

WORKSHOP REPORT

The AI Water Project: Scenario Co-Development Workshop with the Limpopo Watercourse Commission (LIMCOM) and Partners

Maputo, Mozambique | April 16, 2026

Jai Clifford-Holmes, Hugo Retief, Nkateko Nicole Langa, and Mariangel Garcia Andarcia

September 2026



Authors

Jai Clifford-Holmes, Executive Director, Association for Water and Rural Development (AWARD), Hoedspruit, South Africa

Hugo Retief, Senior Manager – Software Innovation for Water Resources, International Water Management Institute (IWMI), Pretoria, South Africa, and Researcher and Development Manager, AWARD, Hoedspruit, South Africa

Nkateko Nicole Langa, Research Officer – Future Creative Technologies for Agricultural Innovation, International Water Management Institute (IWMI), Pretoria, South Africa

Mariangel Garcia Andarcia, Research Group Leader – Water Futures Data & Analytics (WFDA), International Water Management Institute (IWMI), Colombo, Sri Lanka

Author Contributions

Conceptualization: Jai Clifford-Holmes; Methodology: Jai Clifford-Holmes and Hugo Retief; Software: Hugo Retief; Validation: Hugo Retief and Jai Clifford-Holmes; Formal analysis: Jai Clifford-Holmes and Hugo Retief; Investigation: Jai Clifford-Holmes and Hugo Retief; Resources: LIMCOM; Data curation: Jai Clifford-Holmes and Hugo Retief; Writing – original draft: Jai Clifford-Holmes and Hugo Retief; Writing – review & editing: Jai Clifford-Holmes and Hugo Retief; Visualization: Jai Clifford-Holmes and Hugo Retief; Supervision: Mariangel Andarcia Garcia; Project administration: Nkateko Nicole Langa; Funding acquisition: Mariangel Andarcia Garcia.

Acknowledgments

This work was conducted under the CGIAR Accelerator for Digital Transformation. We would like to thank all funders who supported this research through their contributions to the CGIAR Trust Fund (www.cgiar.org/funders).

This work was conducted as part of the CGIAR AI Hub in Abu Dhabi – HydraFound: Global Hydrological Foundation Model Project. We would like to thank the International Affairs Office at the Presidential Court of the United Arab Emirates (UAE) for funding this work. The AI Water Project is being developed under the CGIAR AI Hub for Water, in partnership with IWMI, AI71 and other collaborators such as the American University of Sharjah (AUS), Association for Water and Rural Development (AWARD) and CGIAR Accelerator for Digital Transformation, with support from the UAE-Gates AI for Agriculture Ecosystem. We extend our appreciation to the Limpopo Watercourse Commission (LIMCOM) for their ongoing partnership in advancing transboundary water resource management across the basin.



CGIAR Accelerator for Digital Transformation

Digital Transformation “co-creates inclusive solutions leveraging advancements in AI, machine learning, modeling and big data analytics” to improve decision-making across food, land and water systems. It supports responsible, AI-enabled research and digital services that help partners design evidence-based policies, investments and innovations for climate-resilient development.

Citation

Clifford-Holmes, Jai, Hugo Retief, Nkateko Nicole Langa, and Mariangel Garcia Andarcia. 2026. *The AI Water Project: Scenario Co-Development Workshop with the Limpopo Watercourse Commission (LIMCOM) and Partners*. International Water Management Institute (IWMI).



© 2026 International Water Management Institute. Some rights reserved. This work is licensed under a Creative Commons Attribution 4.0 International License (CC BY 4.0).

Front cover photos: Workshop participants and facilitators interacting over the course of the workshop on April 16, 2026 in Maputo, Mozambique (*photo*: Gold Services Moz).

Back cover photo: Group photo from the April 16, 2026 workshop in Maputo, Mozambique (*photo*: Gold Services Moz).

Disclaimer

This publication has been prepared as an output of the CGIAR Accelerator for Digital Transformation and has not been independently peer reviewed. Responsibility for editing, proofreading, and layout, opinions expressed, and any possible errors lies with the authors and not the institutions involved. Boundaries used in the maps do not imply the expression of any opinion whatsoever on the part of CGIAR concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Borders are approximate and cover some areas for which there may not yet be full agreement.

Contents

Acronyms and Abbreviations	4
The AI Water Project	5
1. Introduction	7
2. Workshop Design	9
3. Workshop Overview	11
4. Strategic and Technical Framing	13
5. Priority Water Management Questions	20
6. Data Availability, Institutional Contributions, and Data Gaps	23
7. Scenario Prioritisation	25
8. Scenario Specification	29
9. User Journey and Interface Design	31
10. Key Findings and Implications	38
11. Recommended Next Steps	40
12. Conclusion	42
13. References	43

Acronyms and Abbreviations

Acronym	Description
AI	Artificial Intelligence
AUS	American University of Sharjah
AWARD	Association for Water and Rural Development
CGIAR	Consultative Group on International Agricultural Research
DT	Digital Twin
GIS	Geographic Information System
GloFAS	Global Flood Awareness System
GWP-SA	Global Water Partnership Southern Africa
HEC-HMS	Hydrologic Engineering Center – Hydrologic Modeling System
IAHS	International Association of Hydrological Sciences
IWMI	International Water Management Institute
KGE	Kling-Gupta Efficiency
LIMCOM	Limpopo Watercourse Commission
LRB	Limpopo River Basin
LULCC	Land use and land cover change
NSE	Nash-Sutcliffe Efficiency
SAHS	South African Hydrological Society
SCADA	Supervisory Control and Data Acquisition
SDG	Sustainable Development Goals
SSP	Shared Socioeconomic Pathway
SWAT	Soil and Water Assessment Tool
UAE	United Arab Emirates
UN Water 2026	2026 United Nations Water Conference
WaterCopilot	Limpopo WaterCopilot conversational decision-support tool

Executive Summary

The **AI Water Project Scenario Co-Development Workshop** was held in Maputo, Mozambique on **April 16, 2026**, convened by the International Water Management Institute (IWMI) in partnership with the Limpopo Watercourse Commission (LIMCOM), with support from the Association for Water and Rural Development (AWARD) and Global Water Partnership Southern Africa (GWP-SA). The workshop brought together technical representatives from the four LIMCOM Member States (Botswana, Mozambique, South Africa and Zimbabwe) to engage with the emerging AI Water Project initiative, as part of a two-day workshop process linked to the Limpopo Digital Twin ecosystem.

The AI Water Project is being developed under the **CGIAR AI Hub for Water**, in partnership with IWMI, AI71 and other collaborators, with support from the **UAE-Gates AI for Agriculture Ecosystem**. Its aim is to accelerate and improve basin-scale hydrological modelling by combining SWAT+ with AI-enabled data ingestion, model setup, calibration, scenario orchestration and decision-support interfaces. The Limpopo River Basin has been selected as a primary Southern African proof-of-concept because it combines transboundary governance relevance, significant hydrological variability, existing LIMCOM institutional structures, and an emerging digital water-management ecosystem through the Limpopo Digital Twin and WaterCopilot. The pilot is also strategically linked to the pathway toward the **2026 United Nations Water Conference**, where the project aims to demonstrate AI-enabled water modelling and decision-support capabilities.

The Day 2 workshop was designed as a structured co-design process rather than a conventional technical presentation. Participants were first introduced to the AI Water Project proposition, the UN Water 2026 alignment, the Limpopo proof-of-concept, progress on automated SWAT+ model setup, and initial calibration results. The workshop then moved through a "scenario funnel": participants identified priority water-management questions, reviewed a bounded catalogue of climate and land use / land cover change scenarios, shortlisted and scored candidate scenarios, provided initial specification inputs, and reflected on user journey and interface-design needs.

Participants' priority management questions were strongly decision-oriented. They focused on water availability and allocation, climate variability, drought and flood risk, water quality and pollution, sedimentation and land degradation, and transboundary cooperation and data sharing. These questions confirmed that future modelling work should be grounded in practical institutional needs, including reservoir operations, environmental flows, groundwater recharge, seasonal forecasting, irrigation demand, sediment loads, water quality risks and shared basin planning.

The workshop also confirmed that Member State institutions hold many datasets that could strengthen model calibration, validation and scenario parameterisation. These include hydrological time series, dam and reservoir data, water quality records, spatial datasets, groundwater information, rainfall data, sediment and siltation records, and operational information. However, participants also highlighted important constraints, including data gaps, institutional approval requirements, access restrictions, format variability, missing gauges, telemetry limitations and national data confidentiality policies. Data availability is therefore both a major opportunity and a key constraint for the next phase of work.

Within the bounded scenario catalogue, the **mid-range climate pathway (SSP2-4.5)** emerged as the clearest climate-related planning scenario. Among the land use/land cover change (LULCC) options, **urban expansion** received the strongest support in the initial shortlisting, while **deforestation / land degradation** scored strongly in relation to impact and value. **Agricultural expansion and irrigation conversion** was recognised as important for water allocation and competing demand, but may require further data scoping before it can be treated as demonstration-ready. **Reforestation and catchment restoration** remains valuable as an intervention-oriented scenario, but is likely better positioned as a paired or second-phase scenario alongside degradation-focused modelling.

The **user journey** findings reinforced the AI Water Project's two-persona design logic. The project identifies the technical basin modeller as the primary early user and the decision-maker or policy analyst as a secondary but important user group. Workshop responses confirmed that technical users need credible modelling workflows, transparent data inputs, calibration information, exportable results and scenario-comparison tools. Management and policy-facing users need maps, dashboards, concise summaries, automated reports, uncertainty explanations and outputs that can be used in planning and transboundary governance settings. Participants also placed strong emphasis on natural-language querying, side-by-side scenario comparison, current-status visualisation, uncertainty communication, and outputs that can be converted into reports, presentations and decision briefings.

The main finding of the workshop is that AI-supported hydrological modelling will be most valuable where it reduces real bottlenecks in current workflows: slow model setup, difficult calibration, fragmented data, delayed access to information, limited scenario comparison, and the difficulty of translating technical outputs into decision-ready products. However, the workshop also highlighted that credibility will depend on human validation,



institutional trust, transparent assumptions, uncertainty communication, and continued Member State involvement.

The report recommends that the next phase should focus on a small, feasible Tier 1 scenario package, beginning with the strongest candidates from the workshop. These should be converted into one-page scenario briefs, linked to a structured data request matrix, and reviewed with LIMCOM Member State data custodians. The report also recommends extending engagement to the wider Southern African hydrological sciences community through a proposed virtual workshop and pre-conference workshop / special session. These engagements would provide structured expert feedback on the AI-augmented SWAT+ workflow, calibration rigour, uncertainty treatment, process fidelity and decision-support framing.

Overall, the workshop provided an important first step in grounding the AI Water Project's technical proposition in a Limpopo Basin scenario agenda informed by LIMCOM and Member State priorities. The Limpopo pilot should now proceed as a staged co-development process: confirm a manageable scenario package, mobilise required data, produce early prototype outputs, test those outputs with intended users, refine dashboard and reporting functions, and align the demonstration pathway with UN Water 2026. If sustained, this process can position the Limpopo pilot as a credible example of how AI-augmented hydrological modelling can support transboundary water governance, scenario-based planning and evidence-informed decision-making.

Introduction

The International Water Management Institute (IWMI), a research for development organization focusing that works with governments, civil society and the private sector to solve water problems in developing countries and scale up solutions hosted the *Limpopo Digital Twin- HydraFound: Capacity Building, Testing and Scenario Co-Development* workshop from 15-16 April 2026 in Maputo, Mozambique in partnership with the Limpopo Watercourse Commission (LIMCOM) and supported by the Global Water Partnership South Africa (GWP-SA) and the Association for Water and Rural Development (AWARD). During a series of interactive sessions attended by national water authority representatives from Botswana, Mozambique, South Africa and Zimbabwe IWMI showcased and trained participants on the latest advancements in digital tools such as the water accounting dashboard, Digital Twin (DT) and water-copilot, co-designed scenarios that these tools could address in the future; introduced the Artificial Intelligence (AI) project to advance the current DT system and mapped milestones to achieve their goals for the next iteration of the project.

1.1. Background to the AI Water Project and the Limpopo Pilot

The AI Water Project is being developed under the **CGIAR AI Hub for Water**, in partnership with IWMI, AI71 and other collaborators, with support from the UAE-Gates AI for Agriculture Ecosystem. At the time of the workshop, the project was working under the name **HydraFound**, although this name was understood as provisional. For the most part, in this workshop report we will refer to the 'AI Water Project'.

The AI Water Project is developing an AI-augmented hydrological modelling framework that combines the physically based SWAT+ model with artificial intelligence methods for data ingestion, model setup, calibration, transfer learning and scenario orchestration. Its overarching aim is to reduce the time and technical effort required to build, calibrate and apply basin-scale hydrological models, especially in regions where water management decisions are urgent but data availability, modelling capacity and monitoring infrastructure remain uneven.

The project responds to a persistent challenge in water resources planning: conventional hydrological modelling is often slow, specialist-driven and difficult to scale. As presented in the project's internal Steering Committee materials, current hydrological modelling workflows can take approximately a year, with substantial time required for data collection and harmonisation, catchment delineation, model setup, calibration, validation and scenario simulation. The AI Water Project seeks to shorten this process from years to months by automating key steps, including standardised data ingestion, basin setup, AI-assisted calibration, uncertainty quantification, scenario execution and decision-dashboard generation.

The Limpopo River Basin has been selected as the primary Southern African proof-of-concept basin for this work. This selection reflects both technical and institutional considerations. The basin is shared by Botswana, Mozambique, South Africa and Zimbabwe, making it highly relevant to transboundary water governance. It is also climatically variable, exposed to floods and droughts, and subject to increasing pressures from population growth, agricultural expansion, land-use change and climate change. At the same time, the basin already has an established institutional platform through LIMCOM and an emerging digital ecosystem through the Limpopo Digital Twin, WaterCopilot and citizen science integrations. These features make the Limpopo Basin a suitable test case for demonstrating how AI-supported hydrological modelling can support both technical analysis and cooperative decision-making.

The Limpopo pilot is also strategically linked to the **2026 United Nations Water Conference**, to be hosted by the United Arab Emirates and Senegal in December 2026. The April 2026 workshop was designed as an early co-development milestone on the pathway to that demonstration. Its purpose was not only to introduce LIMCOM and Member State representatives to the AI Water Project, but also to begin defining a practical Limpopo scenario library: a set of management-relevant modelling scenarios that can be parameterised, tested and demonstrated through the project. In this sense, LIMCOM and its Member States are not simply future users of the system; they are co-design partners whose institutional knowledge, data holdings and decision priorities are essential to making the Limpopo pilot credible, useful and policy-relevant.

1.2. Purpose of the Day 2 Workshop

The workshop was attended by selected member state representatives across the LRB, mostly who had prior engagement with the demo versions. They were technical experts from varying fields ranging from aquatic scientists, data analysts, hydrologists and engineers.

