

ADVANCING SDG 6 THROUGH INTEGRATED WATER CONSERVATION IN SRI LANKA: A REVIEW-BASED FRAMEWORK AND IMPLEMENTATION PATHWAY

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Abstract

Sri Lanka has several existing water conservation measures, including rainwater harvesting, wastewater reuse, demand-side efficiency, green building provisions and policy instruments. However, these measures are often implemented separately, limiting their collective effectiveness and contribution to Sustainable Development Goal 6. This study examines how existing conservation measures can be better integrated within the Sri Lankan context. A structured review-based qualitative thematic synthesis was conducted using journal articles, Sri Lankan policy documents, technical guidelines, project reports and international best-practice sources, with evidence organised and coded to identify recurring conservation measures, implementation barriers and enabling mechanisms. The thematic synthesis resulted in four themes: water supply, treatment and reuse systems; demand-side water use and end-use efficiency; built environment and design-based strategies; and governance, policy and economic instruments. The synthesis identifies fragmented implementation, institutional coordination gaps, inadequate monitoring and inconsistent user adoption as recurring constraints across the four thematic areas. Based on these findings, a Multi-Layer Water Conservation Framework is proposed to connect policy and governance, infrastructure and design, technology and systems, and user and demand considerations. A phased Implementation Pathway Framework further translates these components into short-, medium- and long-term actions aligned with relevant national SDG 6 targets and water-sector priorities. Together, the frameworks provide a structured basis for moving from isolated conservation measures towards more coordinated water conservation planning in Sri Lanka, thereby supporting progress towards SDG 6.

Keywords: End-use efficiency, Wastewater reuse, Green building strategies, Institutional coordination, Implementation

1. Introduction

Sri Lanka faces water management challenges due to uneven rainfall, groundwater vulnerability, infrastructure losses and limited wastewater reuse. Although several conservation measures are available, they are often implemented separately, while institutional fragmentation further limits effective coordination [1]–[4].

Water conservation is also directly related to Sri Lanka's national priorities under SDG 6. These include improving wastewater treatment, recycling and safe reuse under Target 6.3, increasing water-use efficiency under Target 6.4, advancing integrated water resources management under Target 6.5, and strengthening participation in water and sanitation management under Target 6.b [1]. National water-sector policies further emphasise water conservation, rainwater harvesting, wastewater reuse, monitoring and institutional coordination [2], [3]. These priorities provide an important policy basis for integrating currently fragmented conservation measures.

This study synthesises global and Sri Lankan literature to identify key strategies, implementation gaps and opportunities for better integration across the water sector. The review considers technical, built-environment, behavioural and governance-related measures to understand how they can function as part of a coordinated system. Particular attention is given to the connections between policy, infrastructure, technology and user participation. Based on these findings, a Multi-Layer Water Conservation Framework and an Implementation Pathway Framework are proposed to support coordinated action aligned with Sri Lanka's national SDG 6 and water-sector priorities.

2. Methodology

A structured review-based qualitative thematic synthesis was conducted using journal articles, Sri Lankan policy documents, technical guidelines, project reports and international best-practice sources. Search terms were derived from the study objectives and organised around key concepts including water conservation, rainwater harvesting, wastewater and greywater reuse, non-revenue water, water-use efficiency, demand management, green buildings, water governance and SDG 6. Terms relating to Sri Lanka were incorporated where relevant to identify local evidence, while international sources were reviewed to identify established and potentially transferable practices.

Sources were considered where they provided evidence on conservation measures, implementation mechanisms, governance, user participation or barriers relevant to water conservation. Relevant information was organised in a structured review matrix covering the conservation measure, application context, implementation approach, enabling factors and reported implementation constraints.

Following thematic synthesis principles [5], recurring findings were initially coded and related codes were progressively grouped according to their functional role in water conservation. This iterative grouping resulted in four higher-level themes: water supply, treatment and reuse systems; demand-side water use and end-use efficiency; built environment and design-based strategies; and governance, policy and economic instruments. Issues recurring across multiple themes, particularly integration, institutional coordination, monitoring and user adoption, were identified as cross-cutting findings. International approaches were then compared with Sri Lankan practices to identify implementation gaps and opportunities, which formed the basis for the proposed Multi-Layer Water Conservation Framework and phased Implementation Pathway Framework.

3. Results and Discussion

The synthesis shows that Sri Lanka already has conservation mechanisms across the four thematic areas. Water supply, treatment and reuse measures include rainwater harvesting, wastewater and greywater reuse, reclamation and non-revenue water reduction [2], [3]. Demand-side measures include efficient fittings, metering, water audits, awareness and economic mechanisms intended to influence consumption. Built-environment strategies, including metering, rainwater harvesting and water-efficient design, are also recognised within Sri Lankan green building criteria [4]. Governance and policy mechanisms provide the institutional and regulatory basis for conservation, reuse and coordination [1]–[3].

