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RAINWATER HARVESTING PRACTICES IN THE DRY ZONE OF SRI LANKA

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ABSTRACT

Rainwater harvesting enables producers to achieve sustainable water management by reducing their reliance on external sources and enhancing resilience. Water scarcity remains a persistent challenge in Sri Lanka's Dry Zone due to highly seasonal rainfall, prolonged dry periods, and increasing pressure on conventional surface and groundwater resources. Rainwater harvesting (RWH) has been practiced in the region for centuries through traditional systems, while modern techniques have been increasingly promoted in recent decades. However, comprehensive evaluations comparing the effectiveness of different RWH practices across multiple scales remain limited. This study examines the major rainwater harvesting practices used in Sri Lanka's Dry Zone and evaluates their effectiveness in addressing domestic, agricultural, and institutional water needs. The study adopts a structured secondary data–based review and qualitative synthesis approach, drawing on peer-reviewed journal articles, government reports, institutional publications, and documented case studies published between 1995 and 2023. A thematic and comparative analytical framework was applied to assess four main categories of RWH practices: traditional tank cascade systems, rooftop rainwater harvesting, surface runoff harvesting, and institutional-scale systems. The findings indicate that traditional tank cascade systems continue to play a critical role in landscape-level water regulation and agricultural support. However, their effectiveness is increasingly constrained by sedimentation, land-use changes, and inadequate maintenance. Rooftop rainwater harvesting emerges as the most effective option for improving household-level water security, particularly during dry periods. Surface runoff harvesting primarily enhances agricultural resilience through supplementary irrigation, while institutional RWH systems provide reliable non-potable water for sanitation and operational needs but face limitations related to cost and scalability. The study concludes that no single RWH method can independently address water scarcity in Sri Lanka's Dry Zone, highlighting the need for an integrated approach that combines traditional knowledge with modern rainwater harvesting practices to enhance long-term water security and climate resilience.

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1. INTRODUCTION

Water scarcity remains one of the most critical environmental challenges in Sri Lanka's Dry Zone, where rainfall is highly seasonal, evapotranspiration is high, and groundwater resources are often limited or saline. Although the region receives rainfall mainly during the Northeast Monsoon, long dry periods throughout the year create significant pressure on domestic, agricultural, and institutional water needs (Rajendram, 2021). As a result, communities in the Dry Zone have historically relied on both natural and engineered systems to ensure water availability during drought-prone months.

Sri Lanka has a long tradition of rainwater management through small tanks and village-based tank cascade systems (TCSs), which were developed as early as the 5th century BCE to capture, store, and redistribute monsoonal rainfall (Panabokke et al., 2002). In recent decades, modern rainwater harvesting (RWH) technologies, such as rooftop collection, surface runoff harvesting, and institutional-scale systems, have gained recognition as cost-effective and sustainable solutions for addressing water shortages in rural and semi-arid areas (Ariyananda, 2011). Despite this increased interest, existing knowledge on RWH in the Dry Zone remains fragmented across multiple studies, project reports, and institutional publications.

Most previous research has either focused on traditional irrigation systems or documented individual RWH interventions. Still, few studies have systematically reviewed the range of techniques currently practiced and their relevance to household and agricultural water security. Furthermore, there is limited consolidation of available secondary data to evaluate how different RWH methods contribute to resilience during prolonged dry periods. This gap highlights the need for a structured assessment of both traditional and contemporary RWH practices in the Dry Zone. Figure 1 illustrates the extent of Sri Lanka's Dry Zone, where rainfall is highly seasonal and prolonged dry periods are common. The districts located within this zone, such as Anuradhapura, Polonnaruwa, Puttalam, Kurunegala, and Hambantota, experience the greatest water scarcity challenges. This spatial pattern explains the strong dependence on tank cascade systems, rooftop rainwater harvesting, and runoff-based methods in these areas. The distribution shown in the map reinforces the relevance of evaluating rainwater harvesting practices specifically within this climatic region.

