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An Assessment of the State of the Art Rainwater Collecting Technologies for Promoting Green Built Environments

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ABSTRACT
Water shortage, inefficient consumption habits, fast worldwide population growth, a high demand-to-production ratio, and a slew of other issues underscore the urgent need to systematically acquire and use alternative, and, most critically, renewable water supply options. In addition, the use of well-designed and maintained rainwater harvesting systems in the built environment while expanding the focus to a variety of building typologies is advocated as a possible solution to these systemic problems. In developing and green building environments, there is a gap in the effective integration of these design elements to achieve consistent sustainable results in maintenance plans. Governments are urged to play an important role in the education, opportunity creation and support of these decentralized water supply and consumption systems. as meetings, the potential to properly merge them with green roofs and green building environmental criteria, and finally manipulated government regulations to provide information to overcome the above-mentioned problem of intensification of rainfall.

Keywords
Green Built Environment, Government Policies, Rainwater Harvesting Systems, Renewable Water Resources, Water Scarcity

1. INTRODUCTION
Water supply has become a crucial problem for a sustainable urban future throughout the world. Cities are quickly expanding, and their infrastructure is changing to meet the increasing needs of their residents. In directive to react to contemporary social needs and environmental problems, many studies have called courtesy to the conditions of building greener and smarter urban environments. As a result of the fast expansion of the worldwide population, global water resources have become a major international issue [1]. According to UNEP, just around 1% (2.5 percent considering frozen and snow-covered freshwater resources) of all available stream resources are suitable for human use.

Unfluctuating tiny fraction of presently accessible freshwater supplies is, however, being degraded by incremental pollution. Nonetheless, the pace of rise in water use over the preceding century was double that of world population growth [2]. Furthermore, promoting sustainable urban growth necessitates a reduction in the reliance on desalinated water supplies in addition to the use of energy-concentrated water treatment methods. As a result, the necessity to find and utilize alternate water resources becomes increasingly pressing as absolute water demand rises. Water shortage may develop almost everywhere when demand for water exceeds available water supplies. Arid climates and regions with limited water supplies are often linked with scarcity [3]. It may also happen in places with a lot of rain, either because of populace density or because of excessive residential-agrarian-industrial aquatic use. This emphasizes the essential of continuing access to renewable water supplies. Inefficient water transport, treatment, and disposal systems contribute to the issue by using significant quantities of resources and energy, resulting in unwelcomed extra expenditures and environmental damage. It is clear that severe droughts, increasing water demands, and the consequences of storm water run-offs have drawn academics and practitioners' attention to the use of rainwater collecting devices. Rainwater collected as runoff from constructed assets has therefore been recognized as a useful addition to current water supply resources [4].

Harvesting precipitation from developed assets, slightly of needing to manage and slightly curved that water away, provides numerous apparent major sustainability benefits. As a consequence, it is evident that observations on the effectiveness of alternate water distribution systems that are compatible with sustainability objectives are urgently required. Rainwater collection has been found to be useful in urban settings; nevertheless, as many rural locations across the world lack or have restricted access to clean drinking water, the role of rainwater refers to bringing in these areas is equally crucial for human sustainability [5]. Despite the probability of obstacles all along road, rainwater collection devices are projected to be effective in humid and very well locations. While rainwater collection has been demonstrated to be efficient in urban areas with rainfall totals, it has been proved to be ineffective in arid regions. Water reuse is the technique of collecting and conserving rainwater from rooftops, landmasses, or rock catchment areas using technology. Rainwater, in its most primitive sense, employs simple storage facilities and cisterns can collect walk from equipment for later use within that infrastructure or neighboring facilities. More complicated approaches, such as subsurface dams, are also deployed to attain equivalent effects . [6]. Rainwater harvesting systems typically comprise a waterproof catchment surface to collect rainwater at first, a delivery system to transport the collected rainwater to storage tanks, and finally the storage tank. Because of their great durability, it is suggested that plastic or metal equipment be used inside the systems. A common rainwater collecting system's setup. Rainwater harvesting is an excellent, clean, and sustainable foundation of water aimed at use in both residential and non-residential settings [7].

The entire amount of renewable water on the planet. Rainwater harvesting is about more than just collecting and storing water as a backup source to meet rising demand. Individuals rationalizing and controlling water collection, storage, and use have additional consequences as part of a larger water management plan. Rainwater harvesting in urban settings, in addition to its fundamental purpose, may help to avoid urban stream deterioration and floods by acting as a "buffer" for surplus water in the case of severe precipitation [8]. Rainwater harvesting aids in the distribution of both potable and non-potable water. Even when the water from the storage tank is intended for non-potable uses like toilet flushing, washing, outside landscape irrigation, and irrigation, these activities account for approximately 80% of average home water use. The advantages of appropriate design and simulation to examine the effectiveness of proposed rainwater harvesting systems are enhanced. The job is difficult. When determining the performance measurements and setup of a rainwater collecting system, conflicting goals are often taken into account. These include the need for a dependable water supply, the reduction of run-off volume, and the control of system installation costs. As a result, it is highly recommended to simulate and evaluate the performance of a rainwater collecting system over a long period of time. In fact, a life cycle approach must be taken into account while establishing the system, and its capacity to fulfill water quality, supply, and, ultimately, economic goals must be interpreted appropriately. It's a difficult job to design and configure an optimum rainwater collecting system.

