

Groundwater Solutions for Water Security in the Lake Victoria Basin of Kenya

Community-Based Groundwater Assessment in Jimo Aggregated Farm

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Front cover photo: Sao River in Jimo catchment draining to Lake Victoria in Kisumu County (photo by Birhanu Zemadim).

Back cover photo: The upland catchment in Agoro and Jimo (photo by Birhanu Zemadim).

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Acronyms and Abbreviations

AoW	Area of Work
DAPWL	Deepest Advisable Pumping Water Level
IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
LVB	Lake Victoria Basin
LVBC	Lake Victoria Basin Commission
MBGL	Meter below ground level
MFL	Multifunctional Landscapes
VLf-EM-R	Very Low Frequency Electromagnetic Resistivity

Summary

The Lake Victoria Basin (LVB) is East Africa's most productive water resource region, generating an estimated 59% of Kenya's surface water and sustaining the livelihoods of more than 42 million people across five riparian countries. Within Kenya, the basin supports dense rural populations, smallholder agriculture and rapidly growing towns, yet it faces mounting pressure from land degradation, rainfall variability, pollution and unplanned groundwater abstraction. This report synthesizes published hydrogeological and water-resources literature on the Kenyan sector of the LVB and integrates it with a site-specific groundwater assessment for the Jimo Aggregated Farm in Nyakach Sub-County, Kisumu County. The Jimo assessment followed community consultations that identified groundwater as a viable water source for the farm. From March to June 2026, the IWMI and ASAL-Green team consulted with over 80 community members and discussed the farm's water challenges. Community leaders led the final discussion and decision on groundwater management. Groundwater was considered a necessary option because the nearby Sao River flows directly into Lake Victoria, and local authorities have prohibited water abstraction from the river.

The regional hydrogeological review confirms that most of the Kenyan LVB is underlain by a Precambrian Basement Complex whose groundwater potential is controlled by the depth and continuity of weathered and fractured zones rather than by primary porosity. This pattern is consistent with the Jimo findings: a Very Low Frequency Electromagnetic Resistivity (VLF-EM-R) survey of 14 sounding points identified a thickened sequence of weathered and fractured basalts and sediments at one point and recommended a borehole to 120 to 150 m below ground level, with an anticipated yield of 3.0–7.0 m³/hr. The hydrogeological review and the Jimo case study point to three priorities for water management in the Kenyan LVB: (i) pairing community-based demand with properly sited, geophysically verified groundwater development, since appropriately targeted surveys can raise borehole success rates substantially in basement terrain; (ii) embedding groundwater development within catchment-scale soil and water conservation, given that roughly 45% of the basin's land is prone to water erosion; and (iii) strengthening the institutional and data-sharing framework coordinated by the Lake Victoria Basin Commission (LVBC) so that local interventions such as Jimo feed into basin-wide planning. The report concludes that community-scale groundwater assessments, if replicated and properly documented, can meaningfully contribute to the LVB's water security while generating the aquifer data the basin currently lacks.

Groundwater Solutions for Water Security in the Lake Victoria Basin of Kenya

Community-Based Groundwater Assessment in Jimo Aggregated Farm

Background and rationale

Water security in the Lake Victoria Basin (LVB) sits at the intersection of abundant regional water resources and highly localized scarcity. Although the basin accounts for well over half of Kenya's renewable freshwater (Winrock International 2021), individual communities within it often lack a reliable domestic or irrigation water supply, particularly where surface water is seasonal, contested, or, as in this case, legally protected from abstraction. This report was prepared under Area of Work 1 (AoW1) – Integrated Soil and Water Conservation for the Lake Victoria Basin, a program of engagement between the International Water Management Institute (IWMI) and ASAL-Green with communities in the Kenyan LVB. It responds to a specific request from Jimo Aggregated Farm in Lower Nyakach Sub-County, Kisumu County, where local communities identified groundwater development as the most viable pathway to a reliable water supply for irrigation activities on the farm. The report synthesizes published literature on the hydrogeology, water resources, and water-management challenges of the Kenyan LVB, documents the geophysical assessment undertaken for the Jimo Aggregated Farm as a worked example of how community-scale groundwater development can be planned and sited responsibly in the basin's dominant basement-aquifer terrain.