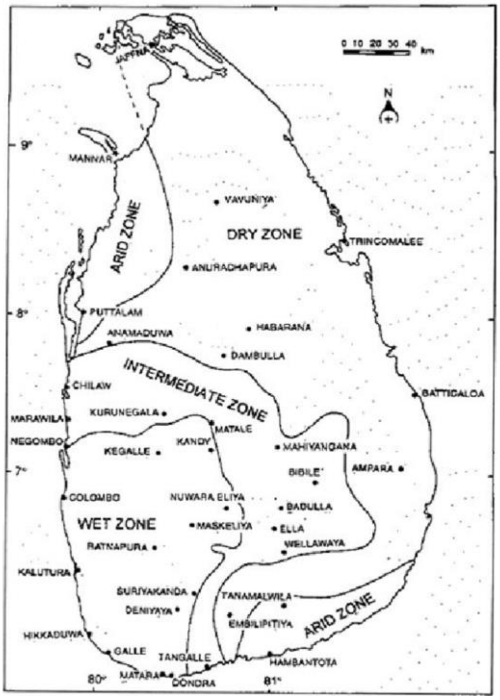

Figure 1. Map of Sri Lanka showing the Dry Zone region
Source: Adapted from Panabokke (1999).

This study aims to:

- To identify and describe the main rainwater harvesting (RWH) practices used in Sri Lanka's Dry Zone, including traditional, rooftop, runoff-based, informal, and institutional systems.
- To evaluate the effectiveness of these rainwater harvesting methods in addressing household, agricultural, and institutional water needs using available secondary data, case studies, and documented evidence.
- To examine the challenges and limitations associated with existing RWH practices in the Dry Zone, with emphasis on technical, environmental, socio-economic, and maintenance-related issues.
- To identify opportunities to strengthen and improve RWH systems through better integration of traditional knowledge and modern approaches for long-term water security.

1.1 Research Problem

Despite the long history of water management in Sri Lanka's Dry Zone, communities continue to face persistent water scarcity due to highly seasonal rainfall, long dry periods, and limited groundwater availability. Although numerous traditional and modern rainwater harvesting (RWH) techniques exist, including tank cascade systems, rooftop harvesting, and runoff-based methods, current knowledge about their overall effectiveness remains fragmented across different studies, project reports, and institutional documents. Previous research often focuses on individual systems or specific interventions but does not provide a consolidated understanding of how these methods function collectively within the Dry Zone's unique climatic and socio-ecological conditions. This lack of integrated analysis creates a gap in assessing which RWH practices most effectively enhance household, agricultural, and institutional water security. Therefore, a synthesized evaluation of existing RWH approaches is needed to guide future planning and strengthen resilient water management in the region.

1.2 Significance of the study

Water insecurity remains a persistent challenge in Sri Lanka's Dry Zone due to long dry periods, high evapotranspiration rates, and limited groundwater availability.

Although both traditional tank systems and modern rainwater harvesting (RWH) technologies have been promoted for decades, existing knowledge is fragmented across separate institutional reports, case studies, and localized interventions. A consolidated assessment is therefore essential to understand how different RWH practices contribute to household, agricultural, and institutional water needs.

This study is significant for three key reasons. First, it provides an integrated review of traditional and contemporary RWH techniques, offering a comprehensive understanding of the systems currently in use within the Dry Zone. Second, it evaluates the effectiveness of rooftop and runoff-based methods using existing secondary data and documented field experiences, helping to identify practices that are most suitable under varying climatic and socio-economic conditions. Third, the study highlights critical challenges, such as water quality issues, inadequate maintenance, and insufficient technical awareness, that must be addressed to improve long-term sustainability.

By synthesizing diverse forms of evidence, the study supports policymakers, development planners, and community organizations in designing more effective RWH interventions. The findings also contribute to academic discussions on climate-resilient water management by demonstrating how traditional hydrological knowledge and modern engineering solutions can be combined to enhance water security in drought-prone regions.

2. LITERATURE REVIEW

2.1 Rainwater Harvesting Concepts and Global Perspectives

Rainwater harvesting (RWH) is widely recognized as a sustainable water management strategy, particularly in semi-arid and drought-prone regions where conventional surface and groundwater resources are increasingly stressed. Globally, RWH has been promoted as an effective means of enhancing domestic water supply, supporting agricultural production, improving groundwater recharge, and strengthening climate resilience under conditions of high rainfall variability and prolonged dry periods (Mati, 2012; Atila & Akhtar, 2017). Several interrelated factors, including rainfall patterns, catchment characteristics, storage capacity, system design, and maintenance practices, influence the effectiveness of RWH systems. As a decentralized approach, RWH is often highlighted for its adaptability to local environmental and socio-economic conditions, making it particularly relevant in developing countries facing water insecurity.

