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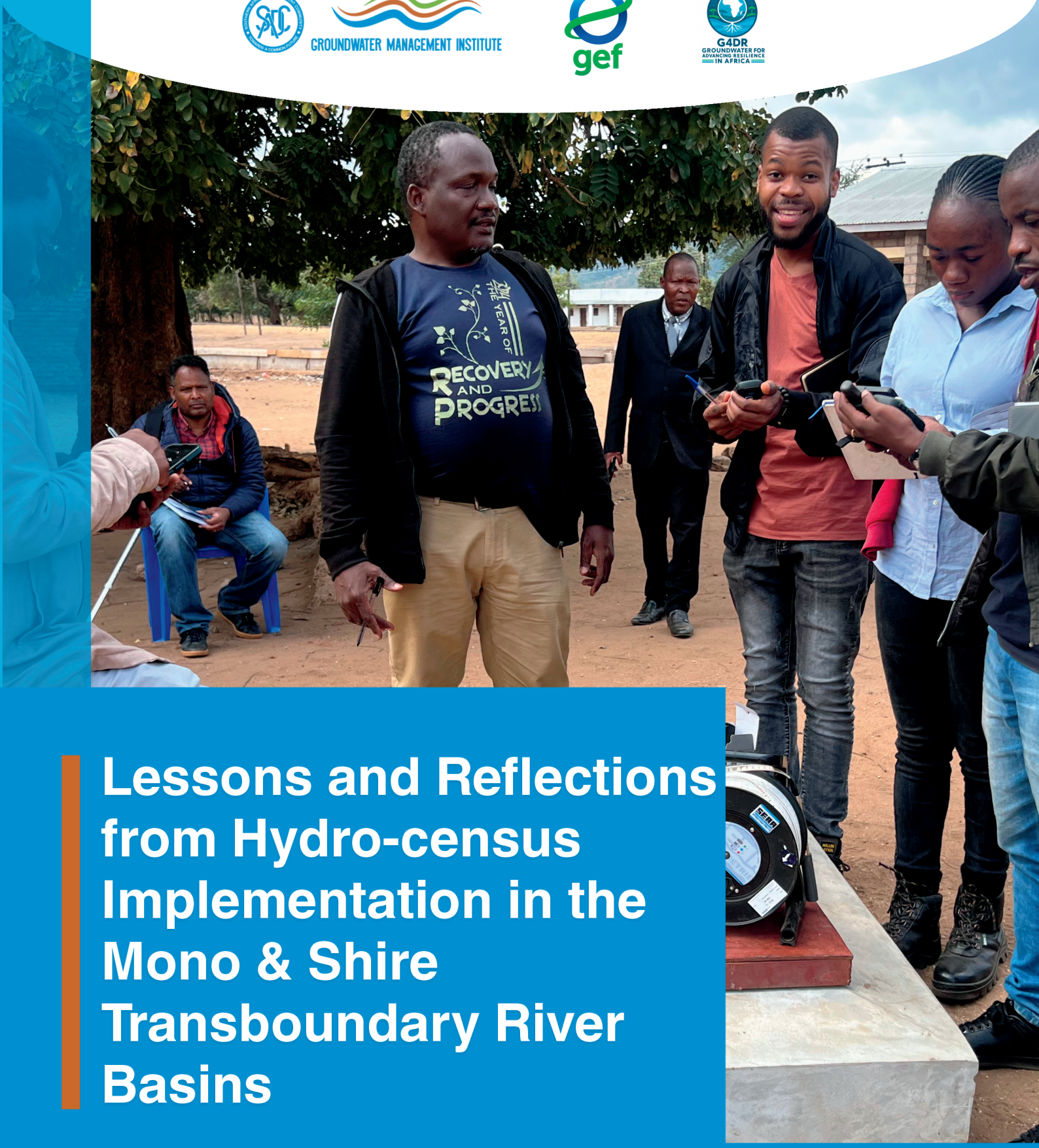
G4DR
GROUNDWATER FOR ADVANCING RESILIENCE IN AFRICA



Lessons and Reflections from Hydro-census Implementation in the Mono & Shire Transboundary River Basins