The Lake Victoria Basin geographic and climatic setting

Lake Victoria is Africa's largest lake and the world's second-largest freshwater lake by surface area, with a total catchment exceeding 180,000 km² shared among Burundi (7%), Kenya (22%), Rwanda (11%), Tanzania (44%) and Uganda (16%). The lake itself is shared between Kenya (6%), Uganda (43%), and Tanzania (51%), has a mean depth of about 40 m, and is the source of the White Nile (Masese et al. 2025). The basin experiences a bimodal climate, with long rains from March to May contributing roughly 39% of annual rainfall and short rains from October to December contributing a further 26%. Rainfall is strongly relief-dependent, ranging from about 800 mm per year in the lowlands near the lake to over 2000 mm per year in the surrounding highlands. Around Kisumu and the Kano Plains – the setting for the Jimo case study – annual precipitation typically falls between 1,600 and 2,000 mm, with a pronounced dry season and fresh lake-shore winds moderating an otherwise hot, humid climate (Masese et al. 2025).

Surface water resources

The LVB is Kenya's most productive surface-water region, contributing an estimated 59% of the country's surface water and 54% of total renewable freshwater (UNEP/GRID-Geneva 2022). Direct precipitation supplies about 80% of its water input, with river discharge and groundwater seepage contributing the remaining 20%; of that inflow, the Kagera, Nzoia, Gucha, Sondu-Miriu and Simiyu rivers together account for over 60% (Masese et al. 2025). On the Kenyan side, the Lake Victoria South catchment – covering Kisumu, Kericho, Bomet, Homa Bay, Migori, Kisii and Nyamira counties over roughly 26,900 km² – is drained by the Nyando, Sondu-Miriu, Gucha (Kuja) and Sao rivers, alongside the transboundary Mara River. Table 1 summarizes the catchment size, rainfall and discharge characteristics of the principal Kenyan rivers draining to the lake. The Jimo Aggregated Farm lies within the Nyando system, immediately south of Kisumu town in the Kano Plains (Figure 1). Community consultations

confirmed that the nearest perennial surface water source, the Sao River, flows directly into Lake Victoria and the County Water Resources Authority has closed it to abstraction, making groundwater the only realistic option for the farm's water augmentation needs.

Table 1: Catchment area, rainfall and discharge of the principal Kenyan rivers draining to Lake Victoria.

River basin	Catchment area (km ²)	Mean annual rainfall (mm)	Mean discharge (m ³ /s)	% of lake inflow
Nzoia	15,143	1,492	116.7	14.8
Nyando	3,517	1,307	18.5	2.3
Sondu-Miriu	3,583	1,511	42.2	5.4
Gucha (Kuja)	6,612	1,519	58.0	7.5
Sao	1,450	1,560	11.4	1.5
Mara (Kenya/Tanzania)	13,915	1,040	37.5	4.7

Source: Masese et al. (2025)