Based on various combinations of impermeable surface measures, storage tank capacity, rainwater stipulation, and local need for water, there are numerous optimal—and near optimal—solutions. This makes choosing the best combination of factors more difficult [9]. As a result, researchers have included the possibility for rainwater accumulation as an additional independent variable that must be measured. Rainwater collecting systems that are particularly designed to work with certain building types and consumption patterns have shown to be useful. Researchers have highlighted the significance of integrating such technologies with facility designs based on their potential to reduce municipal water usage dramatically. A variety of applications for the collected water must be explored. If the water is meant for human consumption, then it must be treated. This may be accomplished using a variety of natural or artificial filtering methods. The "halfway home" option of utilizing the water for reasons other than drinking is a more frequently utilized alternative. For instance, watering plants and flushing bathrooms. All of these applications are advantageous since the water is acquired at a low cost and with less pressure on the infrastructure due to the pumping of rainfall across the system. However, in order to guarantee the success of the aforementioned systems, proper monitoring and maintenance will be required. The design, selection, and capacity of the corresponding water storage tanks play a significant role in constructing an optimal rainwater harvesting system and maximizing rainwater storage [10].

2. DISCUSSION ON RAIN WATER HARVESTING SYSTEM

As two important components in this issue, it is essential to thoroughly investigate the regional quantity of rainfall and the matching roof area. Prior study has shown that in multi-unit buildings, bigger rainwater tanks with more storage capacity may optimize water savings. Surprisingly, this more intense land usage may restrict the amount of area available for rainwater storage tanks in multi-unit buildings. As a result, sufficient rainwater storage tank capacity should be considered throughout the planning phases of a project. The use of a larger storage tank is generally considered as one of the most important requirements for effective rainwater collecting. However, this is not the final answer. The design approach must also include design innovation and creative ideas. Water storage tank placement in building foundations, usage of the tanks as attractive landscape features, and alternatively, the use of a linked series of small tanks rather than a single large tank have all been proposed as solutions to this problem. A bigger tank, on the other hand, comes with greater purchase and installation expenses. The initial financial expenditure for setup and installations is often mentioned as a major barrier to consumers using these systems. The appropriate design of an efficient rainwater collecting system is mostly determined by global location. Rainfall patterns vary depending on the location, latitude, and altitude of a city. As a result, the size and design of rainwater collecting tanks vary depending on the city and its geographical features.

To optimize their return on investment, users in different parts of a city need access to bespoke rainwater collection tanks of different capacities, so researchers need to geographically study different patterns of annual rainfall data from different rain stations. Tank size and capacity can be reduced and optimized in humid regions to focus on harvesting. As a result, water resources under high humidity conditions are expected to be used in "fast-paced" applications such as gray water toilet flushing. Simplified and intermediate methods have shown ineffective in evaluating commercial and industrial complexes, depending on the varied procedures and methodological approaches accessible to evaluate rainwater usage configurations and tank sizes. This is owing to irregular water supply, uncertain outputs and the largely complicated infrastructure needed, including big and costly storage tanks. Without treatments, the grade of the rain water does not necessarily conform to the recognized potable criteria of a catchment region. This is inevitable owing to probable urban pollution and other microbiological and chemical contaminants. Rainwater collecting systems are impacted by a range of elements, including geographic location, prior dry days, time of year, animals and humans activity, temperature overturns, and closeness to other potentially polluting sources. It is believed that the purity of the rainwater collected is also impacted by environmental elements such as environmental pollution and region meteorological conditions, and also the components and roof types; In furthermore, the impermeable subsurface for soaking rainwater has a considerable impact on the condition of the roof. gathered rainwater.

It is therefore essential to determine the quality of the rainwater depending on the type of roofing material. Just as important is the monitoring of microbial pathogens and pesticides in the collected rainwater after roofing materials as well as the consideration of the first-flow-effect. Environmental pollution (total phosphorus and nitrate nitrogen), heavy metal pollution (e.g. lead) and pesticides make an assessment of the quality of rainwater specially collected for domestic use based on the collection of rainwater, runoff water from roofs, essential. It goes without saying for rainwater collection in urban areas. Collecting rainwater from roofs is a popular method of collecting rainwater because its runoff is less polluted than runoff from other impenetrable surfaces such as asphalt roads, parking lots, etc. Water collected from the rooftops of a variety of structures has been used for both drinkable and non-potable uses. In most cases, they are utilized for irrigation in order to be deemed a secondary source of water supply. In fact, if rainwater collecting devices were extensively used in building design, it might be feasible to reduce overall potable water use from centralized supplies. While metal roofs are often suggested for rainwater harvesting system installations, other choices such as cool roofs and concrete tile roofs are also viable. For roof-based rainwater collection systems, typical green roofs are generally not recommended. The presence of dissolved organic carbon concentrations in green roof water run-offs is the reason for this. Rooftop rainwater catchments that are properly built and maintained typically capture less-contaminated, possibly drinkable water. In comparison to traditional and unsecure rooftops, such roofs should not need any further treatments. However, because of the increased risk of contamination, ground and surface rainwater catchments are generally not safe for human consumption unless properly cleaned. Improved sustainability performance of green buildings has been the subject of recent study.

