IWMI International Water Management Institute

Emerging Innovations in Disaster Risk Management: Digital Twin and AI

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Research and Innovation for Water Security
Driving Action • Propelling Change

CGIAR RESEARCH CENTER

Context

Disaster risks are increasing and compounding due to climate change, urbanization, and environmental degradation.

Most systems remain reactive, with limited use of early warning and anticipatory action.

Data exists but is fragmented, poorly integrated, and not decision-ready.

Financing focuses on response, not prevention, early action, or resilience.

Last-mile delivery is weak, with gaps in equity, trust, and local capacity.

Urgent innovation is needed to shift from crisis response to anticipatory, integrated, and people-centered disaster risk management.

AI for Water Management – predict extreme events and enhance early warning, through data analytics and social innovation
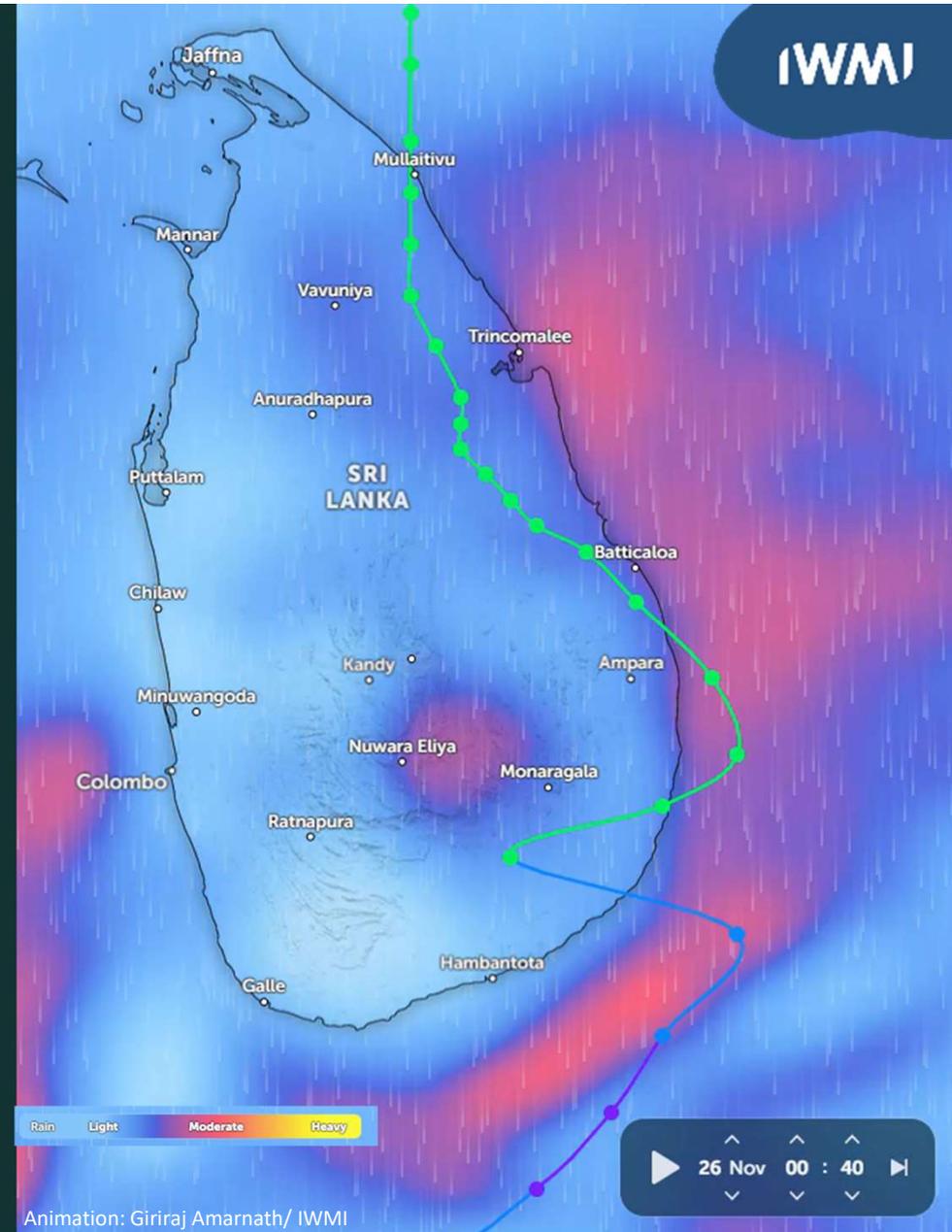
Tracking Cyclone "Ditwah" in Sri Lanka
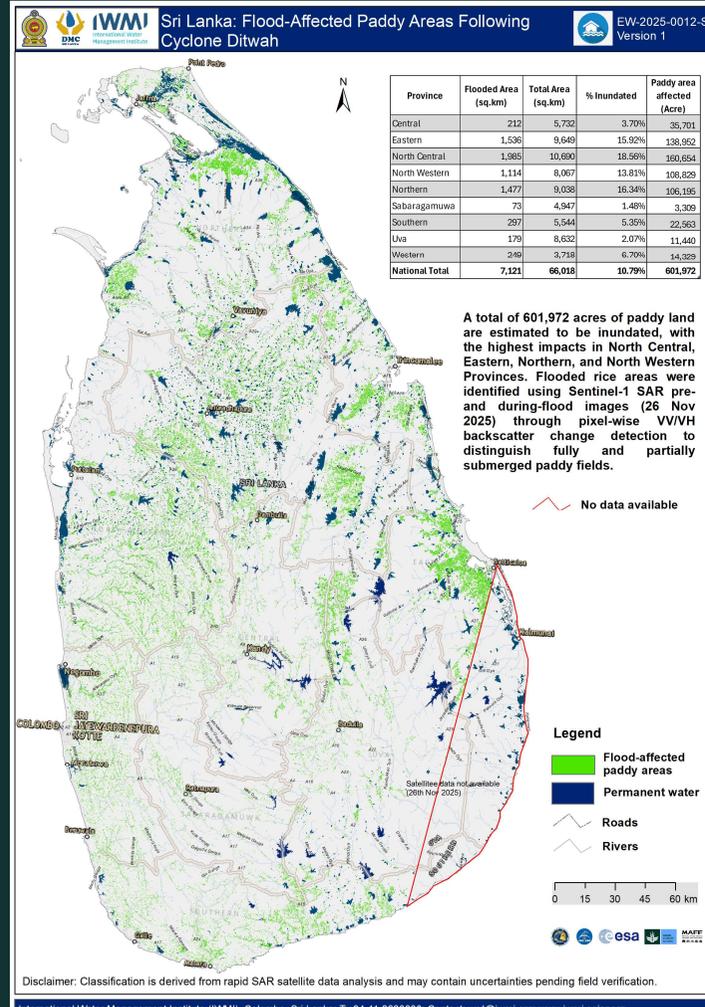
What Drove the Extreme Rainfall?