Across these themes, four recurring implementation issues emerged. First, conservation measures are often implemented as individual interventions rather than as components of an integrated system. Second, responsibilities for water supply, sanitation, buildings and resource management are distributed across different institutions, creating coordination challenges.

Third, monitoring gaps limit the ability to assess water use, system losses and the actual performance of conservation measures. Finally, the effectiveness of demand-side and decentralised measures depends on user adoption, operation and maintenance. The synthesis therefore indicates that Sri Lanka's principal need is stronger integration and coordinated implementation of existing measures rather than reliance on isolated interventions.

3.1 Multi-Layer Water Conservation Framework

The proposed Multi-Layer framework (Figure 1) integrates four interacting layers: Policy and Governance; Infrastructure and Design; Technology and Systems; and User and Demand. Governance provides the regulatory and institutional basis, infrastructure enables physical implementation, technologies support conservation and reuse, and users influence adoption, operation and maintenance.

These layers operate as a feedback system in which governance enables implementation and infrastructure development, infrastructure supports appropriate technologies, and user response and system performance inform subsequent management decisions. The framework therefore provides a mechanism for connecting conservation measures that are otherwise implemented through separate technical and institutional pathways [2], [3].

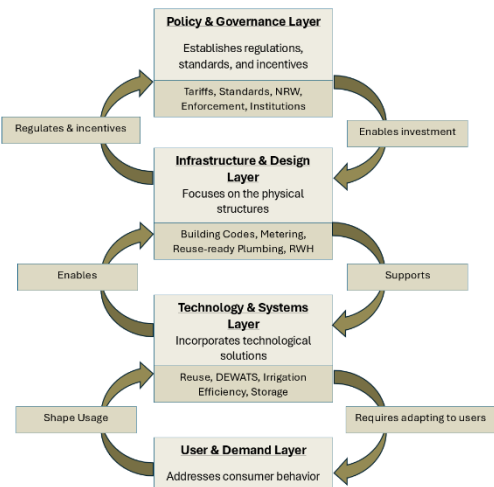


Figure 1: Proposed multi-layer water conservation framework for Sri Lanka.

3.2 Implementation Pathway Framework

The Implementation Pathway (Figure 2) translates the framework into phased actions while relating the proposed measures to Sri Lanka's national SDG 6 and water-sector priorities. Short-term actions focus on strengthening existing mechanisms through rainwater harvesting, awareness, water audits, water-efficient fittings and non-revenue water monitoring. These measures primarily support SDG Target 6.4 on improving water-use efficiency and existing national policy directions on water conservation and rainwater harvesting [1], [2].

Medium-term actions include wider metering, efficiency standards, reuse-ready buildings and fit-for-purpose wastewater reuse. These measures support Targets 6.3 and 6.4 by improving water-use efficiency while increasing opportunities for wastewater treatment, recycling and safe reuse [1], [3].

Long-term actions include advanced reclamation, digital water accounting, basin-scale water management and stronger inter-agency coordination. These actions are consistent with Target 6.5 on integrated water resources management and the broader requirement for coordinated and participatory water management under Target 6.b [1]–[3]. The pathway therefore

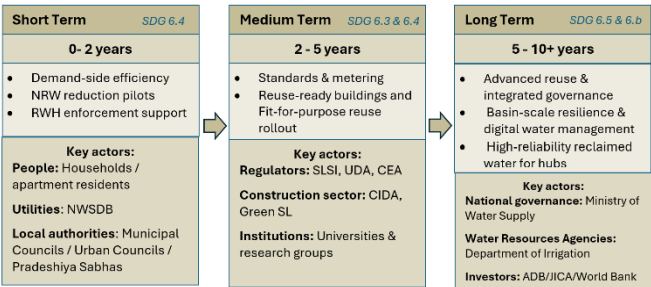


Figure 2: Proposed implementation pathway framework for phased water conservation action in Sri Lanka.

progresses from strengthening existing conservation practices, through institutionalising efficiency and reuse, towards more integrated and data-supported water management.

4. Conclusions

The thematic synthesis shows that Sri Lanka already has several water conservation measures across supply and reuse, demand management, the built environment and governance. However, their effectiveness is constrained by fragmented implementation, institutional coordination and monitoring gaps, and user adoption.

The study therefore proposes a Multi-Layer Water Conservation Framework to connect governance, infrastructure, technology and users, together with a phased Implementation Pathway aligned with relevant national priorities under SDG Targets 6.3, 6.4, 6.5 and 6.b. Together, the frameworks provide a structured basis for progressing from isolated measures towards more coordinated water conservation planning and implementation in Sri Lanka. Future work should focus on stakeholder validation and quantitative assessment of potential water savings.

References

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Graphical Abstract