Day 1 of the workshop covered the full suite of operational tools that together constitute the LIMCOM digital water monitoring information system (including the Digital Twin, WaterCoPilot, and MiniSASS). These tools have been developed across multiple funding streams and partnerships, and the workshop brought them together for the first time in a single structured capacity building event, which also functioned as a formal launch. Day 2 of the workshop – the focus of this report – was designed to move from platform familiarisation to **scenario co-**

development. Whereas Day 1 focused on the operational Limpopo Digital Twin ecosystem, Day 2 focused specifically on introducing LIMCOM and Member State representatives to the AI Water Project / HydraFound initiative and beginning the process of defining a Limpopo scenario library for future model development. The workshop was therefore structured around a practical question: what kinds of water-management decisions should the next generation of AI-supported hydrological modelling tools help LIMCOM and its Member States to address?

The Day 2 process had three linked purposes:

1. It introduced participants to the AI Water Project's modelling proposition, including automated data preparation, SWAT+ model setup, AI-assisted calibration, scenario orchestration, and future dashboard and natural-language interface development;
2. It created a structured process for participants to articulate priority management questions, identify relevant spatial scales and planning horizons, and indicate which datasets their institutions might be able to contribute; and finally,
3. It facilitated a scenario prioritisation and specification process, intended to distinguish between scenarios that could plausibly be developed as part of the December 2026 UN Water Conference demonstration and those that should be retained as a longer-term development backlog.

In this sense, Day 2 was not a conventional consultation or technical presentation. It was a co-design exercise intended to ensure that the Limpopo pilot is shaped by the institutions that manage the basin. LIMCOM and its Member States hold the contextual knowledge, policy mandates, operational constraints and data resources needed to make scenario modelling meaningful for transboundary water governance. The workshop therefore sought to translate institutional priorities into model-relevant inputs: priority decisions, candidate scenarios, indicators, data requirements, feasibility constraints, user-journey needs and follow-up commitments. These outputs provide an initial bridge between the technical development of the AI Water Project and the practical decision-support needs of the Limpopo River Basin.

1.3. Purpose and Scope of this Report

This report documents the design, implementation, outputs, and implications of the AI Water Project Scenario and User Journey Co-Design Workshop held in Maputo on 16 April 2026. It complements the separate user-needs synthesis report (Clifford-Holmes, 2026) by providing the formal workshop record, including the agenda, participant profile, co-design methodology, scenario prioritisation results, user-journey findings, and recommended next steps for the AI Water Project and Limpopo Digital Twin ecosystem.

2. Workshop Design

The workshop was designed as a structured co-design process rather than a conventional presentation or consultation. Its purpose was to move participants from a shared understanding of the AI Water Project and Limpopo pilot toward practical inputs that could inform model development, including:

- priority management questions,
- candidate scenarios,
- scenario scores,
- data requirements,
- user journey needs, and
- next-step commitments.

The design therefore followed a deliberate progression from strategic framing to practical specification, ensuring that scenario development was anchored in real water-management decisions rather than generic modelling possibilities.

2.1. Objectives

The Day 2 workshop had seven linked objectives:

1. Introduce LIMCOM Member State representatives to the AI Water Project initiative, including its modelling approach, core datasets, emerging architecture and relevance for Southern African water management.
2. Position the Limpopo River Basin as the primary Southern African proof-of-concept for the AI Water Project, including the pathway from April 2026 co-design to a curated scenario library for demonstration at UN Water 2026.
3. Ground the co-design process in practical water-management priorities, with participants identifying the decisions, planning questions and institutional challenges that future modelling scenarios should help address.
4. Shortlist and prioritise candidate modelling scenarios using a simple rubric that considered relevance, impact, feasibility, data readiness and time-to-demo.
5. Specify high-priority scenarios in terms of management question, spatial focus, planning horizon, key indicators, data requirements, technical constraints and likely implementation feasibility.
6. Gather user journey and interface-design inputs for the future scenario dashboard and AI-enabled interface, including how users would access, interpret and communicate model outputs.
7. Identify institutional datasets, constraints and follow-up commitments needed to support calibration, validation, scenario parameterisation and review cycles between April and December 2026.

2.2. Workshop Process

The workshop process followed a “scenario funnel” structure. It began broadly, with strategic and technical framing, and progressively narrowed toward a smaller set of decision-relevant, technically feasible and implementation-ready scenarios. This funnel was important because the AI Water Project has the potential to support many different kinds of hydrological analysis, but the Limpopo pilot needed to identify a manageable set of scenarios that could realistically be developed, reviewed and demonstrated within the UN Water 2026 preparation timeline.

The process moved through six main steps:

Step 1: participants were introduced to the broader strategic context – the AI Water Project, the Limpopo Basin proof-of-concept, the relationship between HydraFound and the existing Limpopo Digital Twin ecosystem, and the planned UN Water 2026 demonstration. This framing helped position the workshop as part of a wider development pathway rather than a stand-alone event.

Step 2: participants were asked to identify their own priority water-management questions. This step was designed to ensure that the scenario process began with institutional decision needs rather than with pre-defined technical outputs. Participants were asked what they needed to know to make water-management decisions, where in the basin each question was relevant, and what planning horizon applied.

Step 3: participants reviewed a curated scenario catalogue. The catalogue focused on scenario categories that were both decision-relevant and technically plausible within the emerging HydraFound/SWAT+ modelling framework, particularly climate change scenarios and land use / land cover change scenarios. This provided enough structure to keep the workshop grounded in feasible model-development pathways, while still allowing participants to adapt and prioritise scenarios according to Member State needs.

Step 4: participants shortlisted and scored candidate scenarios. The scoring approach was deliberately simple, using criteria such as transboundary relevance, national relevance, impact or value, feasibility and data readiness. This allowed the group to distinguish between scenarios that were highly relevant but difficult to implement immediately, and those that were both important and potentially achievable within the December 2026 demonstration window.

Step 5: the workshop moved from scenario prioritisation to scenario specification. For high-priority scenarios, participants considered the management question, spatial focus, time horizon, indicators, data needs, constraints and likely feasibility. The user journey component then considered how future users would run scenarios, interpret outputs, compare results, and communicate findings through dashboards, reports, maps, charts or natural-language AI interfaces.

Step 6: the final step in the workshop was the user journey component, which considered how future users would run scenarios, interpret outputs, compare results, and communicate findings through dashboards, reports, maps, charts or natural-language AI interfaces.

This design reflected the underlying principle that a hydrological scenario is only useful if it is connected to a real decision, supported by credible data, interpretable by intended users, and feasible within the available technical and institutional constraints. The resulting workshop outputs therefore provide both a record of participant priorities and a practical input into the next phase of AI Water Project development.

3. Workshop Overview

3.1. Workshop Specifics

The workshop was held on the **16th April 2026** in Maputo, Mozambique, with the following details:

- The venue was the Tivoli Hotel, Maputo;
- The format was as a hybrid workshop (but all active participants present in person);
- Hosted by LIMCOM Secretariat and IWMI;
- Funded through the CGIAR AI Hub for Water / UAE-Gates AI for Agriculture Ecosystem;
- Target audience was LIMCOM Member State technical representatives from Botswana, Mozambique, South Africa, Zimbabwe, and LIMCOM Secretariat staff.

3.2. Summary of the Workshop Agenda

The Day 2 agenda was designed as a progression from strategic framing to practical co-design. The morning introduced the AI Water Project, its alignment with UN Water 2026, and progress on the Limpopo Basin proof-of-concept. Subsequent sessions translated this framing into discussion of management questions, data needs and scenario requirements, before moving into afternoon working sessions on scenario prioritisation, user journey mapping and the April–December 2026 roadmap. A summary version of the Day 2 agenda is provided in Table 1.

Table 1. Workshop agenda (summarized version).

Time	Session	Lead
	Opening	
08:30	Registration and Technical Setup	IWMI
09:00	Welcome and Day 2 Purpose	LIMCOM
	AI Water Project: Project Overview	
09:15	The SDGs, UN Water 2026, and the 6 Interactive Dialogues	IWMI
09:30	AI Water Project: What it is and How it Works	IWMI
09:50	Data Pipelines and Basin Setup	IWMI
10:15	Morning Tea	
	Limpopo Basin Pilot: Progress to Date	
10:30	Initial Calibration Results	IWMI
10:50	Discussion: decisions, challenges, results and implications	IWMI
11:15	Scenario framework: what AI Water Project needs to run a scenario	IWMI / AWARD
12:00	LUNCH	
	Limpopo Scenario Co-Development / Co-design	
13:00	Working Groups for scenario development	IWMI / AWARD
14:00	Plenary consolidation: agreeing upon the Limpopo Scenario Framework	IWMI / AWARD
15:15	Afternoon Tea	
15:30	User Journey and Feature Mapping	IWMI / AWARD / ai71
16:00	Commitment and milestone roadmap for April – Dec. 2026	IWMI
16:20	Two-day Closure	LIMCOM

Source: authors' creation

3.3. Participant Profile

Nine professionals representing institutions from all four LIMCOM Member States – Botswana, Mozambique, South Africa, and Zimbabwe – participated in the workshop (Table 2), with the participants including hydrologists, engineers, scientists, analysts, and managers, illustrative of the project goal that the intended user group spans both technical specialists and individuals with broader coordination or management responsibilities.

Table 2. Workshop participants

Country	Institutions represented	Roles represented
BW Botswana	Department of Water and Sanitation; Water Utilities Corporation	Water resources engineer; hydrologist
MZ Mozambique	National Directorate for Water Resources Management; ARA-Sul	Hydrologist; hydraulic engineer; basin division manager
ZA South Africa	Department of Water and Sanitation	Scientist; LIMCOM focal point/coordinator
ZW Zimbabwe	National Department of Water Resources Development and Utilisation	Hydrologist; hydrological data analyst

Source: authors' creation

Although the respondent group was small, it reflected the institutional diversity likely to matter for future uptake of these tools: national departments, basin authorities, utilities, and transboundary governance structures. This is particularly relevant given that user needs are shaped by institutional position and decision context, and not just technical function or roles. Recognising this, the April 2026 workshop was designed to engage a set of overlapping technical and governance roles, in a transboundary context, rather than a homogenous user profile.

3.4. Workshop Presenters, Facilitators, and Speakers

The workshop presenters, facilitators and speakers were from a number of partner organizations, with representatives of the funder participating, as well as multiple international partners (see Table 3 for details).

Table 3. Workshop presenters, facilitators and speakers.

Name	Organization	Position	Presentation / Role
Sergio Siteo	Limpopo Watercourse Commission (LIMCOM)	Executive Secretary	Welcome and Closure
Dr. Mariangel Andarcia Garcia	International Water Management Institute (IWMI)	Research Group Leader for Water Futures Data and Analytics	Facilitator
Ian Overton		Director of Water Data Science and Country Director – Sri Lanka	The Scaling Challenge for Digital Twins
Shatha Alaydaroos	UAE Presidential Court	Project Study and Development Specialist, International Affairs Office	Introduction
Dr. Hosni Ghedira	American University of Sharjah (AUS) and AI71	Director of GeoAI and Spatial Intelligence Center (AUS); Senior Advisor AI & Water (AI71)	The AI Water Project
Dr. Jai Clifford- Holmes	Association for Water and Rural Development (AWARD)	Executive Director	Scenarios facilitator
Hugo Retief	IWMI and AWARD	Technical Lead (IWMI); R&D Manager (AWARD)	Limpopo Basin: Progress to Date
Dr. Juan Carlos Sanchez Ramirez	IWMI	Research Group Leader for Water Governance and Political Economy	From Science to Decision: A Governance Framework for Digital Twin-Enabled Transboundary Water Management

Source: authors' creation

4. Strategic and Technical Framing

4.1. UN Water 2026 Alignment

The Day 2 workshop was framed not only as a Limpopo Basin scenario co-design exercise, but also as an early step toward the planned **UN Water 2026 demonstration**. The 2026 United Nations Water Conference will provide a major global platform for showcasing practical innovations that can accelerate progress on SDG 6 and strengthen water-related decision-making. Within this context, the Limpopo pilot is intended to demonstrate how AI-supported hydrological modelling, digital twins, scenario dashboards and natural-language interfaces can support more timely, transparent and decision-relevant water management in a complex transboundary basin.

This UN Water 2026 framing was important for the workshop design because it helped narrow the co-design process. Participants were not asked to generate an unlimited list of possible modelling applications. Instead, the workshop focused on scenarios that could speak to real management priorities in the Limpopo River Basin while also contributing to a globally relevant demonstration of AI-enabled water decision support.

The six interactive dialogue themes for UN Water 2026 provided a useful organising lens for this process. As shown in Figure 1, these themes span water and sanitation for people, economic development and the water-energy-food nexus, climate and environmental resilience, transboundary cooperation, multilateral water processes, and investment in water-related technology and capacity. This framing is relevant to the Limpopo Basin, where many of the workshop discussions cut across more than one theme: for example, climate change scenarios relate to **Water for Planet** and **Water for Cooperation**; irrigation and allocation scenarios relate to **Water for Prosperity** and **Water for Cooperation**; sedimentation, water quality and environmental flow scenarios relate to **Water for Planet** and **Water for People**; and the AI Water Project itself speaks directly to **Investments for Water**, through its emphasis on technology, innovation and capacity-building.



Figure 1. The six themes of the Interactive Dialogues at the 2026 UN Water Conference.
Source: IWMI 2026

Figure 1 establishes the global policy frame within which the Limpopo scenario co-design process was situated. It shows that the workshop was not simply about selecting technically feasible scenarios, but about identifying scenarios that could demonstrate how basin-scale AI and modelling tools may contribute to wider SDG 6 implementation, transboundary cooperation and evidence-based water investment. This alignment helped ensure that the scenarios emerging from the workshop would be relevant both to LIMCOM and its Member States, and to the broader international audience expected at UN Water 2026.

4.2. The AI Water Project Proposition

The AI Water Project was presented as a response to a practical bottleneck in basin-scale water planning, namely that while hydrological models are essential for decision support, they are often

- slow to set up,
- difficult to calibrate,
- dependent on specialist workflows, and
- hard for non-specialist decision-makers to access.

The project's core proposition is therefore to **accelerate and simplify the end-to-end hydrological modelling workflow** – from data ingestion and basin setup, through calibration and validation, to scenario simulation, visualisation and decision support. In practical terms, the project aims to compress the time and effort required for basin-scale modelling by automating or streamlining key steps, including data ingestion, model setup, calibration, scenario simulation and the production of reproducible decision-support dashboards.

A central feature of the project is that it is being designed for two related, but distinct, user groups – described here as ‘user personas’. The **primary persona** is the technical basin modeller: hydrologists, researchers and technical experts in ministries, basin authorities or universities who need to build, calibrate, validate and compare hydrological models more efficiently (Figure 2). For these users, the value proposition lies in reducing the time and effort required to prepare data, configure basin models, calibrate SWAT+ simulations, benchmark performance and produce transparent, reproducible outputs. The **secondary persona** is the decision-maker or policy analyst: non-specialist but domain-aware users who need to ask “what-if” questions, interpret scenario results, understand risks and use model outputs for planning, investment, policy and communication. For these users, the value proposition lies in turning complex model outputs into accessible maps, summaries, dashboards and conversational decision-support tools.