- **Warmer oceans:** Bay of Bengal Sea Surface Temperatures (SSTs) were several °C above normal, contributing to the third-warmest November globally.

- **Higher atmospheric moisture:** Warmer SSTs increased evaporation and supercharged rainfall bands over Sri Lanka.

Role of Climate Drivers (2025)

- **Strong Negative Indian Ocean Dipole (IOD):**
  - Pushes warm waters eastward.
  - Enhances convection and rainfall over the eastern Indian Ocean region.
  - Reduces rains in some parts of South Asia but intensifies rainfall in Sri Lanka & SE Asia.

- **La Niña conditions:**
  - Strengthens rainfall patterns in the eastern Indian Ocean.
  - Adds to moisture influx and persistent convective activity.

Animation: Giriraj Amarnath/ IWMI

Rapid Mapping for Humanitarian Responses

Sri Lanka: National Flood Extent Assessment Following Cyclone Ditwah (2025)

EW-2025-0011-SL
Version 1

Province	Flooded Area (sq.km)	Total Area (sq.km)	% Inundated
Central	212	5,732	3.70%
Eastern	1,536	9,649	15.92%
North Central	1,985	10,690	18.56%
North Western	1,114	8,067	13.81%
Northern	1,477	9,038	16.34%
Sabaragamuwa	73	4,947	1.48%
Southern	297	5,544	5.35%
Uva	179	8,632	2.07%
Western	249	3,718	6.70%
National Total	7,121	66,018	10.79%

National satellite analysis indicates that 10.79% of Sri Lanka's land area (7,120.8 sq.km) is inundated following Cyclone Ditwah. The most affected provinces—North Central, Eastern, Northern, and North Western—show 13–18% flooding, particularly across low-lying agricultural areas and settlement clusters. Flood extent is derived from multi-sensor SAR data: Sentinel-1 (26 Nov), SAOCOM (27 Nov), and RADARSAT (28 Nov).