Food and Agriculture Organization of the United Nations

Every drop counts
Count every drop

International Water Management Institute

International Institute for Applied Systems Analysis

KEY LESSONS

- **Effective groundwater management**, particularly in transboundary settings, begins with robust monitoring.
- **A hydro-census is a systematic field survey** carried out to locate and assess groundwater sources such as wells and boreholes.
- **The hydro-census** is the essential initial step in co-designing a transboundary monitoring network, which is crucial for achieving joint data collection in shared aquifers.
- In both basins, the hydro-censuses served as a **key mechanism to ground-truth data collected from national authorities**. Approximately one-third of the monitoring sites reported as functional were, in fact, not functioning. Likewise, potential sites for rehabilitation were fewer than expected.
- Establishing **borehole infrastructure** in secure sites is vital to prevent vandalism that threatens groundwater monitoring, but the long-term viability of monitoring site success relies on community education that fosters local ownership.
- **Maintenance of observation boreholes** should be performed routinely, as many are currently damaged and have received no maintenance or replacement.
- Samples collected for **water quality analysis** do not routinely form part of hydro-census and monitoring activities.

Context

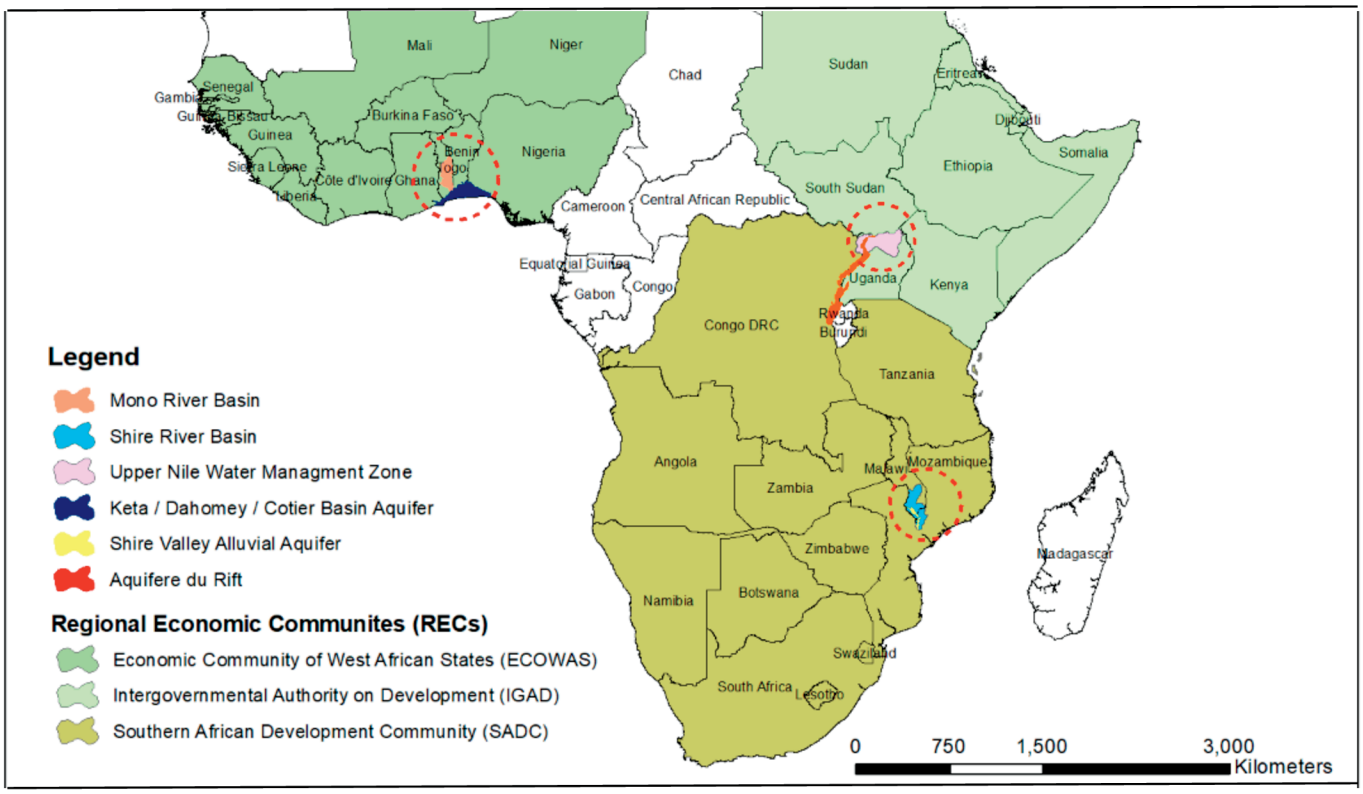


Figure 1: G4DR pilot sites - Mono, Shire, & Uganda

The Groundwater for Advancing Resilience in Africa (G4DR) project aims to demonstrate the benefits of groundwater-based planning for improving water security and resilience through targeted interventions in the Mono Basin (24,300 km^2), shared by Benin and Togo, and the Shire Basin (32,000 km^2), shared by Malawi and Mozambique. A key thrust of this project is to co-design a harmonised groundwater monitoring network for the Mono and Shire River Basins to enhance monitoring of groundwater levels and other key parameters in priority areas, improve water resources management, and understand.

To support the monitoring network design in the Mono and Shire River Basins, a hydro-census was conducted from May to July 2025. The primary purpose of the hydro-censuses was to verify the conditions of existing monitoring boreholes to inform the design of the primary monitoring network and the selection of boreholes for rehabilitation to install data loggers for continuous water-level monitoring. Additionally, the hydro-censuses aimed to identify areas of high groundwater pumping, recharge, and pollution sources to guide the placement of the secondary monitoring network for comprehensive impact assessment. Data collected during the hydro-censuses included borehole location, depth, casing height, water level, and field-based water quality parameters, including pH, electrical conductivity (EC), and temperature. Furthermore, network strength and borehole functionality were recorded. The data gathered provides a solid foundation for designing harmonised groundwater monitoring networks in both basins, supporting coordinated management of shared aquifers and promoting the sustainable use of groundwater resources across the region.

The aim of this brief is to synthesise the key challenges, best practices, and key lessons in groundwater monitoring identified during the hydro-census across both basin regions.

What is a Hydro-census?
