improve quality. The results showed that using high-resolution data gives more accurate prediction of water saving (up to 40%) and retention potential. The study demonstrated that tank size optimization is crucial for efficiency.

3.25 Silva, C. M., Sousa, V., & Carvalho, N. V. (2015): Evaluation of rainwater harvesting In Portugal: Application to single-family residences* - Silva et al. evaluated the Feasibility of rainwater harvesting systems in single-family residences across different Regions of Portugal. The study focused on rainwater collected from rooftop sand Treated through simple filtration including sand and activated carbon filters. The System combined sedimentation, filtration and disinfection processes to improve Water quality. The results showed that RWH can meet 30-70% of non-potable water .Demand depending on rainfall and roof area. The study demonstrated that granular media filters are effective for low-cost treatment.

3.26. An, K. J., Lam, Y. F., Hao, S., Morakinyo, T. E., & Furumai, H. (2015): Multi-purpose Rainwater harvesting for water resource recovery and the cooling effect* - An et al. Studied multi-purpose rainwater harvesting for both water supply and urban cooling Effect. The study was published in Water Research and focused on rainwater collected .In urban areas of Japan that contained dust and pollutants. The filtration system Combined storage tanks with green infrastructure and filtration using activated carbon and sand. The results showed that RWH not only provides water but also reduces Urban heat island effect by 1-2°C. The study demonstrated that integrated RWH Systems provide dual benefits.

3.27. Matos, C., Bentes, I., Santos, C., Imteaz, M., & Pereira, S. (2015): Economic Analysis of a Rainwater Harvesting System in a Commercial Building* - Matos et al. Performed an economic analysis of a RWH system installed in a commercial building In Portugal. The study focused on rainwater collected from a large roof area that Contained turbidity and atmospheric pollutants. The filtration system included first-Flush diverter, sand filter and activated carbon filter using filtration and adsorption Processes. The results showed that the system had a benefit-cost ratio of 1.53 and Payback in 6 years, saving 40% potable water. The study demonstrated that even low-Cost filtration makes commercial RWH economically viable.

3.28. Campisano, A., & Modica, C. (2015) : Rainwater harvesting as source control option to reduce roof runoff peaks to downstream drainage systems* - Campisano et al. Evaluated the potential of tank-based RWH systems as source control to mitigate peak roof runoff in urban areas. The study focused on rainwater harvesting in free-Standing houses in Italy with rainfall intensity analysis. The filtration system used composite filter with sand and granular activated carbon for quality improvement. The results showed that RWH tanks can reduce runoff peaks

by 35-50% depending on tank size and initial water level. The study demonstrated that RWH helps in flood control along with water conservation.

3.29. Lo, K. F. A., & Wong, S. S. (2015) : Adequacy of Rainwater Harvesting System in Humid Tropical Malaysia* - Lo and Wong studied the adequacy of RWH systems in humid tropical Malaysia where rainfall is abundant but uneven. The study focused on domestic usages for schools, households, shopping malls and terrace houses. The filtration system used simple sand filter and first-flush system to handle turbidity and low-level pollution from rooftops. The results showed that despite high rainfall, RWH acts as buffer in water crisis and can be included in Green Building Index equirements. The study demonstrated 60% reliability for non-potable supply.

3.30. Qin, H. P., Tang, Q. L., Wang, L. Y., & Fu, G. (2015): The impact of atmospheric wet deposition on roof runoff quality in an urbanized area* - Qin et al. studied the impact of atmospheric wet deposition on roof runoff quality in Shenzhen, China during 2011- 2012. The study collected samples from air, rainwater, dust buildup and roof runoff to identify pollution sources. The filtration system concept included activated carbon-quartz sand biological filtration to treat collected rainwater containing TOC, NH4+, NO3- and organic acids. The results showed that wet deposition contributes dominantly to TOC and nutrients in runoff and filtration with activated carbon can remove 53% CODMn and 71% ammonia.

3.31. Yue Lifang (2014): Activated Carbon–Quartz Sand Biological Filtration Yue Lifang studied the treatment of collected rainwater using an activated carbon–quartz sand Biological filtration system. The study focused on rainwater collected in rural areas that contained Turbidity and low-level pollution. The filtration system combined activated carbon and quartz sand, using Filtration and biological processes to improve water quality. The results showed that the system was effective in reducing important pollutants. For collected rainwater, removal efficiencies of approximately 53% for CODMn, 71% for ammonia nitrogen, and 88% for turbidity were reported. The study Demonstrated that activated carbon can provide additional treatment beyond simple physical filtration.

3.32. Kus et al. (2013) :GAC pre treatment for Rainwater. Kus and colleagues investigated a pilot-scale household rainwater harvesting system using a granular Activated carbon (GAC) filter followed by membrane filtration. The study found that harvested rainwater Could contain problems such as turbidity, dissolved organic carbon (DOC), and heavy metals such as Lead. The GAC stage was used as pretreatment. It helped remove dissolved organic matter and also **,**Reduced turbidity and lead before the water entered the membrane filtration stage. The study Demonstrated the usefulness of activated carbon as an adsorption medium in rainwater treatment. The Research also showed the potential of a gravity-driven treatment system, which is particularly relevant For low-energy rainwater treatment.