2.2 Rainwater Harvesting in Semi-Arid and Dry Zone Regions

In semi-arid and Dry Zone environments, rainwater harvesting has been extensively studied as a strategy to mitigate seasonal water scarcity. Previous studies emphasize that the intermittent nature of rainfall in these regions necessitates efficient storage and management systems to ensure water availability during extended dry periods. Runoff harvesting, rooftop collection, and small-scale storage structures have been shown to play a significant role in stabilizing water supply for both domestic and agricultural uses. Research conducted in comparable dryland regions highlights that appropriately designed RWH systems can reduce pressure on groundwater resources, enhance soil moisture availability, and contribute to drought resilience, provided that site-specific conditions and long-term maintenance requirements are adequately addressed (Beckers et al., 2013; Mati, 2012).

2.3 Traditional and Modern Rainwater Harvesting Practices in Sri Lanka

Sri Lanka possesses a long history of rainwater management, particularly in the Dry Zone, where traditional systems were developed to cope with seasonal rainfall patterns. The most prominent of these systems is the tank cascade systems (TCSs), which consist of interconnected small tanks designed to capture monsoonal rainfall and regulate surface runoff across the landscape. Panabokke et al. (2002) describe these systems as a highly evolved form of indigenous water management that supports irrigation, groundwater recharge, and ecosystem stability. Subsequent studies highlight the socio-ecological importance of TCSs, emphasizing their role in sustaining agriculture, biodiversity, and rural livelihoods in the Dry Zone (Amarasinghe, 2022; Bebermeier et al., 2023).

Despite their historical significance, several studies report that many small tanks within these cascades are currently abandoned or function below capacity due to sedimentation, encroachment, land-use changes, and weak institutional management. These factors have reduced the effectiveness of traditional systems under contemporary water demand and climatic stress.

Alongside traditional practices, modern rainwater harvesting methods have gained increasing attention in Sri Lanka since the mid-1990s. Rooftop rainwater harvesting has been actively promoted for household water supply, particularly through initiatives led by the Lanka Rainwater Harvesting Forum (LRWHF). Ariyananda (2011) documents the adoption of rooftop systems ranging from simple 200-litre barrels to larger tanks with capacities between 300 and 1,000 litres. Studies conducted in Dry Zone districts such as Anuradhapura and Puttalam indicate that rooftop RWH has reduced daily water collection time and improved household water security during dry months (Ariyananda & Aheeyar, 2011; Balasuriya et al., 2021).

Surface runoff harvesting methods, including micro- and macro-catchment systems, have also been implemented in agricultural and plantation contexts. Research suggests that runoff harvesting enhances soil moisture availability and supports supplementary irrigation, particularly during critical crop growth stages (Bandara & Aheeyar, n.d.; Beckers et al., 2013). However, these studies emphasize that system performance is highly dependent on proper site selection, soil characteristics, and structural design.

Institutional-scale RWH systems have been introduced in schools, religious institutions, and industrial zones, particularly under development programs such as the Community Water Supply and Sanitation Project (CWSSP). Existing literature highlights their contribution to sanitation, hygiene, and non-potable water supply, while also reducing reliance on groundwater resources (LRWHF, 2013; Dissanayake & Dodangoda, 2021). Nevertheless, high installation costs and dependence on external technical support remain key constraints to their wider adoption.

2.4 Case Studies of Rainwater Harvesting Initiatives in Sri Lanka

Several documented case studies illustrate the successful implementation of rainwater harvesting initiatives across different sectors in Sri Lanka, demonstrating the practical applicability of RWH systems under diverse environmental and socio-economic conditions.