These results are preliminary and based on rapid satellite analysis; field validation is pending. Use with caution for operational decision-making.

Legend

- Flooded areas
- Permanent water
- Roads
- Rivers

Population Count in sq.km
30,496
0

0 15 30 45 60 km

International Water Management Institute (IWMI), Colombo, Sri Lanka; T:+94-11-2880000; Contact: wrd@iwmi.org; www.iwmi.cgiar.org

Sri Lanka: Flood-Affected Paddy Areas Following Cyclone Ditwah

EW-2025-0012-SL
Version 1

Province	Flooded Area (sq.km)	Total Area (sq.km)	% Inundated	Paddy area affected (Acre)
Central	212	5,732	3.70%	35,701
Eastern	1,536	9,649	15.92%	138,952
North Central	1,985	10,690	18.56%	160,654
North Western	1,114	8,067	13.81%	108,829
Northern	1,477	9,038	16.34%	106,195
Sabaragamuwa	73	4,947	1.48%	3,309
Southern	297	5,544	5.35%	22,563
Uva	179	8,632	2.07%	11,440
Western	249	3,718	6.70%	14,329
National Total	7,121	66,018	10.79%	601,972

A total of 601,972 acres of paddy land are estimated to be inundated, with the highest impacts in North Central, Eastern, Northern, and North Western Provinces. Flooded rice areas were identified using Sentinel-1 SAR pre- and during-flood images (26 Nov 2025) through pixel-wise VV/VH backscatter change detection to distinguish fully and partially submerged paddy fields.

No data available

Satellite data not available (26th Nov 2025)

Legend

- Flood-affected paddy areas
- Permanent water
- Roads
- Rivers

0 15 30 45 60 km

Disclaimer: Classification is derived from rapid SAR satellite data analysis and may contain uncertainties pending field verification.

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Drones Powering Disaster Risk Reduction

DRONE FOOTAGE OF FLOOD-AFFECTED KOTIKAWATTA, COLOMBO, SRI LANKA
Multispectral Imagery: acquired on 03 Dec 2025 | Published: 04 Dec 2025

EW-2025-0023-SL
Version 1

Multi-spectral drone imagery capturing extensive flood inundation, revealing thousands of submerged houses across the affected landscape.

0   0.025   0.05   0.075   0.1 km

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Drone, IoT, Robotics and AI offers seamless solutions for disaster mitigation

- High resolution flood impacts
- Search-and-rescue operations
- Reconnaissance
- Delivery of medical equipment and supplies

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Landslides Monitored using Drones Following Cyclone Ditwah
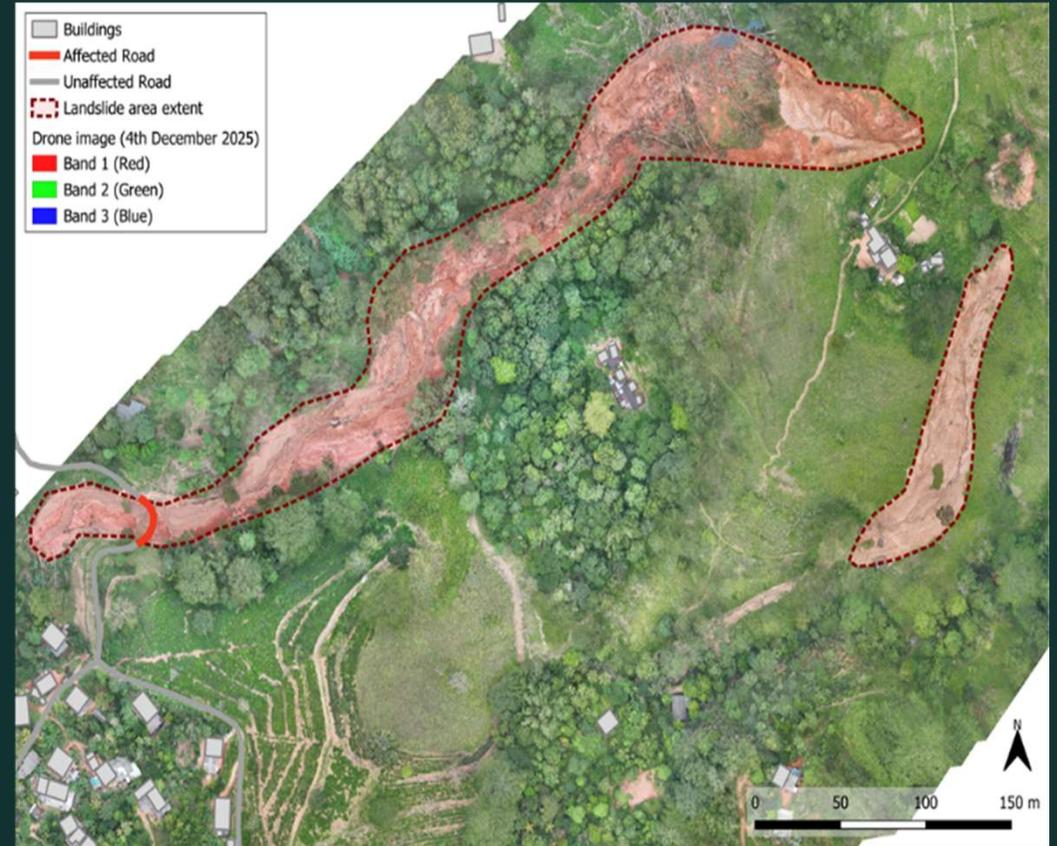
Landslide at Galaha.