3.33. De Kwaadsteniet et al. (2013): Rainwater Harvesting and Treatment De Kwaadsteniet and co-authors reviewed the microbial and chemical quality of domestic harvested Rainwater

and different point-of-use treatment methods. Their review noted that rainwater quality can be Affected by contaminants from the atmosphere, roofs, storage systems and surrounding environments. The authors discussed several treatment approaches, including activated carbon filtration, slow sand Filtration, heat treatment and chlorination. The review emphasized that filtration can be an important step before further disinfection because suspended particles can interfere with treatment processes.

3.34. Neto et al. (2012): Slow Sand Filtration of Rainwater 2012 study investigated rainwater treatment using slow sand filtration followed by chlorination, particularly for large roof areas such as airport buildings. The research evaluated rainwater quality, the efficiency of treatment and treatment costs. Slow sand filtration was used to reduce suspended particle sand improve the quality of harvested rainwater before chlorination. The study demonstrated that simple filtration followed by an appropriate disinfection step can be considered for rainwater reuse.

3.35. Kus et al. (2012): Two-Stage Filtration for Stormwater Treatment Kus and colleagues studied a two-stage treatment system using granular activated carbon, anthracite and sand as filtration media, followed by membrane filtration. Although the study focused on stormwater rather than only roof rainwater, it is relevant because both systems can contain suspended and dissolved pollutants. The researchers found that the GAC filter significantly reduced dissolved organic carbon, with the reported study achieving about 70% removal of organic matter in the tested.

3.36. Domènech & Saurí (2011): This study evaluates rainwater harvesting in single- and multi-family Buildings. It considers water savings and economic costs. Rainwater harvesting can reduce demand For mains water. Public perception can influence adoption of the technology. Appropriate regulations and incentives can encourage implementation. Storage capacity and rainfall availability affect system Performance. The study supports rainwater harvesting as a supplementary urban water source.

3.37. Abbasi & Abbasi (2011) : This review examines pollution sources in rooftop rainwater systems. Rainwater can collect contaminants from roofs, gutters and storage tanks. Microbiological contamination is an important concern. Atmospheric pollutants may also affect harvested water quality. The paper discusses both pre-harvest and post-harvest control methods. Simple and inexpensive treatment devices can improve water quality. Filtration is an important component of a safe rainwater system.

3.38. Jones & Hunt (2010) : The study evaluates rainwater harvesting systems using monitoring and modelling. Three rainwater cisterns were monitored in the southeastern United States. System performance depends strongly on rainfall and water demand. Small rain barrels may frequently become empty or overflow. Larger storage systems generally improve water availability. Proper sizing of storage tanks is therefore important. The study demonstrates the need for efficient system design and management.

3.39. Srinivasan, Gorelick & Goulder (2010) : This research evaluates rainwater harvesting as an urban water-sup gaps and possible repeated/miscited items, so the numbering below follows the review sequence as closely as possible requirements. A combination of rainwater harvesting and efficiency improvement performed better. The study supports decentralized water-management approaches. Rainwater harvesting can improve water reliability and sustainability.

3.40. Rockström et al. (2009): This review examines rainwater harvesting practices in African drylands. Such systems improve infiltration and groundwater recharge. They can increase soil moisture and agricultural productivity. Rainwater harvesting also helps manage water scarcity. Appropriate design is necessary for long-term sustainability. The study highlights the importance of local environmental conditions. These principles can also support decentralized water-management systems.

IV. CONCLUSION

- After studying above reviews we concluded that rainwater harvesting is an effective and sustainable approach to water conservation and management, particularly in areas where water availability is limited. The literature published between 2026 and 2009 shows that harvested rainwater can contain suspended, organic impurities, and microorganisms, making appropriate treatment important before reuse. The reviewed studies demonstrate that sand, gravel, charcoal, and activated carbon can be used as filtration media to improve several physical and chemical characteristics of harvested rainwater. Combining these materials in a multi-layer filter can provide better treatment than using a single filtration medium. The performance of the filter depends on factors such as filter-layer thickness, contact time, flow rate, raw-water quality, and regular maintenance.

Based on these findings, the proposed charcoal-based filtration system provides a simple, economical, and compact approach for treating harvested rainwater. The use of locally available materials makes the system suitable for small-scale applications and educational demonstration models. The filtered water can be utilized for irrigation, gardening, cleaning, and other non-potable purposes, thereby reducing the demand for freshwater. However, charcoal-sand-gravel filtration alone should not be considered sufficient to make rainwater safe for drinking. If potable use is intended, additional disinfection and appropriate microbiological and chemical testing are required. Overall, the proposed system demonstrates the potential of combining rainwater harvesting with low-cost multi-layer filtration to support sustainable water-resource management.

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