The Lanka Rainwater Harvesting Forum (LRWHF) has played a pioneering role in promoting advanced RWH systems, particularly in the Dry Zone. Since 2016, LRWHF has implemented nearly 49,000 rainwater harvesting systems across districts such as Anuradhapura, Mannar, Mullaitivu, Badulla, Monaragala, and Kilinochchi, in collaboration with government agencies, the National Water Supply and Drainage Board, and international partners. These initiatives have benefited approximately 47,000 individuals across households, schools, and medical facilities, demonstrating the effectiveness of decentralized rainwater storage in improving water access in water-scarce regions. Studies further indicate that in areas receiving less than 900 mm of annual rainfall, domestic RWH systems connected to roof catchments of around 50 m^2 can meet essential drinking and cooking water needs even during severe dry periods (Climate Fact Checks, 2023).

Runoff rainwater harvesting has also been successfully applied at larger agricultural scales. A documented case from the Forbes & Walker plantation in Wanathavilluwa, Puttalam District, illustrates the potential of combining roof and land catchments to meet substantial water demands for crop cultivation. Site assessments identified the feasibility of large storage ponds and roof-based tanks, highlighting the scalability of runoff harvesting systems for agricultural production in the Dry Zone.

Industrial rainwater harvesting initiatives further demonstrate the versatility of RWH systems. At MAS Intimates - Unichela in Biyagama, an industrial-scale RWH system utilizing a large roof catchment area was implemented to supply non-potable water for toilet flushing, gardening, and cooling towers. By optimizing tank size and managing water demand seasonally, the system significantly reduced dependence on groundwater resources, illustrating the potential of RWH for industrial water security.

Community-based initiatives have also highlighted the role of RWH in enhancing disaster resilience. The Aranayake Rainwater Harvesting Project, implemented following the 2015 landslide disaster, introduced rooftop RWH systems in schools to address water scarcity and improve hygiene. Through the provision of storage tanks, technical training, and awareness programs, the project ensured reliable water access for school communities while promoting environmental awareness and disaster risk reduction (Sri Lanka Water Partnership, 2025).

Collectively, these case studies demonstrate that rainwater harvesting in Sri Lanka is not a uniform intervention but a flexible strategy adaptable to domestic, agricultural, industrial, and institutional contexts. The literature underscores that system effectiveness depends on appropriate design, catchment assessment, storage capacity, and long-term maintenance.

3. METHODOLOGY

3.1 Study Design

This study adopts a structured literature-based review and qualitative synthesis approach to evaluate rainwater harvesting (RWH) practices in Sri Lanka's Dry Zone. The methodology was designed to systematically examine existing evidence on the performance, limitations, and applicability of different RWH systems rather than to generate primary empirical data.

3.2 Data Sources

The analysis is based on secondary data collected from multiple authoritative sources, including peer-reviewed journal articles, government reports, technical manuals, institutional publications, and documented case studies. Key data sources included publications from agencies such as the Lanka Rainwater Harvesting Forum (LRWHF), National Building Research Organisation (NBRO), Irrigation Department of Sri Lanka, and relevant academic institutions. Literature published between 1995 and 2023 was reviewed to capture both traditional and modern RWH practices.

3.3 Data Analysis

Data analysis involved thematic categorization and comparative evaluation. RWH practices were grouped into four main categories: traditional systems (tank cascade systems), rooftop rainwater harvesting, surface runoff harvesting, and institutional-scale systems. Within each category, systems were evaluated based on scale, intended use (household, agricultural, or institutional), effectiveness, and reported limitations. Case studies and statistical summaries from national reports were synthesized to identify patterns in adoption, functionality, and challenges across different contexts.

3.4 Spatial Context and Limitations

A Dry Zone map adapted from Panabokke (1999) was used solely to define the geographical scope of the study and to contextualize water scarcity conditions. The study acknowledges limitations associated with reliance on secondary data, including variability in reporting standards and the absence of direct field validation. However, the use of multiple data sources enhances the robustness of the synthesis and supports comparative interpretation.

4. RESULTS

The results of this study are derived from a structured synthesis and comparative interpretation of secondary data related to rainwater harvesting (RWH) practices in Sri Lanka's Dry Zone. Rather than reporting isolated facts, this section evaluates how different RWH systems function in practice, compares their effectiveness across scales, and examines their implications for water security in a drought-prone context. The following discussion interprets these comparative findings by situating them within broader empirical evidence and documented case studies from Sri Lanka's Dry Zone.