A hydro-census is a systematic field survey conducted to locate and assess groundwater sources, such as wells and boreholes. It records information on their condition, performance, and key characteristics, such as water level, yield, and quality.

Hydro-census Summary: Mono and Shire Basins

The hydro-census conducted in both basins provided an **overview of the groundwater monitoring networks**. The hydro-census highlighted the current state of the groundwater monitoring networks for rehabilitation and integration into the transboundary groundwater monitoring network.

The hydro-census in the Mono River Basin took place from June 1 to 12, 2025. This effort surveyed 63 sites, comprising **30 observation boreholes** (97% of which were functional) and **33 production boreholes.** The regional coordinator, the national coordinators (Benin and Togo), the representative of the Mono Basin Authority, and the coordinator of Component 3 activities of the G4DR project in West Africa on behalf of the International Water Management Institute (IWMI) took part in the hydro-census to provide a factual overview of the groundwater monitoring facilities in the Mono River Basin.

Separately, the hydro-census for the Shire was carried out from July 1 to 14, 2025. It covered **85 sites across the Basin**, including **42 observation wells** (76% of which were functional), **16 production wells, 7 shallow wells, and 5 artesian wells.** The remaining sites included potential contamination zones and future observation sites for monitoring installations. The hydro-census team consisted of IWMI, the G4DR national coordinators for Malawi and Mozambique, the Ministry of Water and Sanitation, Malawi, the National Directorate of Water Resources Management, Mozambique, and the Central Regional Water Administration.

Remarkably, of the observation boreholes visited in the Mono River Basin, none were found to be dry, obstructed, or abandoned. Piezometric levels were measured in all of them. Two of these boreholes exhibit artesian conditions. Most of the boreholes have only **basic protective structures**. Protection generally consists of a square masonry enclosure with a base of 1.2 m and a height of 80 cm. The top of the structure is sealed with a metallic cover. However, the limited space inside the enclosure makes operation more difficult. Unfortunately, the **dataloggers** installed in the boreholes were mainly **non-operational**. In the Shire River Basin, gaps in knowledge regarding the maintenance of borehole infrastructure and ownership were noted, particularly for hand pumps. Training improved outcomes in specific communities, while vandalism at schools highlighted the need for increased education. Groundwater sites in urban areas are at higher risk of contamination, stressing the importance of continued monitoring and protection. Over **30% of boreholes were inaccessible** due to physical blockages (e.g., filled with stones or concrete), locked compounds (e.g., schools, private estates), or impassable terrain. **Data loggers were either poorly maintained or missing** in many sites. Instances of unsealed logger wells and unauthorized removal were recorded, particularly where community members lacked awareness of their purpose. Many boreholes lacked **proper records**—depths, construction year, lithological logs, or past performance data were missing. This absence complicates trend analysis, rehabilitation planning, and scientific interpretation.