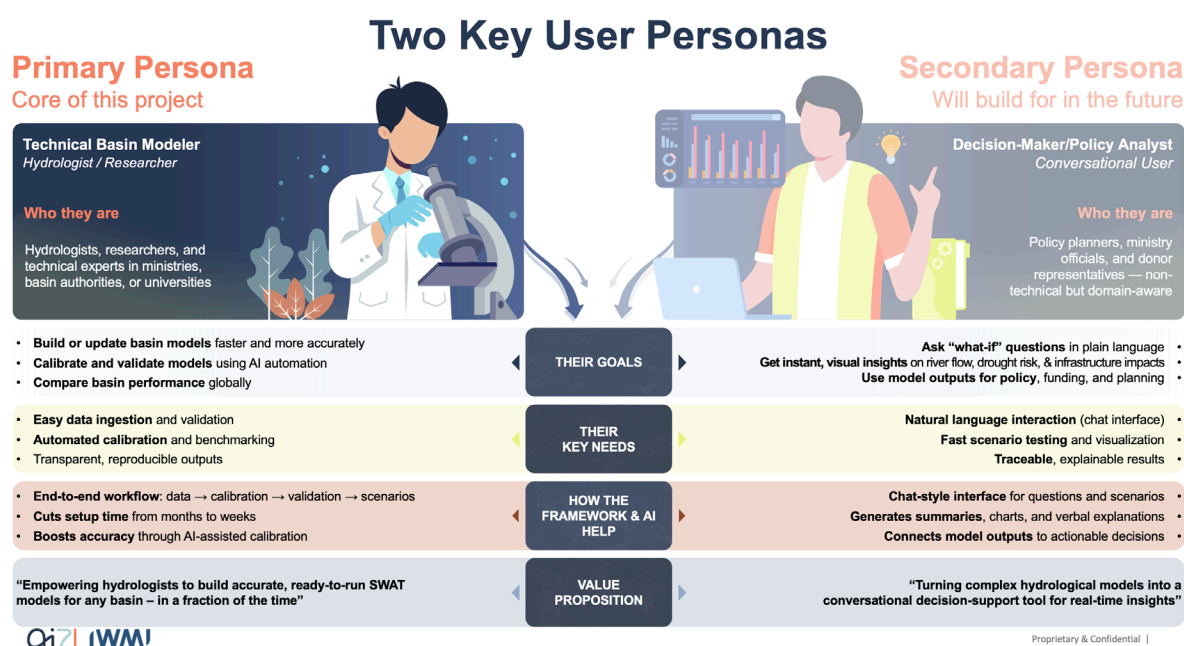


Figure 2. Key user personas.
Source: AI71 and IWMI (2026)

Figure 2 highlights an important design principle for the AI Water Project: the system needs to serve both the people who build and validate models, and the people who use model outputs to make or support decisions. This distinction is especially relevant in a transboundary basin context, where technical modelling work may sit within specialised units, while the resulting information must also support senior planners, policy advisers, basin managers and intergovernmental coordination processes.

The process diagram shown in Figure 3 summarises how the AI Water Project seeks to transform the hydrological modelling workflow. It presents the movement from fragmented source datasets through a data structuring and standardisation engine, into a physics-based SWAT+ hydrological model, and then into AI-augmented components such as a calibration engine, knowledge memory, SWAT emulator and scenario simulator.

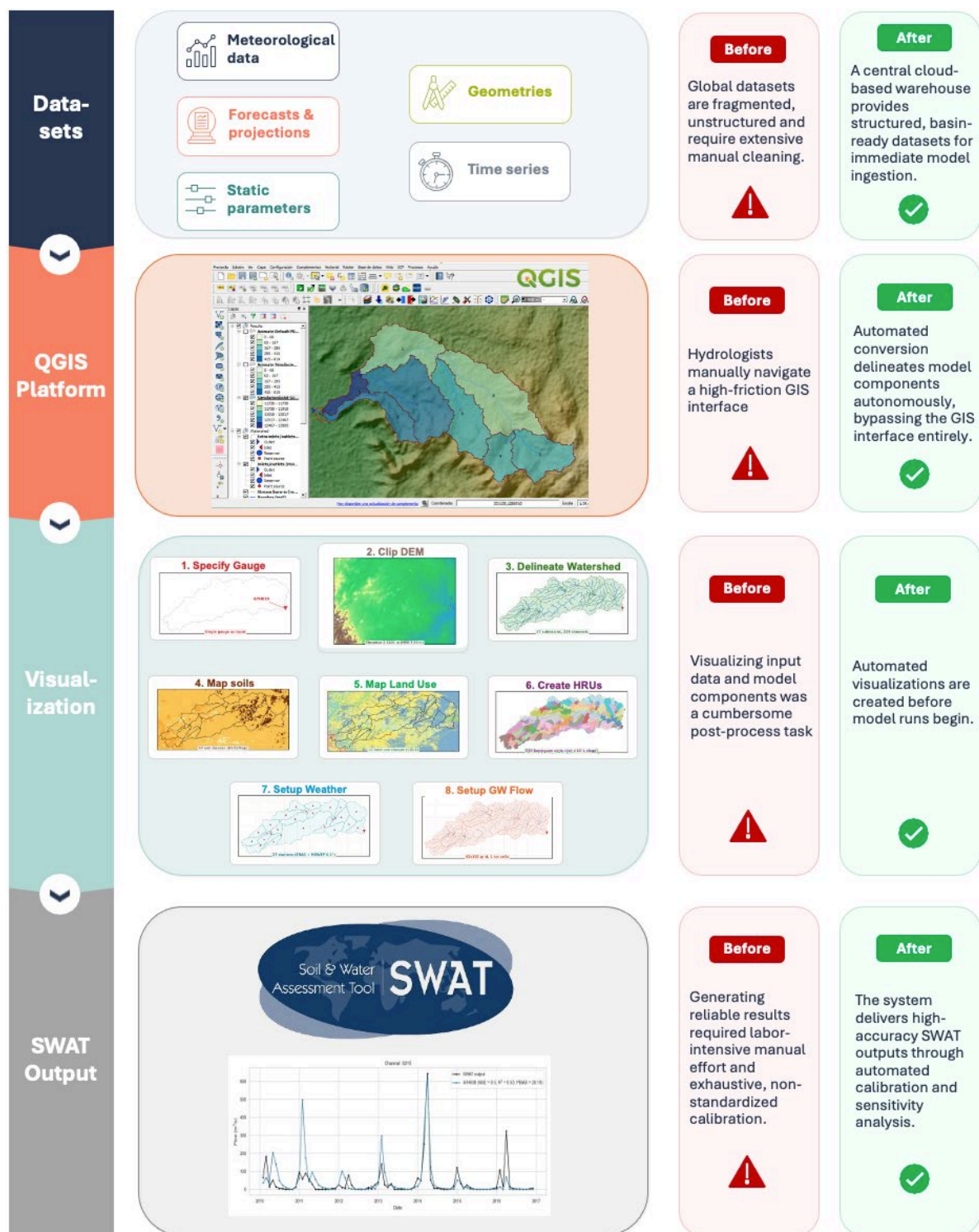


Figure 3. AI Water Project process diagram, showing the end-to-end workflow from data ingestion and SWAT+ model setup to AI-assisted calibration, scenario simulation, and decision-support dashboards.
Source: Adapted from Ai71 and IWM (2026)

These components are intended to support faster model setup, reuse of calibration knowledge, rapid scenario previews, uncertainty tagging, and delivery of outputs through a frontend dashboard. In practical terms, the diagram shows that the project is not replacing hydrological science with AI, but using AI to augment the steps that are currently slow, repetitive or difficult to scale.

This proposition shaped the Day 2 workshop in two ways:

1. It helped participants understand what kinds of scenarios could realistically be supported by the emerging modelling framework; and secondly,
2. It provided a basis for discussing user needs beyond the model itself: how scenarios should be requested, how results should be visualised, how uncertainty should be communicated, and how outputs should be made useful for technical analysis, policy discussion and transboundary decision-making.

4.3. Limpopo Basin Proof-of-Concept

The Limpopo River Basin (LRB) was selected as the primary Southern African proof-of-concept for the AI Water Project because it brings together the technical, institutional and policy conditions needed to test an AI-augmented hydrological modelling framework in a real-world, transboundary setting. It is also highly variable hydrologically, with recurrent drought and flood risks, significant agricultural and urban water demands, and growing pressures from land-use change and climate change. At the same time, the basin already has an operational digital water-management ecosystem through the Limpopo Digital Twin, WaterCopilot and citizen science integrations, as well as a recognised regional governance platform through LIMCOM. This combination makes the Limpopo both technically feasible and policy-relevant as a demonstration basin.

4.3.1. Why the Limpopo River Basin?

The workshop introduced how the LRB is the first real-world test of the AI-driven hydrological model. This framing was important because the AI Water Project is not being tested in an experimental setting, but in a basin where water-management decisions are operationally significant, institutionally complex and politically relevant. The Limpopo pilot therefore provides an opportunity to test whether automated data ingestion, SWAT+ model setup, AI-assisted calibration, scenario orchestration and dashboard-based decision support can be made useful for the institutions that manage a shared river basin.

In summary, the strategic relevance of the LRB is that it is, simultaneously:

- ⇒ data-rich enough to be technically feasible,
- ⇒ transboundary enough to be policy-relevant,
- ⇒ variable enough to test climate and flood/drought dynamics, and
- ⇒ sufficiently connected to an existing Digital Twin ecosystem to enable practical experimentation.

Figure 4 summarises this rationale visually, positioning the LRB pilot as a bridge between technical model development and applied transboundary decision support, showing why the basin is well suited to test both the hydrological modelling approach and the associated dashboard and generative AI interface with technical and policy-facing users.

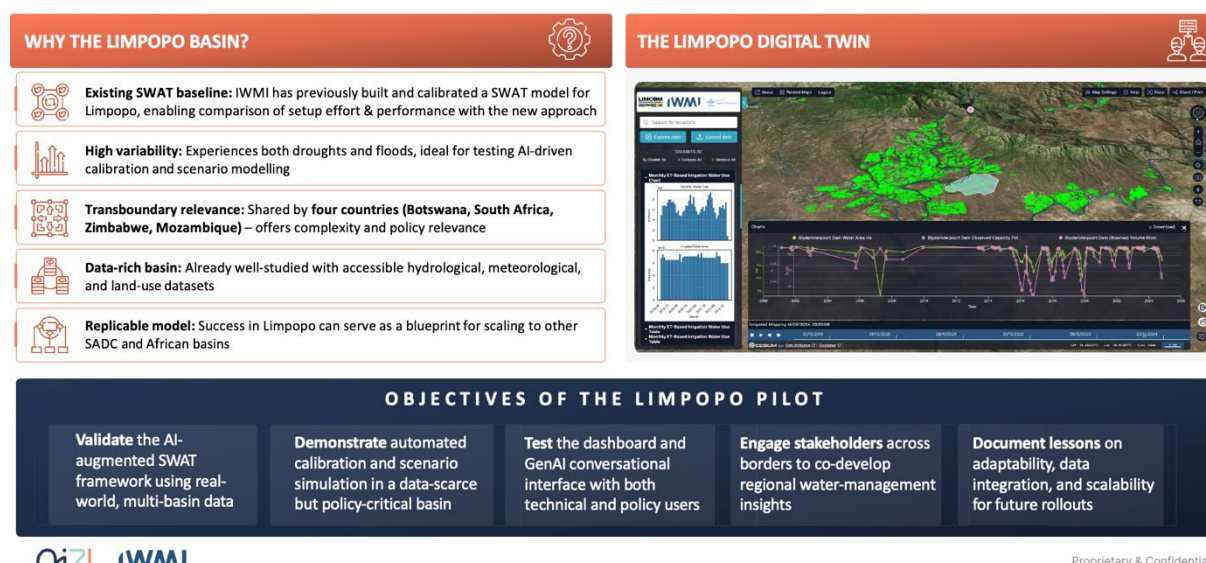


Figure 4. Motivation for the Limpopo River Basin to be the pilot for the AI Water Project.
Source: Adapted from: AI71 and IWMI 2026

4.3.2. SWAT model set-up

A central technical aim of the Limpopo pilot is to test whether key stages of the conventional SWAT+ model setup process can be automated and made more efficient. The project team has developed data preparation and modelling pipelines that reduce reliance on manual GIS workflows, including the high-friction steps typically associated with QGIS-based basin delineation and model configuration, described as a shift from fragmented global datasets and repetitive manual setup steps toward a structured cloud-based “basin-as-a-folder” data warehouse, automated spatial extraction, and model-ready inputs.

For the Limpopo proof-of-concept, the team executed an eight-step SWAT model setup process across two representative sub-basins. This included specifying gauge locations, clipping the digital elevation model, delineating the watershed, mapping soils, mapping land use, creating hydrological response units, setting up weather inputs and configuring groundwater flow (Figure 5).

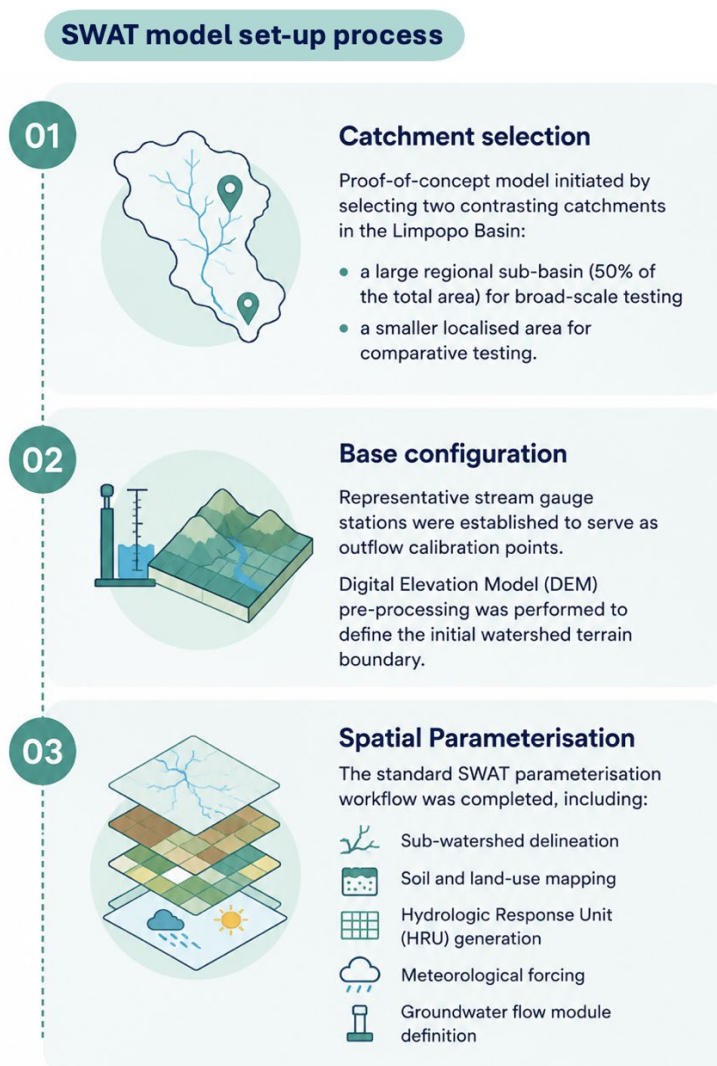


Figure 5. The set-up process followed to date, for the SWAT model component.
Source: IWMI 2026

This setup process is significant because it demonstrates the first layer of the AI Water Project’s value proposition: before AI-assisted calibration and scenario simulation can be useful, the underlying model must be built in a way that is faster, reproducible and scalable. Automating the setup process also creates a foundation for future transfer to other basins, where similar steps could be repeated with less manual effort and with clearer documentation of assumptions, inputs and model versions.