4.1 Performance of Traditional Rainwater Harvesting Systems

Traditional tank cascade systems (TCSs) continue to play a foundational role in the Dry Zone's hydrological landscape. The review indicates that functioning tanks make a significant contribution to seasonal water storage, agricultural irrigation, and groundwater recharge. Where tank cascades remain intact, they help regulate runoff during monsoonal rainfall and reduce water stress during early dry periods.

However, the effectiveness of these systems is uneven. Many tanks suffer from sedimentation, encroachment, and weak maintenance regimes, which reduce storage capacity and disrupt cascade connectivity. As a result, although TCSs support agricultural water availability at the landscape level, they do not adequately address household water needs during prolonged dry spells. This finding suggests that traditional systems alone are insufficient to meet contemporary water demand, particularly under changing climatic conditions.

4.2 Effectiveness of Rooftop Rainwater Harvesting for Household Water Supply

Rooftop rainwater harvesting emerges as one of the most effective methods for improving household-level water security in the Dry Zone. Evidence from multiple case studies shows that rooftop systems substantially reduce dependence on external water sources and lower the time spent collecting water, especially during dry months. This benefit is particularly important for women and children, who are often responsible for water collection.

The analysis also reveals clear limitations. Small-capacity storage systems provide only short-term relief and are rapidly depleted during extended dry periods. Larger storage tanks offer greater reliability but require higher financial investment and regular maintenance. Water quality concerns, such as contamination from roofs or malfunctioning first-flush devices, can further limit usability. Despite these constraints, rooftop RWH remains the most practical solution for domestic water needs when combined with basic maintenance and adequate storage capacity.

4.3 Effectiveness of Surface Runoff Harvesting for Agricultural Use

Surface runoff harvesting systems are particularly effective for agricultural applications in the Dry Zone. These systems capture excess rainfall and store it for supplementary irrigation, thereby extending crop survival during dry periods. The analysis indicates that runoff harvesting supports home gardens, plantation crops, and smallholder agriculture by improving soil moisture availability.

However, system performance is highly site-specific. Poorly designed or unmaintained runoff structures experience significant water losses due to seepage and structural failure. Compared to rooftop systems, runoff harvesting requires greater land availability, technical input, and long-term upkeep. These findings indicate that runoff harvesting is best suited for agricultural purposes but must be carefully designed and managed to remain effective.

4.4 Institutional Rainwater Harvesting Systems and Their Contribution

Institutional-scale RWH systems demonstrate strong performance in meeting non-potable water demands such as sanitation, cleaning, and cooling. Schools, religious institutions, and industrial facilities benefit from consistent water availability during dry periods, reducing pressure on groundwater resources.

Despite their effectiveness, institutional systems are constrained by high installation costs and dependence on external technical support. Their success is largely linked to structured management and maintenance arrangements, which are not always replicable at the household or community level. This suggests that while institutional RWH systems are reliable, their scalability remains limited without policy and financial support.

4.5 Comparative Effectiveness of Rainwater Harvesting Methods

A comparative evaluation of the four categories of rainwater harvesting systems demonstrates that each method addresses distinct water needs within Sri Lanka's Dry Zone, operating effectively at different spatial and functional scales. The findings clearly indicate that the strengths of one system often compensate for the limitations of another, reinforcing the need for integrated water management approaches.

Traditional rainwater harvesting systems, particularly tank cascade systems, are most effective at the landscape level. Their primary strength lies in regulating surface runoff, enhancing groundwater recharge, and supporting agricultural production across extensive areas. These systems contribute to hydrological stability and ecosystem functioning rather than directly supplying household water. However, their ability to meet contemporary domestic water demands is limited due to declining storage capacity, sedimentation, and weakened collective maintenance mechanisms. As a result, while traditional systems remain indispensable for agricultural and ecological sustainability, they are insufficient as standalone solutions for household water security.

In contrast, rooftop rainwater harvesting systems are highly effective at the household scale. The findings indicate that rooftop systems significantly improve domestic water security by providing accessible water for drinking, cooking, and basic hygiene during dry periods. Their decentralized nature allows households to reduce reliance on distant or unreliable water sources. Nevertheless, rooftop systems are constrained by limited storage capacity and roof catchment size, which restrict their potential contribution to agricultural activities. Consequently, while rooftop harvesting plays a critical role in addressing domestic water needs, its benefits remain largely confined to household-level consumption.