To achieve substantial progress against climate change, a variety of sustainability measures must be improved. These will always include water use and management methods that are optimal (i.e., sustainable). Examining and evaluating new water communication technologies in terms of social, environmental, and economic factors. Rainwater collecting is a critical component in achieving future sustainable urban development by providing additional water supplies for metropolitan populations that are increasing. Rainwater harvesting not only optimizes water resource use and management, but it also encourages sustainable development, with a particular emphasis on the built environment. In addition to residential infrastructure, industrial and commercial buildings contribute to the urban environment's ecological footprint. As a result, long-term water resource management concerns should be applied to all of these facilities. Commercial buildings, on the other hand, are recommended to use decentralized water supply management systems. Adaptability of the final sustainability goals is not guaranteed without adequate observational studies to assess their associated performance. Decentralized rainwater collection systems are regarded as environmentally beneficial, sustainable, and green water sources. Decentralized rainwater collection systems, on the other hand, immediately contribute to solving water shortages, pollution reduction, and economic success. Despite the energy industry's obvious preference for renewable resources over fossil technology, the water supply sector seems to lack unambiguous preferences for sustainable water resource delivery over traditional methods. As a result, despite the fact that decentralized rainwater collecting systems contribute to sustainability, centralized infrastructure continues to be prioritized over decentralized alternatives. Annual rainfall patterns, water-retaining capacity, and roof run-off coefficient all influence rainwater collecting. An extended green roof may hold up to 55 percent of annual rainfall, resulting in increased capacity to manage urban storm water run-off and reduce the risk of urban floods.

Storm water runoff from cities and per urban areas is a significant contribution to contamination of downstream marine habitats, as well as waterway and habitat degradation. As a result, implementing green roofs in urban areas is thought to be helpful in decreasing urban storm water runoff and creating sustainable and environmentally friendly settings. Humidity, water ingress into the building envelope, rainfall intensity, concentration, transpiration and evaporation potentials, and soil hydraulic characteristics all play a role in green roof optimization. Green roofs have proven to be quite efficient in coping with regular precipitation in previous study models. Green roofs are able to decrease run-off flow intensity while simultaneously extending the water run-off time when there is more significant rainfall, reducing surge and avoiding urban floods. Green roofs help to bring the pH of collected rainwater closer to neutral, but they also seem to increase the concentration of ions in run-off water. Heavy metals including Fe, Al, and Cu have been found in green roof run-off water in a number of instances.

Furthermore, green roofs filter nutrients such as nitrates and phosphates from run-off water. As a result, despite the many benefits of incorporating green roofs into urban environments, their usage is not suitable for integration with conventional rainwater harvesting systems based on roof run-off. As a result, it is suggested that study be conducted into the creation of green roof design and implementation standards. Many prospective users are unable to recognize the potential advantages of rainwater collecting systems due to a lack of understanding of the system's life cycle cost. Governments should pay interested households to encourage the adoption of these devices, according to researchers, in order to develop sustainable water supply and management systems. Rainwater harvesting as a decentralized water supply system necessitates active participation of people, reducing authorities' control over the central urban water supply flow. Many nations' relatively cheap water supply prices are owing to government subsidies; therefore, dynamic public participation in rainwater collecting techniques may essentially assist decrease government subsidies if properly used. Long repayment periods for initial capital investments in homes with rainwater harvesting systems have been shown to reduce the viability of their widespread adoption. Dealing with private homeowners is a fact of life. They may be pleased with their "green credentials," or how sustainably they live. There is no economic motivation to depart from "regular practice" unless there is a fast return on investment. Government assistance in the form of grants or subsidies the so-called "carrot" method is required to encourage such private homeowners to change. Alternatively, private households must be compelled to use these technologies by existing or planned future legislative changes.

3. CONCLUSION AND IMPLICATION

This study gave an overview of the various rainwater collecting methods that are currently in use. The importance of focusing on the size of the water storage tanks according to the geographic conditions, the roof area measurements, the precipitation regulations and the household population is underscored by the correct design and configuration of rainwater harvesting systems. Facilities, especially in metropolitan areas. The quality of the roof rainwater collected in this way corresponds to the roof typologies. The quality of the roof-based rainwater collected as a consequence is consistent with rooftop typologies. This study shows how conventional green roofs have a detrimental effect on the quality of rainwater collected. They filter certain essential nutrients and add light and heavy metals, as well as many other contaminants, to the rainwater collected. Finally, governments are urged to support rainwater collecting systems in regions where climatic conditions and rainfall patterns indicate a high likelihood of success. In less ideal circumstances, it is preferable to support these systems in public buildings and infrastructures rather than more broadly throughout private homes and other areas. Finally, governments should educate the target community about the short- and long-term advantages of these systems, as well as the environmental sustainability potentials of decentralized water supply and consumption resources, based on pay-back periods.

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