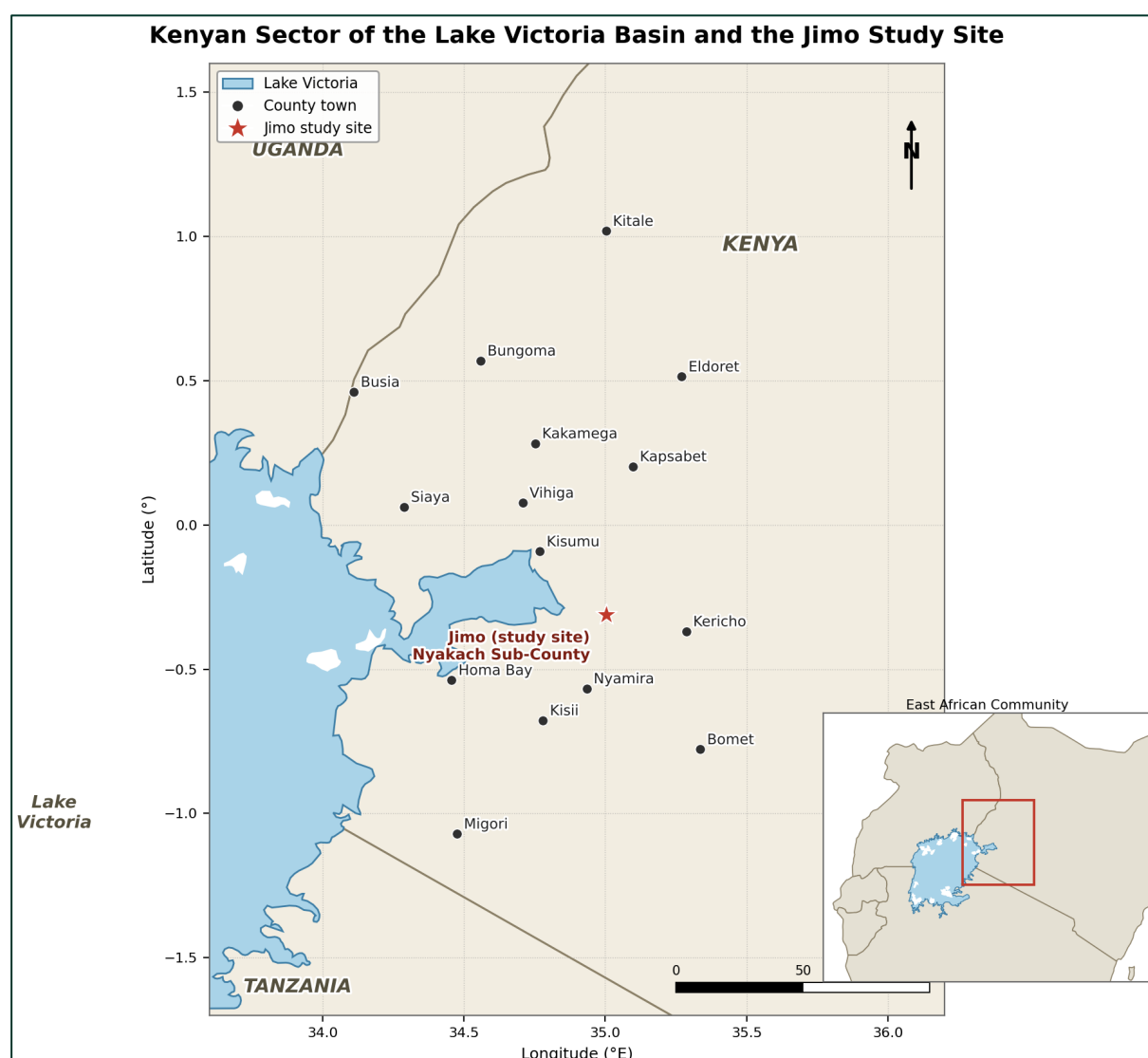


Figure 1: Location of the Kenyan sector of the Lake Victoria Basin and the Jimo study site, with the county towns of the seven-county Lake Victoria South catchment shown for reference. (Source: Authors' data)

Hydrogeology and groundwater resources

Across most of the Kenyan LVB, groundwater occurs within the weathered and fractured zones of the Precambrian Basement Complex (the Nyanzian and Kavirondian Systems and associated granitic intrusives), with additional storage in Tertiary volcanic rocks and in Recent alluvial and lacustrine deposits fringing the lake shore and major river floodplains (British Geological Survey 2024).

Basement-complex rocks have essentially no primary (inter-granular) porosity; economically useful groundwater occurs only in the secondary porosity created by weathering and fracturing, so borehole yields depend heavily on the thickness of the weathered profile and the presence of transmissive fracture zones rather than on rock type alone (MacDonald et al. 2012). Continent-wide mapping by MacDonald et al. (2012) places much of Kenya's basement terrain in a low-to-moderate aquifer-productivity class, typically capable of supporting handpumps and small motorized boreholes (yields of roughly 0.1–5 l/s) rather than high-volume abstraction, though local fracture concentrations can yield considerably more. Groundwater flow in the Kano Plains is topography-driven towards Lake Victoria (Mutua et al. 2020).

Land degradation, soil erosion and land use change

The LVB is one of Africa's most densely settled rural regions. It is now home to more than 42 million people, with an average density of about 250 persons/km² and locally over 1,000–1,200 persons/km², and the population has grown by more than 40 million over the past century (Masese et al. 2025). Population growth directly increases demand for domestic, agricultural, and industrial water and is identified in the literature as the underlying driver of most other pressures on the basin's water resources, from wetland conversion to over-abstraction. Conversion of native forests and wetlands to smallholder farmland and plantations, combined with overgrazing, unpaved roads, and expanding settlements, has driven widespread soil erosion across the basin; an estimated 45% of LVB land is classed as prone to water erosion. Farm-level surveys in the transboundary Sio-Malaba-Malakisi basin confirm that soil and water conservation practices are applied inconsistently and vary by a farm's position in the landscape, even though most farmers recognize soil erosion as a problem affecting their livelihoods (Mwanake et al. 2023). Eroded sediment increases turbidity in rivers and the lake itself, with measurable effects on aquatic biodiversity, and reduces the effectiveness of natural infiltration that would otherwise recharge shallow aquifers.