Surface runoff harvesting systems occupy an intermediate functional scale, primarily supporting agricultural resilience. These systems enhance soil moisture availability and provide supplementary irrigation during critical crop growth stages, particularly under variable rainfall conditions. However, their effectiveness is highly dependent on site-specific factors such as slope, soil characteristics, and system design. Poorly planned or inadequately maintained runoff harvesting structures are vulnerable to seepage, erosion, and rapid degradation, which can undermine long-term performance. This highlights the importance of technical guidance, localized planning, and ongoing maintenance in ensuring the sustainability of runoff-based systems.

Institutional rainwater harvesting systems are most effective in meeting non-potable water demands in schools, hospitals, religious institutions, and industrial facilities. Their structured management frameworks and larger storage capacities contribute to higher reliability compared to household systems. These systems significantly reduce pressure on groundwater resources by supplying water for sanitation, cleaning, and operational uses. However, high installation costs, technical complexity, and dependence on institutional capacity limit their widespread adoption, particularly in resource-constrained settings.

Collectively, these findings confirm that no single rainwater harvesting method can independently resolve water scarcity in Sri Lanka's Dry Zone. Each system performs optimally within a specific functional domain, and reliance on any one approach exposes vulnerabilities under climatic variability and changing water demand. An integrated approach that combines traditional, rooftop, runoff, and institutional rainwater harvesting systems across multiple scales offers the most resilient and adaptable solution for long-term water security in the Dry Zone.

5. DISCUSSION

Rainwater harvesting (RWH) continues to play a central role in enhancing water security in Sri Lanka's Dry Zone, where rainfall is highly seasonal, and both surface and groundwater resources are increasingly stressed. The findings of this study indicate that the effectiveness of RWH is not dependent on a single dominant system but on the complementary coexistence of traditional, household, agricultural, and institutional approaches. This discussion critically examines the observed patterns in relation to climatic variability, socio-economic conditions, and long-term sustainability, integrating evidence from documented case studies to contextualize practical applicability.

Traditional tank cascade systems (TCSs) remain foundational for landscape-level water management. They regulate runoff, enhance groundwater recharge, and support agricultural livelihoods. However, their effectiveness has declined in many areas due to sedimentation, encroachment, and weak institutional maintenance, reflecting the erosion of communal management practices. This aligns with observations from Panabokke et al. (2002) and Amarasinghe (2022), as well as practical findings from large-scale implementations documented in the literature. While these systems are structurally present, their capacity to fully meet current water demands is diminished, particularly during extended dry periods.

Rooftop RWH systems have proven highly effective for household water supply, reducing dependence on distant or unreliable sources during dry months. They also reduce labor burdens associated with water collection, which disproportionately affects women and children. Nevertheless, storage limitations, affordability, and water quality concerns constrain their overall effectiveness. Evidence from LRWHF-supported household projects, such as the

Aranayake RWH initiative, demonstrates that small roof catchments (approximately 50 m^2) can meet essential drinking and cooking needs even in extremely dry conditions (Climate Fact Checks, 2023; Sri Lanka Water Partnership, 2025). These case studies reinforce the critical role of rooftop systems as a decentralized water security measure while highlighting the need for supplementary infrastructure at the community level.

Surface runoff harvesting complements household systems by supporting agricultural water needs, enhancing soil moisture availability, and providing supplementary irrigation during critical crop growth stages. However, its success depends on site-specific conditions, including soil type, slope, and maintenance. Large-scale implementations, such as the Forbes & Walker plantation in Wanathavilluwa, demonstrate the feasibility of integrating roof and land catchments to meet substantial agricultural water demands. These examples emphasize that runoff harvesting can be scalable and sustainable when appropriately designed and managed.

Institutional RWH systems, implemented in schools, religious institutions, and industrial facilities, provide reliable non-potable water for sanitation and operational use. Industrial applications, such as the MAS Intimates - Unichela system in Biyagama, demonstrate that with appropriate tank sizing, demand management, and seasonal adjustments, RWH can reduce reliance on groundwater even in water-stressed regions. Case studies highlight that structured management frameworks enhance reliability, but high capital costs and dependence on technical support remain barriers to wider replication. These findings underscore the need for integrated planning and capacity-building for long-term sustainability.