As noted above, the project team selected two proof-of-concept sub-basins, chosen to be representative, yet at contrasting scales: the first being a large, regional-level sub-basin and the second, a much smaller, localized basin. The two basins are introduced further in Figure 6.

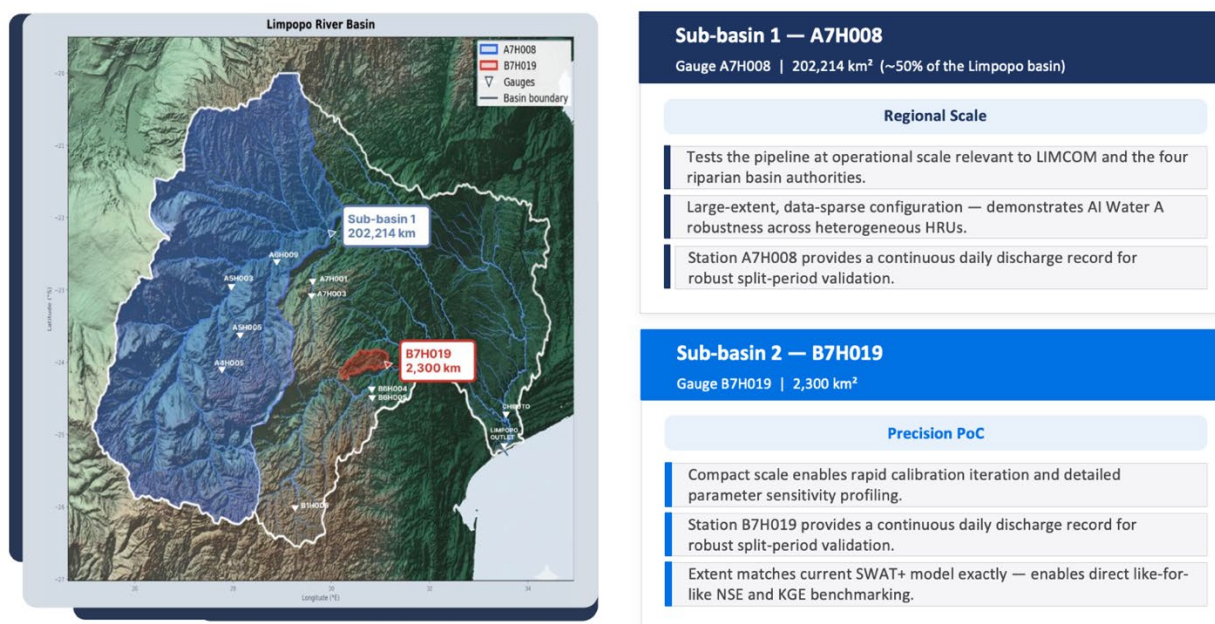


Figure 6. Overview of the two sub-basins selected for the initial proof-of-concept.

Source: Adapted from: AI71 and IWMI 2026

4.3.3. Initial calibration

The workshop also presented initial calibration results from the Limpopo proof-of-concept. These results are evidence that the automated pipeline is producing physically plausible and increasingly accurate simulations. The calibration process focused on improving the statistical fit between simulated and observed flows, using standard hydrological performance metrics, including:

- **Nash-Sutcliffe Efficiency (NSE):** a “predictive power” score measuring how much better the model is at forecasting flow than simply using the historical average.
- **Kling-Gupta Efficiency (KGE):** a comprehensive “fitness” score that balances the model accuracy in total volume, flow variability, and timing.

The initial calibration results are summarized in Figure 7, below, demonstrating how the automated pipeline was benchmarked against a baseline model. Even before full AI-based calibration, there are significant performance improvements relative performance relative to the baseline model:

- for the larger sub-basin, the SWAT+ model achieved **NSE of 0.78** and **KGE of 0.84** compared with baseline values of 0.50 and 0.64;
- for the second, much smaller sub-basin, the model achieved **NSE of 0.65** and **KGE of 0.82** compared with baseline values of 0.01 and 0.31 (see Figure 7).

These early results were important for the workshop because they helped ground the co-design discussion in a real technical development trajectory. They showed that the system had progressed beyond concept-stage architecture and had begun producing measurable modelling results in the Limpopo Basin. At the same time, the project team also acknowledged current limitations, including:

- that testing had so far been limited to two specific stations,
- that model performance remains dependent on the quality and availability of sub-basin and station data, and
- that transfer learning to ungauged sub-basins was still a planned rather, than fully operational, capability.

This balance between progress and limitation was useful for the scenario co-design process, because it helped participants distinguish between scenarios that may be feasible for near-term demonstration and those that will require further data, calibration or model development.



Figure 7. Calibration approach (left-hand panel) and calibration results (performance against baseline – right-hand panel). NSE = Nash-Sutcliffe Efficiency; KGE = Kling-Gupta Efficiency.
Source: AI71 and IWMI (2026)

5. Priority Water Management Questions

A central aim of the Day 2 workshop was to ensure that scenario development began with the **water-management decisions participants actually need to make or support**, rather than with pre-defined modelling outputs. Participants were therefore asked to identify up to three priority management questions from the perspective of their own institutions. For each question, they were also asked to indicate where in the basin the issue was relevant and what planning horizon applied. This helped connect each potential scenario to a specific decision context, spatial scale and time frame.

The responses showed that participants were not seeking abstract or generic hydrological analysis. Their questions were concrete and decision-oriented, covering issues such as seasonal water availability, dam operations, environmental flows, groundwater recharge, flood risk, water quality deterioration, sedimentation, land degradation, and transboundary cooperation (Figure 8). Several questions also pointed to the kinds of data and model outputs required to support decisions, including future flow projections, reservoir operation impacts, abstraction scenarios, nutrient loading, pollution hotspots, sediment yield estimates and erosion-control options. Taken together, the responses provide a practical basis for defining modelling scenarios that are relevant to Member State planning needs and to basin-wide decision support.

The specific management questions asked by participants are grouped into five categories, each of which is briefly described below.

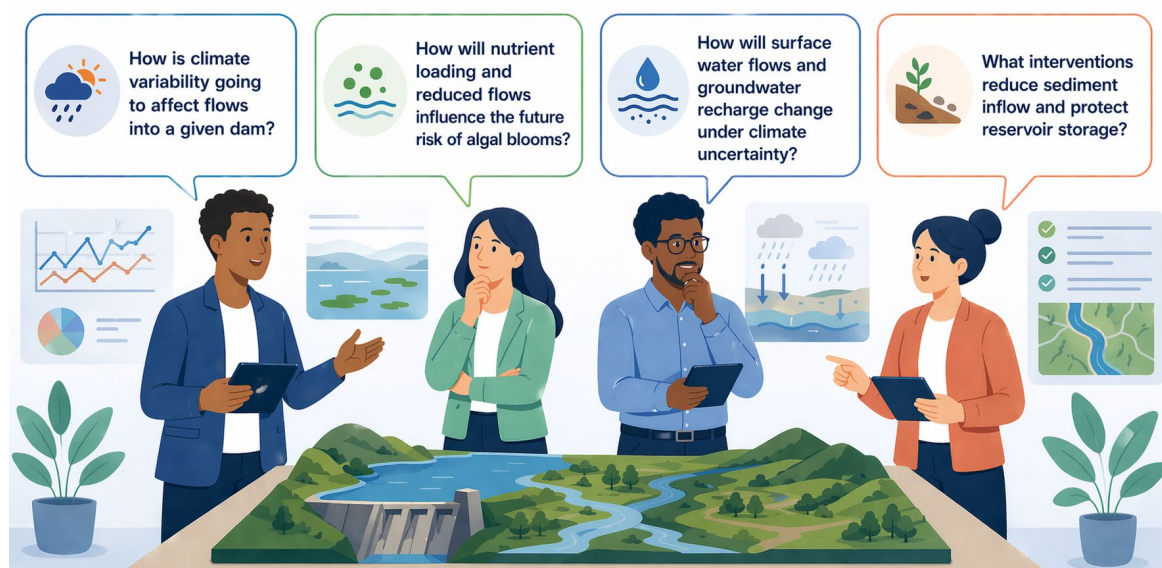


Figure 8. Examples of management questions asked by participants at the 16/04/2026 workshop in Maputo.
Source: IWMI (2026)

5.1. Water Availability and Allocation

Water availability and allocation emerged as a foundational concern across the responses. Participants raised questions about

- how much water is available in rivers, dams and wellfields;
- how much water is required or requested by users; and
- how water can be allocated efficiently and equitably among competing demands.

These questions are closely linked to operational reservoir management, seasonal water supply planning, environmental flow requirements, and longer-term adaptation to increasing demand.

Several responses framed water availability as a forward-looking planning challenge rather than only a current-status monitoring issue. For example, participants asked what combination of infrastructure investments and operational strategies (including reservoirs, transfers and conjunctive use) would ensure reliable water supply under increasing demand and climate uncertainty. Others linked water allocation directly to future development and land-use change scenarios, emphasising the need to maintain environmental flow requirements while also supporting domestic, agricultural and other water users.

For the AI Water Project, these questions point to the importance of scenarios and outputs that can estimate seasonal streamflow, dam inflows, reservoir storage, abstraction pressure, water balance changes and allocation

stress under different future conditions. They also suggest the need for tools that can compare trade-offs between water users and make the implications of allocation choices visible to both technical and policy-facing audiences.

5.2. Climate Variability, Drought, and Flood Risk

Climate variability and climate change were also prominent themes. Participants asked how climate change and variability will alter surface water flows, groundwater recharge, seasonal river flows, dam yields, drought duration and flood risk across different parts of the basin. These questions were raised at multiple planning horizons, from short-term seasonal forecasting to medium- and long-term planning for 2030, 2040 and beyond.

Some questions focused on **long-term water security**, asking what adaptation strategies would be needed if climate change reduces surface flows or groundwater recharge. Others were more **operational**, such as the need for accurate seasonal forecasts, estimates of expected dam yields, and warnings of possible spillway discharges. **Flood-related questions** also emerged, particularly around how dam releases, full reservoirs and intense rainfall events could be managed without increasing downstream flood risk.

These responses indicate that climate-related scenarios need to support both strategic planning and operational risk management. Useful outputs would include seasonal flow changes, dry-season baseflows, groundwater recharge estimates, drought and flood indices, flood peak changes, and reservoir inflow projections. They also suggest that uncertainty communication will be essential, because climate futures and seasonal forecasts need to be presented in ways that support decision-making without overstating precision.

5.3. Water Quality and Pollution

Water quality was a recurring management concern, raised both as a general basin-wide issue and in relation to specific pollution pressures. Participants asked

- what mechanisms or systems could be used to improve water quality across the basin,
- how nutrient loading and reduced flows might influence algal blooms, and
- what monitoring thresholds or interventions would be needed to protect downstream users and ecosystems.

The questions also pointed to the interaction between water quantity and water quality. Reduced flows can concentrate pollutants, increase water temperature effects, and worsen the frequency or severity of algal blooms. Participants noted that relevant analysis would require data on nutrient loading from agriculture, wastewater treatment works and mining; seasonal flow dynamics; water temperature trends; pollution hotspots; and the effectiveness of pollution reduction measures.

For scenario development, this suggests that water quality cannot be treated as separate from hydrological modelling. Even where the first generation of scenarios focuses primarily on flow and land-use drivers, the workshop findings indicate a need to connect future modelling outputs to water quality risks, pollution pathways and ecological consequences. This may be especially important for later phases of model development or for Tier 2 scenarios requiring additional local data.

5.4. Sedimentation and Land Degradation

Participants also identified sedimentation, land degradation and erosion as important decision-support needs. These concerns were linked to reservoir storage, catchment condition, mining impacts, agricultural land use and long-term water security. Questions included

- how land degradation and erosion may affect sediment loads and reservoir storage capacity, and
- which catchment interventions could most effectively reduce sediment inflows and protect infrastructure.

This theme is particularly important because it connects directly to the land-use and land-cover change scenarios explored later in the workshop. Land degradation, deforestation, poor land management, mining and catchment disturbance can all affect runoff, erosion, sediment transport and reservoir siltation. Conversely, restoration, reforestation and catchment rehabilitation scenarios may help test the potential benefits of interventions.

The modelling implications are clear: participants need outputs that can identify erosion hotspots, estimate sediment yield, assess likely reservoir storage impacts, and compare the benefits of different catchment-management responses. This makes sedimentation and land degradation a strong candidate theme for scenario specification, particularly where it can be linked to practical interventions such as conservation agriculture, rehabilitation of degraded areas, or targeted erosion-control measures.

5.5. Transboundary Cooperation and Data Sharing

Finally, several responses highlighted the importance of transboundary cooperation, shared data systems and improved hydrological information exchange. Participants noted the need for appropriate water management tools, better hydrological and climatological models, improved real-time monitoring networks, and stronger cooperation to facilitate data and information sharing across Member States.

This theme cuts across all the others. Water availability, climate risk, water quality, sedimentation and allocation questions all become more complex in a shared basin where upstream and downstream decisions affect one another. Participants' responses therefore reinforce the importance of developing tools that can support both national decision-making **and** basin-wide coordination.

For the AI Water Project, this means that scenario outputs need to be **transparent, interpretable** and **trusted** across institutions. The value of the Limpopo pilot lies not only in producing better technical simulations, but in creating a shared evidence base that can support

- cooperative planning,
- joint review of assumptions, and
- more consistent communication between Member States.

Taken together, the management questions show that participants were looking for scenario tools that support specific operational and planning decisions: how much water is likely to be available, where risks are emerging, how future change affects allocation and environmental flows, and what interventions may reduce future vulnerability. This provides the practical foundation for the scenario prioritisation and specification process described in the following sections.

6. Data Availability, Institutional Contributions, and Data Gaps

The scenario co-design process also asked participants to identify datasets that their institutions may be able to contribute to support model calibration, validation and scenario parameterisation. This was an important part of the workshop because the usefulness of AI-supported hydrological modelling depends not only on global datasets and automated workflows, but also on the availability of trusted local and national data. For the Limpopo pilot, Member State datasets are especially important for improving model credibility, grounding scenarios in observed conditions, and ensuring that outputs are relevant to operational and policy decisions across the basin.

The responses confirmed that the institutions represented in the workshop hold a wide range of potentially relevant datasets. These include hydrological time series, dam and reservoir data, water quality records, spatial datasets, groundwater information, rainfall data, sediment and siltation records, and operational information relating to infrastructure and water allocation. At the same time, participants also identified important constraints, including data gaps, access restrictions, institutional approval requirements, varying data formats, missing gauges and limits to telemetry coverage. These constraints do not prevent scenario development, but they do affect which scenarios can be treated as near-term priorities and which should be developed more cautiously or retained as longer-term options.

6.1. Potential Datasets Participants Could Contribute

Participants identified several categories of data that could support future calibration, validation and scenario development. These datasets are directly relevant to the management questions raised earlier in the workshop and to the scenario categories prioritised during the afternoon sessions.