Climate variability, change, and institutional challenges

Rainfall across the Kenyan LVB has become less predictable in onset, cessation, and intensity over the past three decades, even where long-term average totals have not changed dramatically (Evans et al. 2020). Because groundwater responds much more slowly than surface water to short-term rainfall fluctuations, it provides a natural buffer against this variability (MacDonald et al. 2012) — one of the clearest arguments, alongside the legal restriction on surface abstraction encountered at Jimo, for prioritizing groundwater development in communities exposed to increasingly erratic rainfall. In Kenya, groundwater monitoring data remain limited: Kenya's Water Resources Authority collects groundwater levels quarterly to monthly through regional offices, but catchment boundaries used for surface water do not align with aquifer boundaries, complicating basin-wide groundwater accounting (IGRAC 2025).

Integrated soil and water conservation and groundwater development

Population growth drives land conversion, accelerating erosion and reducing infiltration. Reduced infiltration increases flood risk and challenges groundwater development. Technically, this requires integrated, catchment-scale management—combining soil and water conservation on farmland, protecting riparian buffers and wetlands, and properly siting groundwater development—delivered through a coordinated Integrated Water Resources Management (IWRM) approach rather than single-sector interventions (EEAS 2020). The Jimo groundwater assessment, presented in this paper, is one practical building block within that wider approach: a community-requested, geophysically verified groundwater source that reduces pressure on a protected surface-water resource while generating aquifer data that is otherwise scarce for the Lake Victoria Basin.

Community engagement approach for groundwater development in Jimo Aggregated Farm

The Jimo Aggregated Farm is located in Jimo Village, Lower Nyakach Location, Nyakach Sub-County, Kisumu County, within the Jimo-East Living Landscape of Kenya's Lake Victoria Basin. The farm is managed by the Jimo Farmers Co-operative Society Limited, which has set aside land for communal farming. Common crops grown in the area include maize, sugarcane, vegetables, and beans. Erratic rainfall limits agricultural production, which is largely confined to the long rainy season from March to June. The nearby Sao River is the main source of water for domestic use. The farm does not experience flooding; however, water scarcity is a major constraint. Although irrigation is not currently practiced in the area, the farming community has highlighted the need for a reliable water supply to support irrigation and a proposed aquaculture setup on approximately five hectares of land.

From March to June 2026, the IWMI and ASAL-Green team consulted with over 80 members of the Jimo Aggregated Farm communities and discussed the farm's water challenges. The final discussion and decision on ground water management was made with the leaders of the community, consisting of six individuals (Figure 2). The Jimo aggregated farm slopes toward the nearby Sao River. The team conducted a transect walk to identify potential water sources; the nearby Sao River (Figure 3) could in principle serve as a pumped source, but community members explained that it flows directly to Lake Victoria and that local authorities have banned abstraction from it. Groundwater development was therefore identified as the option to explore, motivating the hydrogeological study summarized in the next sections.



Figure 2: Left: IWMI and ASAL Green team in final discussion with leaders of the Jimo aggregated farm association.



Figure 3: Right: Identification of a potential water development site (*photo: Birhanu Zemadim/IWMI*)

Geology and hydrogeological setting

The Jimo area lies on Basement terrain of the Kavirondo Rift, with a thin veneer of Lake Basin sediments—the same Precambrian Nyanzian, Kavirondian, and intrusive rock groups, overlain locally by Tertiary volcanics and Recent alluvial deposits—that also characterize the wider Kenyan LVB. Groundwater at Jimo therefore occurs principally in weathered and/or fractured zones within the Basement Complex and in alluvial deposits along the Lake Basin channels—a two-part system, highland fractured basement grading into a lowland Kano Plains system, described regionally by Mutua et al. (2020). Because igneous and metamorphic basement rocks have essentially no primary porosity, groundwater storage at the site depends on secondary (fracture) porosity, controlled by weathering thickness and the density of water-bearing fractures rather than rock type alone.