Comparative analysis of RWH methods confirms that no single system can fully address water scarcity in the Dry Zone. Traditional systems optimize agricultural and hydrological regulation, rooftop systems secure domestic supply, runoff harvesting supports crop resilience, and institutional systems meet sanitation and operational needs. Case studies provide practical evidence of these complementarities, demonstrating that integrated, multi-scalar approaches combining traditional knowledge with modern engineering practices yield the most effective outcomes.

Persistent challenges, including inadequate maintenance, limited technical knowledge, unclear institutional responsibilities, and financial constraints, undermine the long-term effectiveness of all RWH types. Water quality issues further complicate household use, particularly where filtration and first-flush mechanisms are absent or poorly maintained. These observations from both secondary data and case studies highlight that technological solutions alone are insufficient; social, institutional, and governance factors are equally critical.

Policy and Adaptation Implications

The findings emphasize aligning RWH interventions with local environmental conditions and community capacities. Past initiatives often prioritized rapid installation over long-term performance. Evidence from case studies suggests that maintenance training, community participation, and adaptive system design are essential. Integrating traditional tank cascade practices with modern rooftop, runoff, and institutional systems provides a pathway to enhance climate resilience in a region increasingly affected by rainfall variability.

Overall, RWH in Sri Lanka's Dry Zone should be conceptualized as a multi-scalar, adaptive water management strategy rather than a single technological solution. Strengthening institutional coordination, improving technical standards, and fostering community ownership are essential for maximizing long-term benefits. The integration of case study evidence demonstrates that effective RWH can enhance water security and disaster resilience, providing a strong foundation for evidence-based policy and planning in drought-prone regions.

6. CONCLUSION

This study examined the range of rainwater harvesting (RWH) practices used in Sri Lanka's Dry Zone and evaluated their effectiveness using a structured review of secondary data, case studies, and institutional reports. The findings clearly show that RWH plays a central role in strengthening water security in a region where rainfall is highly seasonal, groundwater is often limited or saline, and long dry periods place pressure on domestic and agricultural water needs.

Traditional tank cascade systems remain essential for regulating landscape hydrology and supporting small-scale agriculture. However, their performance depends heavily on maintenance, sediment control, and catchment management. Rooftop RWH systems have proven to be one of the most effective solutions for household water supply, reducing daily water collection burden and improving access to potable water during dry periods. Their limitations relate mainly to storage size and maintenance of first-flush mechanisms. Runoff-based harvesting systems provide significant benefits for agriculture by enhancing soil moisture and supplementing irrigation, but require appropriate engineering and regular upkeep to prevent seepage and structural failure. Institutional RWH systems offer reliable water for sanitation and non-potable needs, although their wider adoption is constrained by cost and technical requirements.

Overall, no single method can address all water needs in the Dry Zone; instead, the results underscore the importance of combining multiple RWH practices at household, community, and institutional levels. The findings also reveal cross-cutting challenges such as inadequate maintenance, lack of technical knowledge, water quality concerns, and limited financial capacity. Addressing these constraints is essential for ensuring long-term system functionality.

Rainwater harvesting offers multiple social, economic, and environmental advantages, including improved household water access, reduced time and cost of water collection, groundwater recharge, and mitigation of drought and flood impacts. However, its long-term effectiveness in the Dry Zone is constrained by water quality concerns, limited technical capacity, inadequate maintenance, and financial barriers, particularly for advanced treatment and large storage systems. Addressing these challenges through improved design standards, community awareness, and affordable technological support is essential to maximize the benefits of rainwater harvesting under increasing climate variability.

The study highlights the need to integrate traditional hydrological knowledge, particularly the tank cascade heritage, with modern engineering approaches to develop resilient and context-appropriate RWH solutions. Strengthening community awareness, improving technical guidelines, and expanding support for medium- and large-scale storage can significantly enhance the contribution of RWH to Dry Zone water security. Future research should focus on quantifying long-term performance, cost-effectiveness, and climate resilience of different RWH methods to support evidence-based planning and policy development.

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