Hydrological time series were among the most important data types identified. These include river discharge records, river levels, gauging-station data, inflow and outflow series, and other hydrometric records. Such datasets are central to model calibration and validation, particularly where the model needs to reproduce observed flow dynamics at specific stations, reservoirs or sub-basins.

Dam and reservoir data were also identified as a priority. Participants referred to dam levels, dam parameters, storage records, inflows and outflows, reservoir operation data and operation rules. These data are particularly important for scenarios concerned with water allocation, seasonal supply reliability, flood releases, reservoir yield, drought planning and infrastructure performance.

Water quality data were another important category. Participants referred to water quality monitoring records, pollution source data, compliance information and parameters such as nutrients, salinity, metals and biological indicators. These datasets are relevant to questions about deteriorating water quality, algal blooms, pollution hotspots, mining impacts and the relationship between reduced flows and water quality risks.

Spatial datasets were also identified, including land use, irrigation areas, mining activity, catchment boundaries and other GIS layers. These datasets are especially relevant to land use and land cover change scenarios, including urban expansion, agricultural expansion, deforestation, land degradation and catchment restoration. Spatial data can help define where scenario changes should be applied and how outputs should be interpreted across sub-basins or priority hotspots.

Participants also identified **sediment and siltation data**, including sediment loads and rates of siltation in rivers and reservoirs. These data are important for scenarios concerned with erosion, reservoir storage loss, land degradation, mining impacts and catchment rehabilitation. In addition, participants referred to **climate and rainfall data**, **groundwater levels**, **borehole abstraction datasets**, and other information relevant to recharge, conjunctive use and long-term water security.

These datasets suggest that Member States hold many of the data types needed to strengthen the Limpopo pilot. However, their availability for modelling purposes will depend on follow-up engagement with data custodians, clarification of formats and coverage, and agreement on what can be shared, under what conditions, and by when.

6.2. Data Constraints

The workshop responses also highlighted several constraints that will need to be addressed in the next phase of work. These constraints are not unusual in transboundary basin modelling, but they are important because they shape the feasibility, credibility and timing of different scenarios.

The first constraint is **institutional approval**. Several datasets are held by national departments, water authorities or utilities and may require formal permission before they can be shared. This is particularly relevant for hydrological time series, reservoir operation data, water quality records, groundwater datasets and infrastructure-related information.

The second constraint is **restricted access or confidentiality**. Some datasets may be governed by national data policies, internal institutional procedures, or sensitivity around infrastructure and operational decision-making. While these constraints do not necessarily prevent data use, they may require controlled access arrangements, data-sharing agreements, aggregation, anonymization or use within a restricted modelling environment.

The third constraint is **data completeness and quality**. Participants referred to data gaps, missing gauges, uneven monitoring coverage and calibration risks. These issues are especially important for scenarios that require local validation, such as reservoir operations, sedimentation, water quality, groundwater recharge or sub-basin-level flow projections. Where observed data are sparse or incomplete, outputs will need to include uncertainty ranges and clear caveats.

The fourth constraint is **format variability**. Datasets may exist in Excel, CSV, GIS shapefiles, databases, SCADA systems, Word documents or multiple other formats. This creates additional work for ingestion, cleaning, harmonization and quality assurance. It also reinforces the value of the AI Water Project's data-pipeline approach but does not remove the need for careful local validation.

The fifth constraint is **telemetry and monitoring limitations**. Participants noted the need for improved real-time hydro-climatological networks and better coverage of modern monitoring equipment. This matters because near-real-time or operational forecasting functions require more frequent and reliable data than long-term planning scenarios.

6.3. Implications for Calibration and Scenario Design

The data availability findings have direct implications for how the Limpopo scenario library should be developed.

Implication 1: Tier 1 scenarios should draw, wherever possible, on datasets that are already available through the HydraFound/IWMI data stack, the Limpopo Digital Twin ecosystem, and Member State datasets that are likely to be shareable within the project timeline. This is especially important given the December 2026 demonstration target.

Implication 2: not all high-priority scenarios will be equally ready for implementation. Scenarios such as mid-range climate change, urban expansion and broad land-use change may be more immediately feasible because they can draw on global or regional climate, land cover and hydrological datasets already being integrated into the AI Water Project workflow. By contrast, scenarios involving reservoir operations, water quality, sedimentation, groundwater abstraction or illegal mining impacts may require more local data, stronger institutional approval and additional calibration before they can be presented with confidence.

Implication 3 is that some scenarios should be designed with explicit uncertainty and data-readiness categories. Rather than excluding important but data-constrained scenarios, the project can distinguish between scenarios that are suitable for near-term demonstration and those that should be retained as Tier 2 or phased scenarios. This would allow the scenario library to reflect Member State priorities while remaining honest about what can be credibly modelled in the short term.

Implication 4 is that a structured post-workshop data request process is needed. For each proposed Tier 1 scenario, the project team should identify the minimum datasets required, the preferred formats, the relevant country or institutional custodian, known constraints, and the deadline by which the data would need to be available. This could be developed as a simple data request matrix linked directly to the scenario briefs proposed in [Section 10.2](#).

Overall, the workshop showed that data availability is not only a technical issue, but also an institutional and governance issue. The Limpopo pilot will depend on combining global datasets, Digital Twin infrastructure and Member State data contributions in a way that is transparent, auditable and trusted. This reinforces the importance of treating scenario development as a co-development process, not simply a technical modelling exercise.

7. Scenario Prioritisation

A major purpose of the Day 2 workshop was to begin translating Member State management priorities into an initial Limpopo scenario library for the AI Water Project. The workshop therefore introduced participants to a curated scenario catalogue, structured around scenario categories that were both relevant to the management questions raised by participants and technically plausible within the emerging modelling framework. The aim was not to finalise every scenario in detail during the workshop, but to identify which scenario types had the strongest combination of decision relevance, transboundary value, data readiness and feasibility for further development.

7.1. Scenario Catalogue Used in the Workshop

The scenario catalogue used in the workshop focused on two primary categories: **climate change scenarios** and **land use / land cover change scenarios**. These categories were selected because they correspond closely to the main drivers of future hydrological change in the Limpopo River Basin and because they can be represented within the modelling architecture being developed for the AI Water Project.

As shown in Figure 9, the climate change scenarios included three Shared Socioeconomic Pathway (SSP)-style futures: a low-emissions pathway, a mid-range pathway and a high-emissions stress-test pathway. These were intended to help participants think through how changes in rainfall, temperature, evaporation, seasonal flow patterns, groundwater recharge, drought duration and flood peaks could affect future water management decisions. The land use and land cover change (LULCC) scenarios focused on urban expansion, deforestation, reforestation or catchment restoration, and agricultural expansion or irrigation conversion. These scenarios were intended to explore how changes on the land surface may affect runoff, infiltration, sediment yield, evapotranspiration, recharge and water demand.

 Category 1 — Climate / SSP Pathways	 Category 2 — Land Use / LULCC Pathways
SSP1-2.6 Low-emissions pathway (best-case) <i>Rapid global decarbonisation scenario.</i> Simulates changes in seasonal streamflow, dry-season baseflows, groundwater recharge, drought frequency, and flood peak magnitude to 2050 and 2100.	<i>Doubles urban area and impervious surfaces.</i> Urban expansion Outputs: surface runoff increase, flood peak rise, infiltration loss, GW recharge shift (uses GHSL urban projections). No local data required.
SSP2-4.5 Mid-range pathway (most likely) <i>Most probable trajectory under current national climate commitments.</i> Models flow regime shifts, baseflow changes, drought duration, and rainfall timing at multiple planning horizons.	<i>Forest to cropland conversion.</i> Deforestation Outputs: sediment yield, ET regime shift, runoff increase, GW recharge loss (uses Hansen Forest Change dataset (30m)). No local data required.
SSP5-8.5 High-emissions stress test <i>Worst-case scenario for stress-testing infrastructure and governance.</i> Quantifies extreme flood peaks, prolonged drought duration, ET shifts, and GCM ensemble uncertainty to 2070/2100.	<i>Upstream catchment restoration.</i> Reforestation Outputs: sediment reduction, ET increase, runoff regulation, GW recharge recovery. Requires national reforestation boundaries as spatial input. <i>Rainfed to irrigated conversion.</i> Agricultural expansion Outputs: runoff change, ET shift, irrigation demand proxy. Requires member state data for crop-specific management schedules.

Figure 9. The two categories of scenarios explored in the workshop – Category 1 (climate change-related) on the left, and Category 2 (Land Use and Land Cover Change (LULCC)) on the right.

Source: IWMI 2026

The catalogue was deliberately bounded. Although many other scenario types are potentially relevant to the Limpopo River Basin – including infrastructure development, groundwater abstraction, water quality interventions, reservoir operations and policy or allocation scenarios – the workshop prioritized climate and land-use scenarios as the first stage of co-design. This allowed participants to work within a feasible technical frame while still addressing many of the management concerns raised earlier in the day, including water availability, climate variability, flood and drought risk, land degradation, sedimentation, agricultural expansion and long-term planning uncertainty.

Figure 9 therefore served as the bridge between the management questions identified by participants and the scenario prioritization process that followed. It translated broad concerns into a set of scenario families that could be discussed, shortlisted, scored and, where appropriate, specified for further development.

7.2. Scenario Selection Patterns

Participants were asked to shortlist the scenarios they considered most relevant to their institutional priorities and water-management questions. The results – summarized in Figure 10 – show a clear concentration of interest around a small number of climate and land-use scenarios, rather than an even spread across all options.

The strongest selection pattern was around urban expansion, which was selected by eight of the nine respondents. This suggests strong concern about how increasing impervious surfaces, settlement growth and urban water demand may affect runoff, flood risk, recharge and downstream water security. The mid-range climate pathway was also strongly supported, selected by seven respondents, indicating that participants saw this as the most useful climate planning scenario for current policy and operational decision-making. This is consistent with its role as a plausible planning trajectory rather than either a best-case or worst-case pathway.

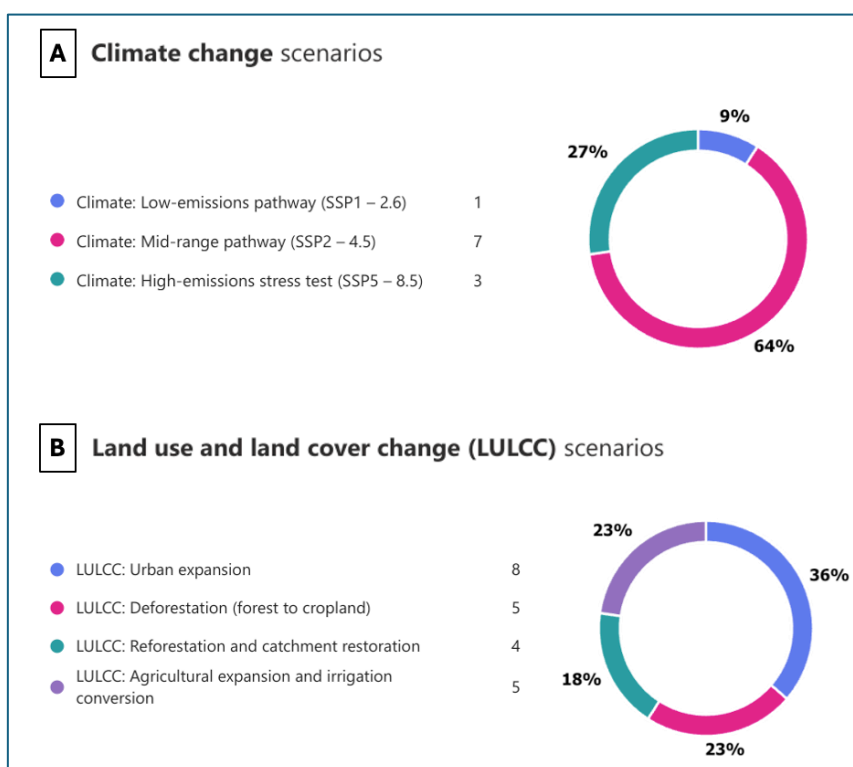


Figure 10. Shortlisted scenarios

Source: IWMI 2026

Agricultural expansion and irrigation conversion, and deforestation, were each selected by five respondents. These selections align closely with the workshop's earlier management questions around water allocation, competing demands, land degradation, sedimentation and reservoir storage. Reforestation and catchment restoration was selected by four respondents, indicating interest not only in pressure scenarios, but also in intervention-oriented scenarios that could test the potential benefits of catchment management and ecosystem-based responses. The high-emissions climate stress-test pathway was selected by three respondents, suggesting that while it remains relevant, it is perhaps more as a stress-testing scenario than as the core planning pathway. The low-emissions pathway attracted the least interest, suggesting that participants were more focused on likely and adverse future conditions than on best-case, overly-optimistic global mitigation assumptions.

These results suggest that the emerging Limpopo scenario library should not be organized only around climate futures. Land-use dynamics, agricultural water demand, urbanization, degradation and restoration are equally important to Member State decision-making. The selection pattern also indicates that participants were interested in scenarios that could support both risk analysis and practical intervention planning: not only "what happens if conditions worsen?", but also "what options could reduce future vulnerability?"

7.3. Scenario Scoring Results

Following the initial shortlisting, participants scored their selected scenarios against a set of prioritization criteria. The scoring process was intended to help distinguish between scenarios that were broadly interesting and those that had the strongest case for near-term development. The criteria focused on

- transboundary relevance,
- national relevance,
- impact or value, and
- feasibility / data readiness,

reflecting the need to balance decision importance with practical implementability. Each criterion was scored on a scale of 1 to 5. The scoring process was intended to help distinguish between scenarios that were broadly interesting and those that had the strongest case for near-term development. Scenarios with a combined score of 14 or above were proposed as potential Tier 1 scenarios, meaning that they may be suitable for development toward the December 2026 demonstration, subject to further technical review and data confirmation.

Figure 11 summarises the average scores for the five highest-priority scenario categories emerging from the workshop. The dashed line indicates the approximate average-score equivalent of the Tier 1 threshold (i.e. $14/4 = 3.5$). This makes it possible to see not only which scenarios scored highly overall, but also where each scenario is strong or weak across the different prioritisation criteria.