Geophysical survey

A Very Low Frequency Electromagnetic Resistivity (VLF-EM-R) survey was carried out to determine the thickness and composition of the volcanic and basement rocks, identify faults, and trace water-bearing zones, calibrated against existing borehole logs. Fieldwork was conducted from 5 to 15 July 2026 at 14 sounding points arranged along a straight survey line, with electrode spacing of 5–10 m and a total line length of 30 m (Figures 4a and 4 b). The resulting resistivity section (Figure 5a) and sounding curves (Figure 5b) show a relatively thickened sequence of weathered and fractured basalts with agglomerates at sounding Point 12, indicating higher yield potential than the surrounding points. The sediments at this location range from fine-grained to medium-grained aggregate; because the strata are less clayey than elsewhere on the line, aquifer potential is judged to be higher. The bulk of the water supply is expected to derive from fractured and weathered lava, with a second aquifer at the base of the basalt-agglomerate-derived sediments. At Point 12 where VLF-EM-R resulted a low resistivity, the top layer is black cotton soil, overlying alternating weathered/fractured and compact metamorphic rock. The upper 25 metres of the shallow aquifer could provide a potential source of water, notwithstanding the risk of aquifer depletion under conditions of erratic rainfall.

Based on the sounding curves, drilling at Point 12 is therefore recommended to a minimum depth of 120 m below ground level (mbgl) and a maximum depth of 150 m below ground level (mbgl) (Figure 5 a&b). Box 1 presents the recommended standards of practice for well construction and development.



Figure 4: (a) Geophysical survey using Very Low Frequency Electromagnetic Resistivity (VLF-EM-R) (4b) Jimo community leader interacting with the hydrogeologist during the VLF-EM-R survey. (photo: Obadiah Mwangi/ASAL Green)

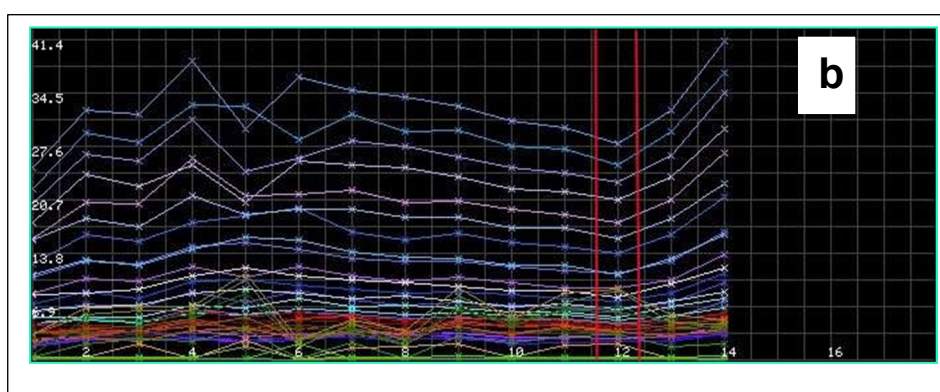
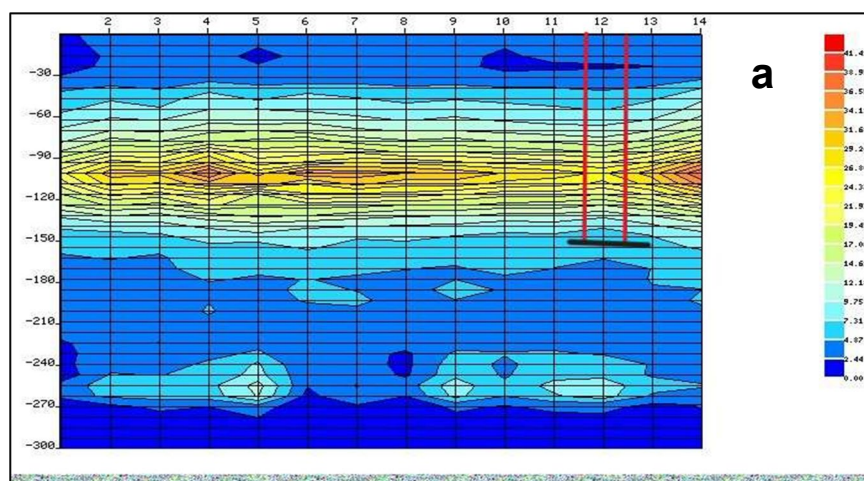


Figure 5: VLF-EM resistivity section (a) and sounding curves (b) for the Jimo survey line, recommending Point 12 to a drilled depth of between 120 and 150 m below ground level (bgl). (Source: VLF-EM field resistivity data)