Common Challenges

Across both basins, recurring technical and institutional factors continue to constrain the establishment and sustainability of groundwater monitoring networks. Common challenges include:

- **Vandalism of monitoring infrastructure** – Protective covers, padlocks, and data loggers are often damaged or stolen, compromising long-term data collection.·
- **Limited awareness and engagement** – Low understanding among local communities and limited coordination among national and regional institutions hinder regular monitoring.
- **Equipment and maintenance gaps** – Many automatic loggers require recalibration or replacement, and limited technical capacity affects consistent data retrieval.
- **Insufficient spatial coverage** – Observation networks remain unevenly distributed, particularly in bedrock zones and transboundary areas, reducing data representativeness.
- **Insufficient water quality monitoring** – Urban and agricultural pollution were observed in both basins, underscoring the need for integrating water-quality monitoring.

During the hydro-census, it was noted that the Mono River Basin discharges large volumes of uncontrolled groundwater into the environment through freely flowing artesian wells. This continuous discharge and loss of groundwater resources require monitoring and controlling the temporal evolution of artesian pressures to assess the risks of groundwater depletion. The hydro-census in the Shire River Basin underscored the need for a dedicated water quality hydro-census across the Shire Basin. This is needed to systematically assess physical, chemical, and microbiological parameters at production and observation boreholes and wells to identify contamination hotspots, evaluate salinity trends, and propose targeted mitigation measures. Findings from this exercise will inform water safety interventions, the protection of recharge zones, and the improved siting of future groundwater infrastructure.

Key Lessons Learned: Reflecting on hydro-census in the Mono & Shire River Basins

The hydro-census exercises in the Mono and Shire River Basins provided valuable insights into the technical, environmental, and social factors that influence the sustainability of groundwater monitoring networks. The following lessons emerged across both basins:

- **There is a need to verify conditions on-ground, not just on-paper, routinely.** Hydro-censuses in both basins provided a powerful ground truth for national datasets. In Mono, 18 potential rehabilitation sites were identified—a substantially greater number than reported in government records. In the Shire, the state of the monitoring network required more investment than previously reported, as more than 10 monitoring sites, reported as functional, were in fact non-operational.

- **Design for security and community ownership.** Vandalism of borehole components and loggers remains a widespread challenge. Securing wellheads in trusted locations and raising community awareness are both essential for sustainable protection.

- **Site selection affects borehole longevity**. Environmental factors such as tree-root intrusion can block or damage wells, underscoring the need for careful siting and environmental screening.

- **Artesian wells require proper control**. Free-flowing wells must be capped or sealed to prevent uncontrolled discharge and contamination.

- **Reliable data retrieval is vital**. Many loggers lack telemetry and rely on manual downloads, which are often delayed by access or connectivity issues. Expanding the use of automated systems and improving maintenance will enhance data continuity.

- **Awareness and capacity underpin sustainability.** A limited understanding of groundwater monitoring underscores the need for ongoing engagement, training, and community participation.

- **Monitoring networks must expand strategically.** Significant data gaps remain, particularly in the Mono's basement aquifers and Mozambique's portion of the Shire Basin. Investments in new observation wells and citizen-science initiatives can strengthen spatial coverage.

- **Integrating monitoring with water-supply functions adds value.** Designing dual-purpose wells can meet community needs while maintaining monitoring objectives and reducing vandalism.

- **Capacity building is critical at all levels.** Technicians, data managers, and decision-makers all require continued training to ensure data quality and institutional continuity.

- **Water-quality monitoring is integral.** High salinity and pollution risks in both basins underline the importance of coupling groundwater-level tracking with routine water-quality testing

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