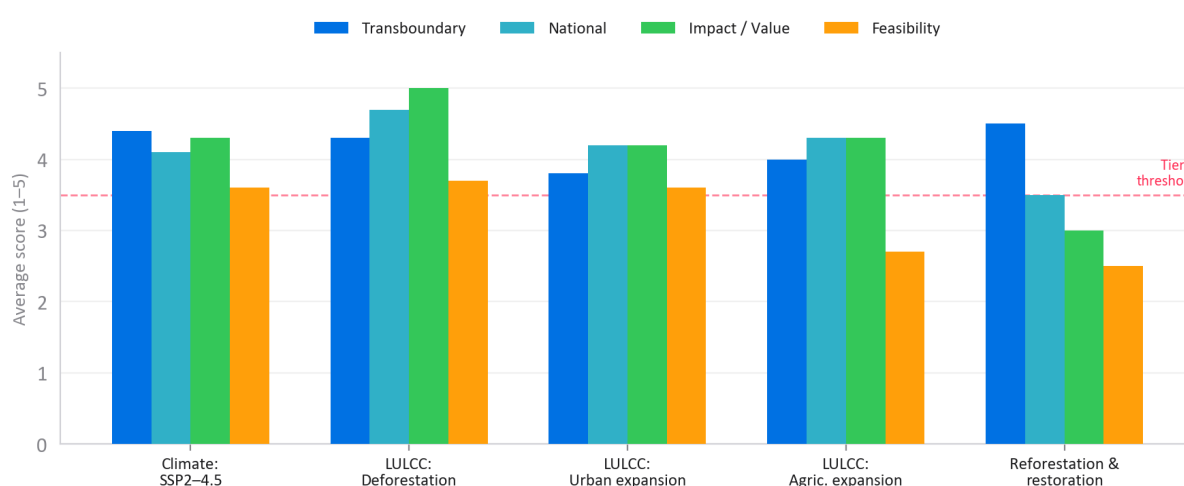


Figure 11. Average scenario scores across four prioritization criteria: transboundary relevance, national relevance, impact / value, and feasibility / data readiness. The dashed line indicates the approximate Tier 1 threshold.

Source: IWMI 2026

The results show that all five scenarios score above the Tier 1 threshold on most relevance and impact criteria. This confirms that the scenarios taken forward from the shortlisting process were not marginal interests: they were perceived by participants as relevant to real national and transboundary water-management decisions. In particular, the **mid-range climate pathway, deforestation, urban expansion, and agricultural expansion** scenarios all scored strongly across national relevance and impact / value. This reinforces the earlier finding that participants were interested in scenarios that connect climate and land-use change to practical planning concerns such as water availability, allocation, flood risk, sedimentation, and long-term resilience.

Figure 11 also shows that **LULCC: deforestation** received the highest average impact / value score and strong national relevance. This is important because it suggests that participants saw degradation and land-cover conversion not simply as environmental issues, but as drivers of hydrological risk with implications for sedimentation, runoff, storage capacity and downstream water security. However, the feasibility score for deforestation is lower than its relevance and impact scores, indicating that implementation may depend on better land-cover change data, erosion or sediment records, and locally validated assumptions.

The **mid-range climate pathway (SSP2-4.5)** appears to be one of the most balanced candidates for Tier 1 development. It scored strongly for transboundary relevance, national relevance and impact / value, and its feasibility score is close to or above the Tier 1 threshold. This supports treating SSP2-4.5 as a core planning scenario for the Limpopo pilot. It is likely to be more immediately implementable than some locally specific scenarios because it can draw on existing climate and hydrological datasets already being integrated into the AI Water Project workflow.

The **urban expansion** scenario also appears to be a strong Tier 1 candidate. Its scores are relatively consistent across all four criteria, including feasibility. This suggests that participants saw urban expansion as both decision-relevant and technically plausible for near-term modelling. This scenario could support analysis of changing runoff, flood peaks, recharge reduction and downstream risk, while also linking to wider planning concerns around settlement growth, infrastructure exposure and urban water demand.

The **agricultural expansion and irrigation conversion** scenario scored well for national relevance and impact, but lower on feasibility. This pattern is meaningful: participants clearly recognised the importance of irrigation and agricultural change for water allocation and basin planning, but the lower feasibility score suggests that credible implementation may require additional local data on irrigation areas, crop types, abstraction, return flows, reservoir operations or water-use efficiency. It may therefore be a strong Tier 1 candidate only if the data requirements can be narrowed, or a phased scenario if more detailed Member State data are needed.

The **reforestation and restoration** scenario has a somewhat different profile. It scored highest on transboundary relevance but lower on national relevance, impact / value and feasibility. This suggests that participants may see restoration as basin-relevant and potentially useful for cooperative planning, but less immediately connected to current national operational decisions or less ready for near-term modelling. It may therefore be best treated as an intervention-oriented scenario for further development, potentially paired with the deforestation or degradation scenario, rather than as a stand-alone first demonstration priority.

Taken together, the scoring results support a pragmatic approach to scenario development. The **mid-range climate pathway, urban expansion**, and possibly **deforestation** appear to have the strongest case for near-term Tier 1 development. **Agricultural expansion and irrigation conversion** is highly relevant but may need additional data scoping before it can be treated as demonstration-ready. **Reforestation and restoration** remains valuable, particularly as a positive intervention scenario, but may be better retained as a paired or second-phase scenario unless its assumptions and data requirements can be simplified.

The main implication is that scenario prioritisation should not be based on relevance alone. Several scenarios are clearly important to Member States, but their feasibility differs. The figure therefore helps identify where the next phase of work should focus: confirming which scenarios are both decision-relevant and data-ready, and documenting data dependencies for those that require further development before inclusion in the December 2026 demonstration.

8. Scenario Specification

Following the scenario shortlisting and scoring process, the workshop moved toward initial scenario specification. The purpose of this step was to begin translating priority scenario themes into model-relevant inputs, including:

- the management question each scenario should address,
- the relevant spatial focus,
- planning horizon,
- indicators or outputs required,
- data needs, and
- known feasibility constraints.

The intention was not to finalise complete model-ready specifications during the workshop, but to establish a first set of structured inputs that could guide post-workshop technical development.

In practice, the workshop generated useful early specification inputs, but these should be treated as preliminary. Participants identified the broad scenario families of greatest relevance – especially mid-range climate change, urban expansion, agricultural expansion and irrigation conversion, deforestation or land degradation, and restoration or catchment rehabilitation – and linked these to practical concerns such as water availability, allocation, flood risk, groundwater recharge, sedimentation, reservoir storage, water quality and environmental flows. However, further work is required to convert these priorities into fully parameterised model scenarios with agreed assumptions, datasets, baseline conditions, intervention levers and output indicators.

8.1. Emerging Tier 1 Scenario Specifications

Based on the workshop results, the most promising near-term scenario specifications are likely to be those that combine strong management relevance with reasonable technical feasibility and data availability. These include:

Mid-range climate change pathway

This scenario would explore how a plausible mid-range climate future affects seasonal streamflow, dry-season baseflows, groundwater recharge, drought duration, flood peaks and reservoir inflows. It responds directly to participant questions about climate variability, future water availability, drought and flood risk, and long-term water security.

Urban expansion and runoff/flood risk

This scenario would examine how increasing urban area and impervious surfaces affect runoff, flood peaks, infiltration and groundwater recharge. It is relevant to questions about urban flood risk, infrastructure planning and downstream impacts.

Agricultural expansion and irrigation conversion

This scenario would test how agricultural expansion, shifts from rainfed to irrigated production, or changes in irrigation demand affect water availability, allocation pressure, environmental flows and downstream water security. It links closely to participant concerns about competing water uses and future demand.

Deforestation, land degradation and sedimentation

This scenario would assess how land degradation, vegetation loss or forest-to-cropland conversion may affect runoff, erosion, sediment yield and reservoir storage. It responds to concerns about sediment loads, siltation, land degradation and the long-term protection of water infrastructure.

Reforestation and catchment restoration

This intervention-oriented scenario would explore how restoration of degraded catchments could affect sediment reduction, streamflow regulation, infiltration, groundwater recharge and ecological resilience. It offers a useful counterpoint to degradation scenarios by testing the potential benefits of catchment management interventions.

8.2. Requirements for Further Specification

Each of these scenarios requires further technical and institutional refinement before implementation. At minimum, the next phase should define:

- the exact management question the scenario will answer;
- the spatial unit of analysis, such as whole basin, sub-basin, tributary, reservoir or priority hotspot;
- the baseline period and future time horizons;
- the scenario lever or change being modelled;
- the required outputs and indicators;
- the global, regional and local datasets to be used;
- known data gaps and calibration risks;
- the assumptions that need to be reviewed by LIMCOM and Member States;

- and whether the scenario is suitable for the December 2026 demonstration or should remain in a Tier 2 backlog.

This additional specification is especially important for scenarios involving water quality, sedimentation, reservoir operations or local infrastructure, where credible outputs may depend on Member State datasets, institutional approvals and locally validated assumptions. In these cases, the workshop outputs provide a strong starting point, but not yet a complete technical specification.

8.3. Implications for Post-Workshop Development

The main implication is that scenario development should proceed in two stages. First, IWMI, AI71 and AWARD should translate the strongest workshop priorities into a small set of draft one-page scenario briefs. These briefs should use a common template and be circulated to LIMCOM and Member State focal points for review. Second, the project team should use these reviewed briefs to confirm which scenarios are genuinely Tier 1: that is, feasible, decision-relevant and suitable for development toward the UN Water 2026 demonstration.

This approach would preserve the participatory value of the workshop while avoiding premature closure. The workshop identified the right scenario directions; the next task is to turn those directions into clear, technically implementable and institutionally validated scenario specifications.



Participants from Mozambique, South Africa, Zimbabwe and Botswana interact with the project team and funder representatives in the April 2026 workshop.

Photo: Gold Services Moz

9. User Journey and Interface Design

The final part of the Day 2 workshop considered how future users might interact with the AI Water Project interface, including how they would request scenarios, interpret model outputs, compare results, and communicate findings to colleagues or decision-makers. This component was important because the usefulness of the system will depend not only on the quality of the underlying hydrological modelling, but also on whether users can access and apply the outputs within their everyday institutional workflows. The workshop therefore explored both the current decision-support context and the kinds of interface features that would make AI-enabled modelling more usable for technical, management and policy-facing audiences.

9.1. Status Quo

Participants described a current decision-support environment that remains heavily dependent on a combination of institutional datasets, technical reports, spreadsheets, gauge records, dam information, professional judgement and established internal procedures. In many cases, water-management decisions are supported by hydrological and climatological records, reservoir levels, rainfall data, discharge measurements, water quality monitoring results, GIS layers and periodic reports produced by national agencies or basin institutions. Some participants also referred to the need for improved hydrological models, telemetry systems, modern monitoring networks and better software tools, indicating that digital decision support is already recognized as important, but is unevenly available across institutions.

Tools currently used by workshop participants include:

- GIS software packages & Google Earth
- Excel dashboards
- ZEDNET monitoring
- HEC-HMS
- Digital Twin / CoPilot
- GloFAS
- Hydstra / HydroNet

The current workflow appears to be highly fragmented. Data are often held by different departments, utilities, basin authorities or national agencies, and may exist in different formats, including spreadsheets, databases, GIS files, reports, SCADA systems and paper-based or document-based records. This means that decision-makers and technical staff often need to assemble evidence manually from multiple sources before they can assess water availability, reservoir status, drought or flood risk, water allocation options, water quality concerns or infrastructure implications.

The workshop responses further suggest that current decision workflows differ by institutional role and planning horizon:

- Some users need **near-term operational information**, such as seasonal forecasts, dam yields, spillway risks, reservoir levels or short-term flood conditions;
- Other users need **medium- to long-term planning information**, such as projected climate impacts, future surface water availability, groundwater recharge, environmental flow compliance, infrastructure investment options, land-use change impacts or catchment degradation risks.

This reinforces the need for a system that can support multiple time horizons rather than a single static dashboard.

In practical terms, the status quo is not a complete absence of data or expertise. Rather, it is a situation in which relevant data and knowledge exist, but are often difficult to bring together quickly, compare across scenarios, translate into decision-ready outputs, and communicate across technical and non-technical audiences. This is the gap that the AI Water Project and its future interface are intended to help address.

9.2. Pain Points/Key Challenges

Workshop responses point to several recurring pain points in the current decision-support environment, namely:

- data fragmentation;
- data gaps and uneven monitoring coverage;
- delayed access to information;
- limited ability to compare options;
- technical capacity and accessibility;
- communication across audiences; and
- trust and validation.

Each of these pain points (AKA 'key challenges') is briefly described below. Note that these are not ordered or prioritised in any way, and should therefore rather just be read as a list.

The first challenge is **data fragmentation**. Participants identified a wide range of relevant datasets, but these are distributed across institutions, formats and custodians. This makes it difficult to build a shared, up-to-date picture of basin conditions, particularly where decisions have transboundary implications.

The second challenge is **data gaps and uneven monitoring coverage**. Participants referred to

- missing gauges,
- incomplete hydrological records,
- limited telemetry,
- gaps in rainfall and flow data, and
- constraints in hydro-climatological monitoring networks.

These gaps affect both operational decision-making and model calibration. They are especially important for sub-basins, tributaries, reservoirs or hotspots where local decisions depend on reliable observed data.

The third pain point is **delayed access to information**. Even where data exist, they may not be available in time to support decisions. This is particularly relevant for flood preparedness, reservoir operations, drought response and seasonal water allocation, where delayed information can reduce the practical value of otherwise useful data.

The fourth challenge is **limited ability to compare options**. Participants' management questions repeatedly pointed to the need to understand "what if" conditions: what happens under climate change, urban expansion, irrigation growth, land degradation, catchment restoration or altered reservoir operations. Existing workflows do not always make it easy to compare these futures side by side, assess trade-offs, or communicate the consequences of different decisions.

The fifth challenge is **technical capacity and accessibility**. Conventional hydrological models and specialist tools are often designed for expert users, making them difficult to use across the full range of people involved in water governance. This matters because basin decisions are not made by modellers alone. Outputs also need to be useful to planners, managers, policy advisers, LIMCOM structures and, in some cases, leadership audiences who need clear summaries rather than technical model files.

The sixth challenge is **communication across audiences**. Participants' needs imply that water information must travel between technical analysis, institutional planning and policy communication. Maps, charts, dashboards, tables, short reports and plain-language summaries all have a role. A technically valid model output may still have limited influence if it cannot be easily explained, exported, shared or incorporated into planning and reporting processes (or if technical staff have difficulty communicating outputs to their organisation's managers and leaders).

Finally, participants' responses highlight the underlying issue of **trust and validation**. In a transboundary setting, scenario outputs need to be transparent, auditable and open to review by Member State institutions. Users need to understand

- what data were used
- what assumptions were made,
- how uncertainty is represented, and
- where outputs are more or less reliable.

This is particularly important for AI-enabled systems, where the value of automation must be balanced with human review, institutional ownership and confidence in the results.

9.3. Desired Platform Functions

The user journey responses provide a clear indication of what participants would value in a future AI-enabled hydrological decision-support platform. Although the number of respondents was small, the pattern across the responses is consistent: participants want tools that help them see current basin conditions, explore plausible future scenarios, interpret and share results, and ask questions in natural language. In other words, they are not looking for a single static dashboard or a purely technical modelling interface. Rather, they need a platform that can support different stages of the decision process, including:

- diagnosing current conditions,
- testing future changes,
- interpreting uncertainty,
- preparing outputs for communication, and
- moving between technical analysis and management-level reporting.

The results also show that participants placed strong emphasis on usability and communication. Most functions were rated as either “important” or “critical”, suggesting that users see value in a broad suite of functions. This is consistent with the wider workshop findings: water-management decisions in the Limpopo Basin require information that is **spatial, temporal, comparative, explainable** and **shareable**. The preferred platform would therefore need to combine maps, charts, scenario comparison, reports, natural-language access and uncertainty information in a way that is technically credible but accessible to different institutional users.