Box 1: Recommended standard of practice: Groundwater development at Jimo

1. Install a monitoring tube in the drilled intake to allow regular water-level measurement, as required for final pumping-equipment installation.
2. Install clay or cement seals in the annular space between the borehole wall and metal casing to safeguard against contaminant movement.
3. Install screens only at the deeper aquifers, using plasma-slotted pipes with enhanced slot density to improve the lifespan of the bore.
4. Pumping Test for at least 10 hours of step testing at 2-hour intervals, followed by a constant-rate test of 30 hours.
5. Use a rotary drilling plant to attain the recommended 150 m drill depth, with rock samples logged at 2 m intervals. Drilling could be done using a nominal diameter of 203 mm (8') with a nominal casing diameter of 153 mm (6').
6. Take particular care with well completion and development — an aspect too often neglected in Kenyan borehole construction — to avoid reduced yield and hydraulic efficiency over the life of the well.
7. Define a Deepest Advisable Pumping Water Level (DAPWL) during screen design to avoid screen encrustation from air exposure.
8. Ensure full penetration of the deep Simbara Series aquifer sections to attain high, sustainable aquifer flows, since clays are common in the weathered sediments of this series.
9. Adopt controlled pumping after development; a limited abstraction capacity of at least 5.0 m³/hr is envisaged as the ultimate design yield, which is not considered excessive relative to the aquifer's capacity.

Discussion: lessons for water management across the LVB

The Jimo water resources assessment illustrates a replicable model: a community raises a specific water constraint, a transect walk and consultation clarify why surface water is not a viable option, and a targeted geophysical survey—identifies a borehole location and potential depth for drilling. This sequence matters in basement terrain, where surface geology gives little indication of the sub-surface weathering and fracture patterns that actually control yield (British Geological Survey 2024), and where the wider evidence base shows that properly targeted siting meaningfully improves borehole outcomes compared with undirected drilling (Olayinka 1992). Given the density of similar smallholder and community groups across the Kenyan LVB's basement terrain, this model is well suited to replication, provided each site receives its own survey rather than relying on generic regional assumptions. For the Jimo Aggregated Farm, the proposed borehole is expected to yield approximately 3–7 m³/hour, which should be sufficient to meet the estimated daily water requirement of 40 m³ for domestic use, irrigation, and the planned aquaculture unit.

Land degradation and erosion are basin-wide concerns, reducing infiltration and therefore the recharge that sustains shallow aquifers even as demand for groundwater rises. A borehole sited without paying attention to catchment condition risks drawing on a resource whose recharge is itself declining. The AoW1 program's pairing of groundwater development with integrated soil and water conservation is therefore well justified by the regional evidence: measures such as riparian buffer protection, reduced tillage near watercourses and controlled grazing (Mwanake et al. 2023) directly support the recharge on which sites like Jimo depend, and should be considered a complement to, not a substitute for, the borehole itself. Groundwater data for the Kenyan LVB remain fragmented, with catchment boundaries used for monitoring not aligned to aquifer extents (IGRAC 2025) and conceptual models for even well-studied areas such as the Nyando Basin still described as a first step towards fuller characterization (Mutua et al 2020). Site assessments such as Jimo's — particularly the transmissivity estimate, sounding data and water-quality results (to be done after drilling) generate exactly the kind of local aquifer data that regional models currently lack. Systematically compiling and sharing results from future community-scale assessments, ideally through the Water Resources Authority's regional groundwater database and in coordination with the LVBC's basin-wide monitoring ambitions (EEAS 2020), would allow individual site studies to accumulate genuine basin-scale knowledge rather than remaining isolated reports.

Conclusions and recommendations

The Kenyan sector of the Lake Victoria Basin combines regional water abundance with widespread local scarcity, driven by population growth, land degradation and increasingly variable rainfall acting on a basement-aquifer system whose productivity depends on weathering and fracturing rather than primary porosity. The Jimo Aggregated Farm case study demonstrates that this local scarcity can be addressed responsibly: a community-identified need, informed by the legal closure of the nearest surface source, was matched to a geophysically sited borehole recommendation (150 m bgl at Point 12, anticipated yield approximately 3–7 m³/hour, which should be sufficient to meet the estimated daily water requirement of 40 m³ for domestic use, irrigation, and the planned aquaculture unit. Groundwater quality to be checked during pumping test against WHO guideline values. On the basis of this synthesis, the following recommendations are made:

1. Groundwater exploration needs to align with catchment-level soil and water conservation measures on the farm and its immediate surroundings, to protect the recharge that will sustain the new source over time.
2. Where similar water-scarcity constraints are identified in other LVB communities, apply the same sequence — community consultation, desk study, targeted VLF-EM or

equivalent geophysical survey as aquifer conditions in basement terrain vary over short distances.

3. Over time, aggregate results from multiple community-scale assessments across the Kenyan LVB into a shared dataset to support both local water-security planning and the wider IWRM objectives coordinated by the Lake Victoria Basin Commission.

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