9.3.1. Seeing current conditions and exploring scenarios

Figure 12 summarises responses to the question of how participants would like to see the current state of water resources represented. All three options – river flow maps, water balance overviews, and drought/flood indicators – were rated as either important or critical by all valid respondents. Drought and flood indicators were particularly strongly supported, with four of the five respondents rating them as critical. This suggests a strong need for visual, risk-oriented summaries that can show where conditions are changing and where management attention may be needed. River flow maps and water balance overviews were also highly valued, indicating that users need both spatial representations of flow conditions and integrated summaries of how water moves through the basin.

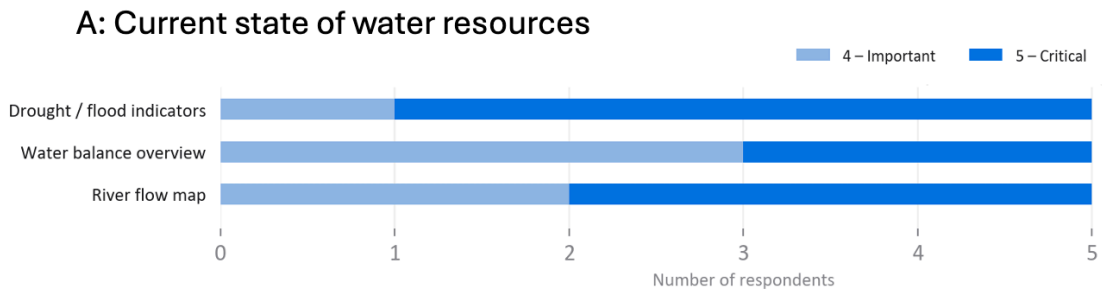


Figure 12. Results for the question ‘how would you want to see the current state of water resources represented?’
Source: IWMI 2026

Figure 13 extends the above findings into scenario exploration. Participants rated climate change impact, land use change impact, and side-by-side scenario comparison highly. The strongest response was for comparing scenarios side-by-side, with three of five respondents rating this as critical and the remaining two rating it as important. This is significant because it shows that users are not only interested in individual model outputs; they want to compare alternatives. For the AI Water Project, this points to the importance of interface functions that allow users to view scenarios in relation to one another, for example by comparing climate futures, land-use pathways, intervention options or baseline versus altered conditions. This aligns closely with the workshop’s broader emphasis on scenario-based decision support.

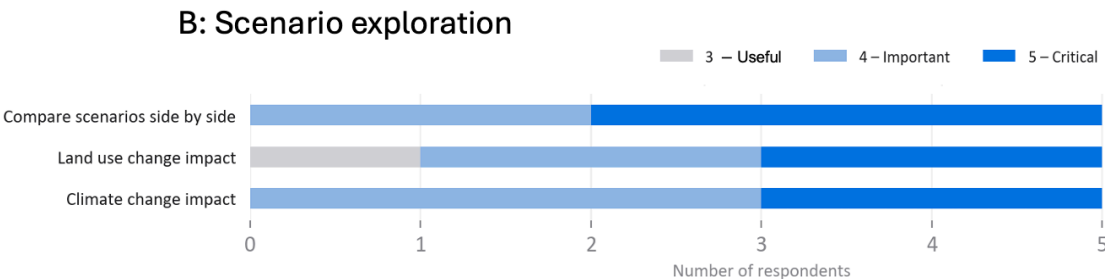


Figure 13. Results for the ‘what if?’ scenarios exploration question.
Source: IWMI 2026

9.3.2. Understanding, sharing, and querying results

Figure 14 focuses on how participants want to understand and share model results. Simple summary charts, map-based results, automated reports and uncertainty information were all rated positively. Uncertainty

information received the strongest response, with three of four valid respondents rating it as critical. This is an important result: participants do not simply want outputs that look clear; they also want to know how confident the model is, where results are more or less reliable, and what assumptions or data limitations affect interpretation. This finding is especially relevant for AI-enabled modelling in a transboundary setting, where trust, transparency and validation are central to adoption.

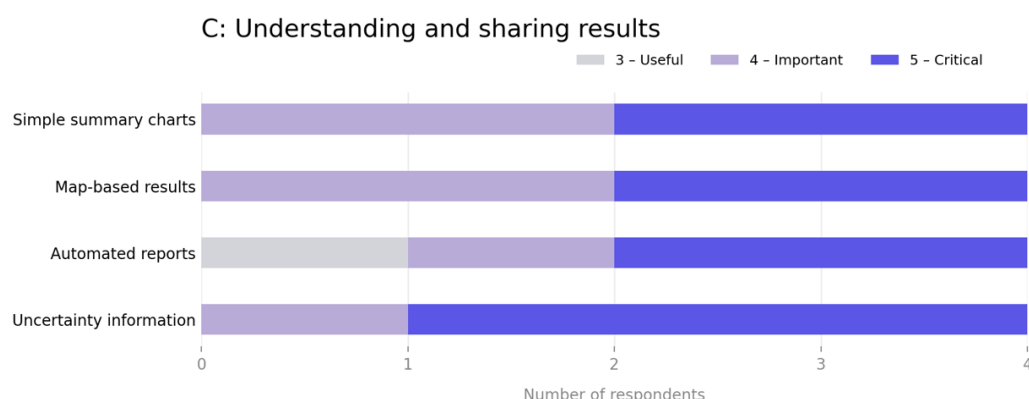


Figure 14. Results for the question of how participants would like to interpret and share results.
Source: IWMI 2026

Figure 15 shows strong interest in natural-language interaction, similar to WaterCopilot. Participants rated the ability to ask about current conditions especially highly: four of five respondents considered this critical. Asking about scenarios, generating reports and receiving explanations were also rated as important or critical by most respondents. This suggests that a conversational interface could be valuable not only as a convenience feature, but as a way of lowering barriers to accessing complex hydrological information. However, the slightly lower rating for “get explanations” also suggests that explanation quality will need careful design: users may value natural-language access, but they will still need responses that are transparent, traceable and grounded in trusted data.

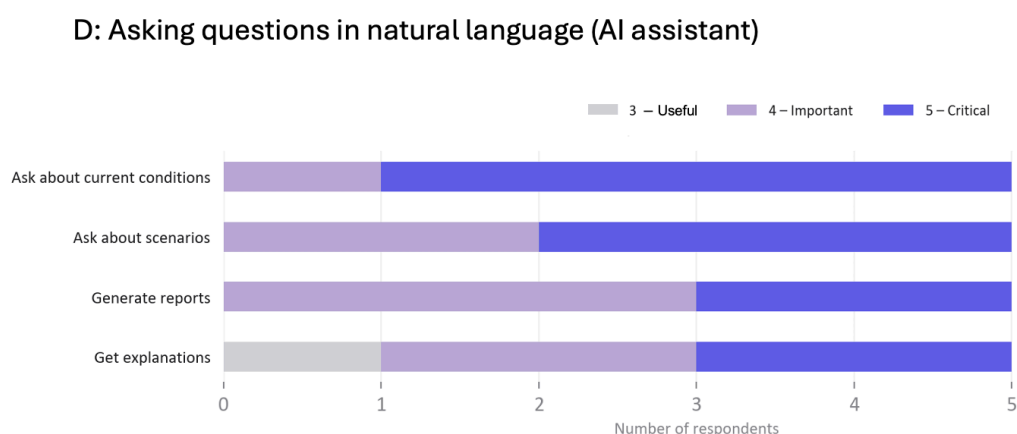


Figure 15. Results for the question ‘asking questions in natural language, e.g. of an AI assistant’?
Source: IWMI 2026

Figure 16 summarizes preferred information formats. Participants expressed interest in multiple formats: color-coded maps, charts and graphs, exportable tables, written summaries and integrated dashboards. No single format dominated. Instead, the results suggest that different users and decision contexts require different forms of presentation:

- **maps** help locate risks and spatial patterns;
- **charts** help communicate change over time;
- **tables** support technical review and export;
- **written summaries** help explain implications; and

- **dashboards** can combine key elements on one screen.

This supports the need for a flexible interface rather than a single fixed output format.

E: Information presentation preferences

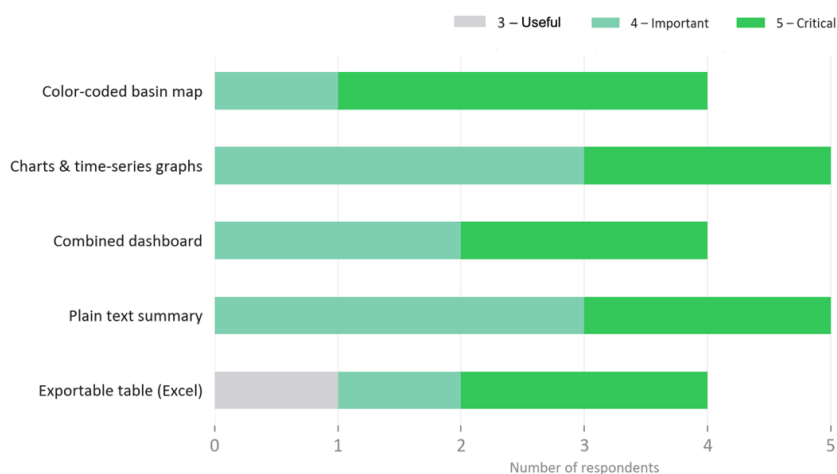


Figure 16. Results for the question of how participants would like to see information presented/represented.
Source: IWMI 2026

The results shown in Figure 12 - Figure 16 are consistent with the user-needs report (Clifford-Holmes, 2026). They show that participants require AI-enabled platforms that can support current-status visualisation, scenario comparison, natural-language querying, uncertainty communication, exportable outputs and decision-ready reporting. These more specific interface preferences align with six broader platform capabilities identified in the user-needs work, namely:

- reducing response delays,
- improving scenario relevance,
- strengthening evidence for choices,
- making information more accessible across audiences,
- preserving institutional knowledge, and
- supporting mobile and natural-language access.

These six broader capabilities are shown in graphical form in Figure 17, below, with each of the capabilities briefly defined and illustrated.

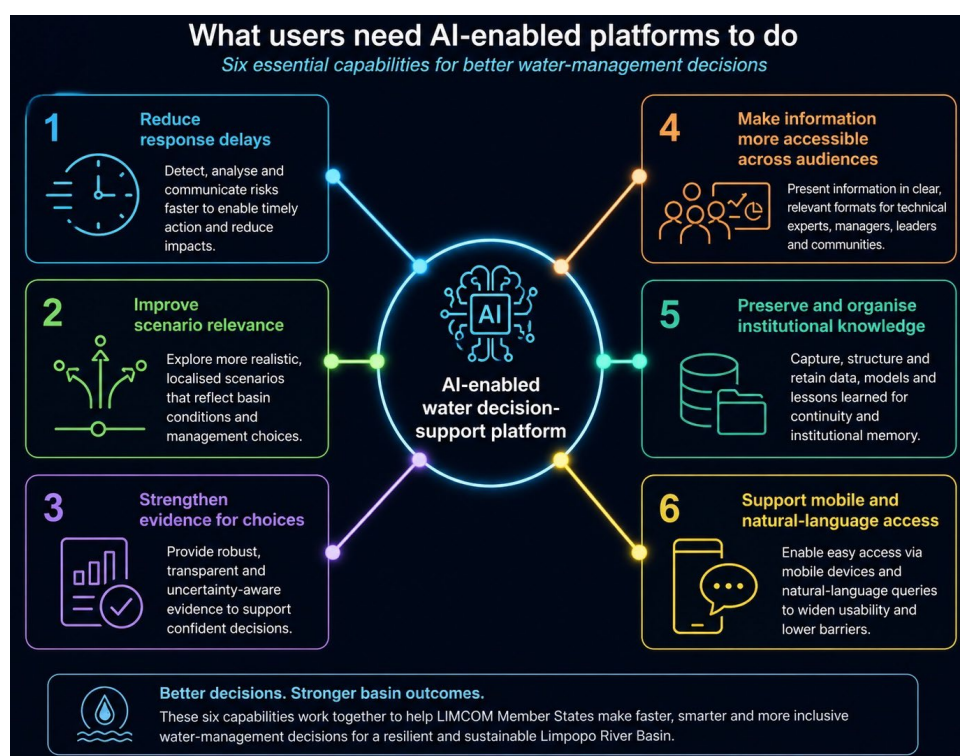


Figure 17. Six broader capabilities that users need AI-enabled water decision support platforms to provide.
Source: IWMI 2026

9.4. Communication and Reporting Formats

The user journey results also highlight that platform outputs need to be designed for **communication**, not only for analysis. Participants indicated that they currently present water information to leadership and decision-makers in a range of formats, including reports, PowerPoint presentations, maps, dashboards, graphs, tables and, in some cases, raw data. This reflects the mixed audiences involved in water management: technical teams may need detailed datasets and model outputs, while managers and policy audiences often need concise, visual and decision-oriented summaries.

The responses suggest that no single reporting format will be sufficient (or should dominate). A future AI Water Project interface should therefore support multiple output pathways:

- For **technical users**, exportable tables, charts and underlying data will remain important for review, verification and further analysis.
- For **management and policy users**, map-based summaries, dashboard views, scenario comparisons, short written interpretations and PowerPoint- or report-ready graphics are likely to be more useful.

For time-sensitive operational contexts, such as flood preparedness or drought response, users may also need concise alerts, rapid summaries and clear indication of where risk is increasing.

A strong theme across the responses is the need for outputs that can “travel” across institutional settings. In practice, this means that the system should help users move from model results to usable communication products: for example,

- a map showing areas of concern,
- a short, written explanation of what the result means,
- a chart comparing two scenarios,
- a table that can be exported to Excel, or
- an automated PDF summary for a seasonal water outlook or drought-risk briefing.

This is particularly important in a transboundary context, where results may need to be shared across national agencies, LIMCOM structures, technical working groups and senior decision-makers.

The strong interest in **uncertainty information** is also directly relevant to communication. As noted above, participants want more than just clear results; they also want to know how confident the model is in those results. This implies that reporting outputs should include plain-language explanations of uncertainty, data gaps and assumptions, rather than presenting model outputs as definitive predictions or forecasts. For example, scenario reports should distinguish between observed data, modelled estimates, assumptions, confidence levels and known limitations. This would help build trust and avoid misinterpretation, particularly where outputs may inform sensitive decisions around water allocation, infrastructure, flood risk or transboundary cooperation.

For **interface design**, the implication is that communication and reporting functions should be built into the platform from the beginning. The system should not only answer questions or produce model runs; it should help users package those results for different audiences. Useful reporting functions could include:

- automated summary reports,
- downloadable charts,
- map exports,
- dashboard snapshots,
- side-by-side scenario comparison panels,
- short narrative summaries,
- uncertainty notes, and
- PowerPoint- and report-ready figures.

These functions would help ensure that AI-supported modelling outputs can be used in real institutional workflows, rather than remaining confined to the technical modelling environment.

Overall, the workshop findings point toward a reporting model that is **layered**:

- technical users need access to detail,
- managers need synthesis, and
- leadership audiences need concise, decision-oriented messages.

The future platform should therefore allow users to move between levels of detail, from raw or exportable data through to charts, maps, dashboards, written summaries and briefing-ready products. This layered approach would make the AI Water Project more useful across the full decision chain, from hydrological analysis to policy communication and transboundary coordination.

10. Key Findings and Implications

The Day 2 workshop generated a set of practical findings for the next phase of the AI Water Project. These findings relate not only to the specific scenarios participants prioritized, but also to how AI-enabled hydrological modelling should be designed, governed and communicated in a transboundary basin context. Considered collectively, the findings suggest that the value of the Limpopo pilot will depend on its ability to connect technical modelling capability with real management questions, credible data, institutional trust and usable decision-support outputs – all within a phased co-development process.

10.1. Key Findings

The first key finding is that participants prioritised **decision-relevant scenarios**, not generic modelling experiments. Their management questions focused on practical issues such as water availability, dam operations, flood and drought risk, water allocation, environmental flows, water quality, sedimentation, land degradation and transboundary data sharing. This indicates that future model development should begin from clearly defined decision needs, rather than from technical capability alone.

Second, within the bounded climate and LULCC scenario menu, the **mid-range climate pathway (SSP2-4.5)** emerged as the clearest climate-related planning scenario, while **urban expansion** was the strongest LULCC scenario in the initial shortlisting. **Deforestation / land degradation** also scored strongly, especially in relation to impact and value, reflecting concerns about erosion, sedimentation, reservoir storage and downstream water security. **Agricultural expansion and irrigation conversion** was recognised as important for water allocation and competing demand, but appears to require further data scoping before it can be treated as fully demonstration-ready. **Reforestation and catchment restoration** remains useful as an intervention-oriented scenario, but is likely better treated as a paired or second-phase scenario alongside degradation-focused modelling.

Third, the workshop confirmed that the Limpopo Basin's **transboundary character** is central to the value of the AI Water Project. Many of the priority questions raised by participants cannot be answered at national scale alone. Upstream water use, land-use change, tributary flows, dam operations, flood risk, sedimentation and environmental flow compliance all have cross-border implications. This makes shared scenario tools potentially valuable for LIMCOM and its Member States, provided that outputs are transparent, reviewable and trusted.

Fourth, **data availability** is both a major opportunity and a major constraint. Participants identified many potentially useful datasets, including hydrological time series, reservoir data, water quality records, spatial datasets, groundwater information, sediment and siltation records, and operational information. However, they also highlighted significant data gaps, access restrictions, institutional approval requirements, format variability, missing gauges and telemetry limitations. This means that scenario development must be realistic about data readiness and must distinguish between scenarios that are immediately feasible and those that require further data mobilisation.

Fifth, the workshop reinforced the AI Water Project's two-persona design logic (as summarised in Figure 2). The project already identifies the **technical basin modeller** as the primary early user and the **decision-maker or policy analyst** as a secondary but important user group. The workshop findings add practical detail to this framework. Technical users require credible modelling workflows, transparent data inputs, calibration information, exportable results and scenario-comparison tools. Management and policy-facing users require maps, dashboards, concise summaries, automated reports, uncertainty explanations and outputs that can be used in planning and transboundary governance settings. The implication is not to dilute the initial focus on technical modellers, but to ensure that technical outputs are designed from the outset to be interpretable, shareable and reusable in decision-making contexts.

Sixth, **AI is most valuable where it reduces real bottlenecks** in the current modelling and decision-support workflow. These bottlenecks include slow model setup, difficult calibration, fragmented datasets, delayed access to information, limited ability to compare scenarios, and difficulty translating technical outputs into decision-ready summaries. The workshop therefore supports the project's core proposition: AI should augment hydrological modelling by making workflows faster, more scalable, more accessible and more useful under data-constrained conditions.

Finally, the workshop highlighted the importance of **human validation, institutional trust and data governance**. Participants were interested in AI-enabled tools, but the findings also point to the need for clear assumptions, transparent data sources, uncertainty communication, review processes and Member State involvement. In a transboundary setting, the credibility of the system will depend as much on how outputs are generated, reviewed and communicated as on the technical performance of the model itself.

10.2. Implications for the AI Water Project

The first implication is that the next phase of work should focus on a **small, feasible Tier 1 scenario package** rather than attempting to implement the full range of possible scenarios at once. Based on the workshop results, the mid-range climate pathway, urban expansion and selected land-use change scenarios appear to offer the strongest starting point. These scenarios are decision-relevant, aligned with workshop priorities, and more likely to be feasible within the December 2026 demonstration timeline.

The second implication is that scenario development should proceed through **one-page scenario briefs** that translate workshop priorities into implementable model specifications. Each brief should define the management question, spatial focus, time horizon, scenario lever, required indicators, data inputs, assumptions, known limitations, uncertainty considerations and intended decision audience. This would help avoid premature closure while creating a clear bridge between workshop outputs and technical implementation.

The third implication is that a structured **data request and validation process** is needed. For each proposed Tier 1 scenario, the project team should identify minimum data requirements, preferred formats, data custodians, approval processes, constraints and deadlines. This process should also identify which datasets can be drawn from the existing IWMI/HydraFound data stack and which require Member State contribution. Data mobilisation should therefore be treated as a core co-development activity, not as an administrative follow-up.

The fourth implication is that the project should design for **uncertainty and explainability from the outset**. Participants' strong interest in uncertainty information shows that users need more than model outputs; they need to understand confidence, assumptions, data gaps and limitations. This is especially important for scenarios involving climate futures, land-use change, reservoir operations, water quality or sedimentation, where results may influence sensitive planning or transboundary discussions.

The fifth implication is that **interface design should be developed in parallel with scenario development**. A technically credible scenario will only be useful if users can request it, interpret it, compare it, export it and communicate it. The platform should therefore prioritise map-based results, side-by-side scenario comparison, concise charts, automated summaries, exportable tables, report-ready graphics and natural-language query functions linked to traceable evidence.

The sixth implication is that the Limpopo pilot should remain explicitly **co-owned and reviewed** by LIMCOM and Member State representatives. Their role should not end with the April 2026 workshop. Follow-up engagement will be needed to confirm scenario priorities, review assumptions, validate early outputs, test interface prototypes and agree how results should be presented for UN Water 2026. This will strengthen both the technical quality and institutional legitimacy of the demonstration.

Overall, the workshop suggests that the AI Water Project should proceed as a **staged co-development process**:

- confirm a manageable Tier 1 scenario package,
- mobilise the minimum required data,
- produce early prototype outputs,
- test those outputs with intended users, and
- refine the dashboard and reporting functions before the UN Water 2026 demonstration.

This pathway would allow the project to remain ambitious while staying grounded in the practical decision-support needs identified by LIMCOM and its Member States.

11. Recommended Next Steps

The Day 2 workshop should be treated as the first step in a broader co-development pathway rather than as a once-off engagement. The next phase should

- consolidate the workshop outputs into a small set of technically feasible scenario briefs,
- mobilise the datasets required to support them, and
- extend the review process to both LIMCOM Member State users and the wider Southern African hydrological sciences community.

This is especially important because the AI Water Project must demonstrate not only technical progress, but also credibility, usability and trust among the hydrologists, modellers, basin institutions and decision-makers who may later use or evaluate the system. Ten recommended next steps are put forward here, briefly described below.

Step 1: Confirm the Tier 1 scenario package

The first priority is to confirm a manageable Tier 1 scenario package with IWMI, AI71, LIMCOM and Member State representatives. Based on the workshop results, the strongest candidates are likely to include the mid-range climate pathway, urban expansion, and selected land-use change scenarios such as deforestation / land degradation and agricultural expansion. However, the final selection should be based on both workshop priority and technical readiness. Each scenario should be assessed against data availability, calibration requirements, uncertainty, feasibility for demonstration, and relevance to the UN Water 2026 storyline.

Step 2: Prepare one-page scenario briefs

Each proposed Tier 1 scenario should be converted into a concise one-page scenario brief, for sharing with LIMCOM and the Member States. These briefs should specify the management question, spatial focus, time horizon, scenario lever, key indicators, data requirements, assumptions, uncertainty considerations, output formats and intended decision audience. The briefs should also clarify which elements can be supported by the existing IWMI / AI Water Project data stack and which depend on Member State datasets or validation. These briefs would provide a practical bridge between the workshop outputs and the technical implementation process.

Step 3: Develop a scenario-linked data request matrix

A structured data request matrix should be prepared for each Tier 1 scenario. This should identify the minimum required datasets, desired formats, national or institutional custodians, approval requirements, known gaps and submission timelines. This matrix should be designed to support model calibration, validation and scenario parameterisation, while also recognising Member State data constraints. It should also distinguish between data required for the December 2026 demonstration and data that would strengthen later Tier 2 scenario development.

Step 4: Hold a technical follow-up with LIMCOM Member State data custodians

A focused technical follow-up session should be held with Member State data custodians and technical focal points. The purpose should be to

- review the proposed scenario briefs and data matrix,
- confirm what data can realistically be shared,
- identify approval pathways, and
- clarify where uncertainty or missing data will need to be explicitly represented.

This follow-up should also help determine which scenarios are genuinely demonstration-ready and which should remain in a longer-term backlog.

Step 5: Extend the engagement to the wider hydrological sciences community

The LIMCOM workshop generated important input from institutional users, but the next phase should also involve the wider Southern African hydrological sciences community. A proposed virtual engagement with hydrologists, modellers, researchers, practitioners and early-career scientists would provide an opportunity to introduce the AI Water Project, share lessons from the Limpopo proof-of-concept, and invite technical feedback on the opportunities, limitations and risks of AI-assisted hydrological modelling in data-scarce basins. This proposed engagement is a structured process for connecting IWMI's emerging AI-enabled water modelling work with regional hydrology networks, including the South African Hydrological Society (SAHS), WaterNet, the regional committee of the International Association of Hydrological Sciences (IAHS), Global Water Partnership Southern Africa (GWP-SA), universities, consultancies and research institutions.

This engagement should be designed as a technical learning and feedback process rather than a promotional webinar. Key questions should include where AI-assisted modelling could add the most value, what risks need to be managed, and what hydrologists would need in order to trust, test and use AI-enabled model outputs. It should also explore collaboration pathways such as postgraduate research, technical working groups, training sessions, short courses, or communities of practice.

Step 6: Use the virtual engagement to prepare for the SAHS 2026 Conference

The proposed virtual workshop should also serve as a preparatory step toward the planned SAHS 2026 pre-conference workshop / special session. The SAHS proposal is framed as a half-day, demonstration-led expert-feedback session on the AI-augmented SWAT+ workflow and the Limpopo Digital Twin, structured around three demonstrations and three feedback rounds. Its central question is whether differentiable and automated methods can ease the calibration burden without sacrificing process fidelity, and where hydrologists can trust such methods.

The virtual engagement can help test this framing in advance, identify interested hydrologists and institutions, surface priority technical questions, and refine the feedback prompts for the in-person SAHS session. It can also help build continuity between the LIMCOM institutional co-design process and the wider hydrological modelling community. This would strengthen the scientific credibility of the AI Water Project by exposing the workflow to structured peer scrutiny before the UN Water 2026 demonstration.

Step 7: Develop prototype outputs for selected scenarios

Once the Tier 1 scenario package and data requirements are confirmed, the project team should develop prototype outputs for two or three priority scenarios. These should include maps, charts, uncertainty information, comparison views, concise summaries and exportable reporting formats. The purpose should not be to present final results immediately, but to create testable outputs that can be reviewed by LIMCOM users, technical modellers and hydrological science reviewers.

Step 8: Test dashboard and reporting formats with intended users

Prototype outputs should be tested with both primary and secondary user groups. For technical modellers, the review should focus on data inputs, calibration performance, assumptions, uncertainty, reproducibility and exportability. For decision-makers and policy-facing users, the review should focus on whether outputs are understandable, credible, useful for planning, and easy to communicate. This staged testing would reflect the AI Water Project's two-persona design logic while keeping the initial focus on the technical modeller workflow.

Step 9: Produce a synthesis of feedback and update the roadmap

Feedback from the LIMCOM follow-up, the virtual hydrology-community engagement, and the SAHS 2026 session should be consolidated into a written synthesis. The SAHS proposal already envisages a verified feedback synthesis, co-authored by IWMI and LIMCOM, capturing expert hydrologist judgement on process fidelity, calibration rigour, uncertainty treatment and decision-support framing. This synthesis should be used to update the AI Water Project roadmap, especially around modelling choices, uncertainty communication, dashboard functions, trust-building measures and capacity-building needs.

Step 10: Align the demonstration pathway with UN Water 2026

Finally, the scenario package, prototype outputs, user testing and expert feedback should be aligned with the UN Water 2026 demonstration pathway. The demonstration should show both the technical capabilities of the AI Water Project and the co-development process behind it: LIMCOM and Member State scenario priorities, data mobilisation, user journey insights, hydrological science review, and clear communication of uncertainty. This would position the Limpopo pilot as both a technical proof-of-concept and an example of participatory, evidence-based, transboundary water modelling.

12. Conclusion

The Day 2 workshop provided an important step in moving the AI Water Project from a technical proposition toward a co-developed Limpopo Basin scenario agenda. By engaging LIMCOM and Member State representatives directly, the workshop helped ground future model development in practical water-management questions, institutional data realities, and the communication needs of intended users.

The workshop confirmed strong interest in AI-supported hydrological modelling where it can help address real bottlenecks: faster model setup, improved calibration, more accessible scenario analysis, clearer uncertainty communication, and outputs that can support both technical review and decision-making. It also showed that credible implementation will depend on careful prioritization. Not all scenarios are equally ready for near-term development, and the next phase should focus on a manageable Tier 1 package that is decision-relevant, technically feasible, and supported by available or shareable data.

The Limpopo pilot is therefore best understood not only as a modelling exercise, but as a staged co-development process. Its success will depend on continued collaboration between IWM, AI71, LIMCOM, Member State institutions, and the wider hydrological sciences community. If this process is sustained, the Limpopo demonstration can provide a credible example of how AI-augmented hydrological modelling can support transboundary water governance, strengthen scenario-based planning, and contribute meaningfully to the UN Water 2026 pathway.

13. References

Clifford-Holmes, J.K. (2026). *User Needs for AI-supported Water Management in the Limpopo River Basin*. Report (internal draft). Colombo, Sri Lanka: International Water Management Institute (IWMI).

Garcia Andarcia, M.; Ruckstuhl, S.; Retief, H.; Seid, A.; Roman, H.; Storr, S.; Palay, I. 2025. *Digital twins for river basin water management*. Colombo, Sri Lanka: International Water Management Institute (IWMI). CGIAR Accelerator for Digital Transformation, CGIAR Food Frontiers and Security Program. 9p.



CGIAR is a global research partnership for a food-secure future. CGIAR science is dedicated to transforming food, land, and water systems in a climate crisis. Its research is carried out by 13 CGIAR Centres/Alliances in close collaboration with hundreds of partners, including national and regional research institutes, civil society organisations, academia, development organisations and the private sector. www.cgiar.org

To learn more about this Science Program, please visit:
www.cgiar.org/cgiar-research-portfolio-2025-2030/digital-transformation

Contact

Mariangel Garcia Andarcia, Research Group Leader, Water Futures Data & Analytics (WFDA), IWMI, Colombo, Sri Lanka (M.GarciaAndarcia@cgiar.org)



CGIAR

DIGITAL
TRANSFORMATION