AWARE Platform for Early Warning, Early Action & Early Finance

This innovative system serves as a centralised, real-time hub that seamlessly integrates meteorological data, socio-economic indicators, and sophisticated forecast-based triggers to transform how communities prepare for and respond to climate-related disasters.

Integrated Intelligence

Real-time data fusion combining weather forecasts, early warning signals, and community vulnerability assessments

Coordinated Response

Rapid, systematic anticipatory actions triggered automatically when thresholds are reached

Immediate Funding

Direct financial disbursements linked to early warnings, ensuring resources reach vulnerable communities instantly

- Multi-hazard alerts **increase lead time** for action, reducing losses to lives, livelihoods, and assets.
- Risk triggers **activate anticipatory actions** and financing, shifting response from reactive to preventive.
- Supports farmers, women, and at-risk communities through locally relevant, **decision-ready information**.
- Integrates climate, water, agriculture, and DRM data to enable coordinated, **whole-of-government action**.
- **Embedded in country institutions** and deployed across multiple countries, using open, interoperable digital and AI innovations.

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AWARE Platform

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CGIAR CLIMATE ACTION

Early Action Plans

Early Finance Module

Early Warning Module

Early Warning Module (Flood Trigger)_
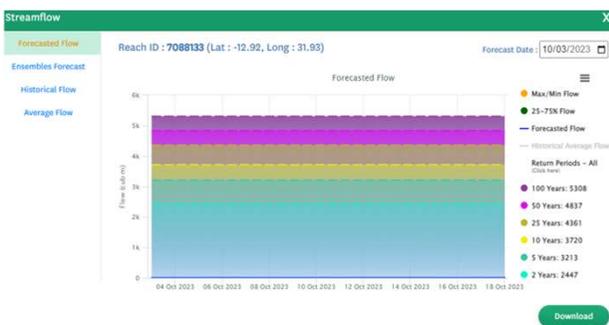
Flood simulation drill in Nuwara Eiliya District, Sri Lanka

AWARE - Development Phase

Operationalized
Validation Phase
Implementation Phase

- National Platforms
- Early Warning components on floods, drought and landslides available
- Standard AA Protocols completed
- Alert Dashboard in progress

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CGIAR CLIMATE ACTION

MAFF Ministry of Agriculture, Forestry and Fisheries 農林水産省

SukhaRakshak AI Chatbot

Near real-time drought management among smallholder farmers

Multi-data source integration as AI Agents:

- SADMS, Earth Observation (EO), (sub)seasonal forecasts, satellite indices, national drought manual and agriculture contingency plans

AI core:

- Google Gemini model, RAG (retrieval-augmented generation), vector database (Qdrant)

- AI4Bharat and Sarvam multilingual module (native language dissemination)

- Automated pipeline: from data → prediction → localized advice

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Management Institute
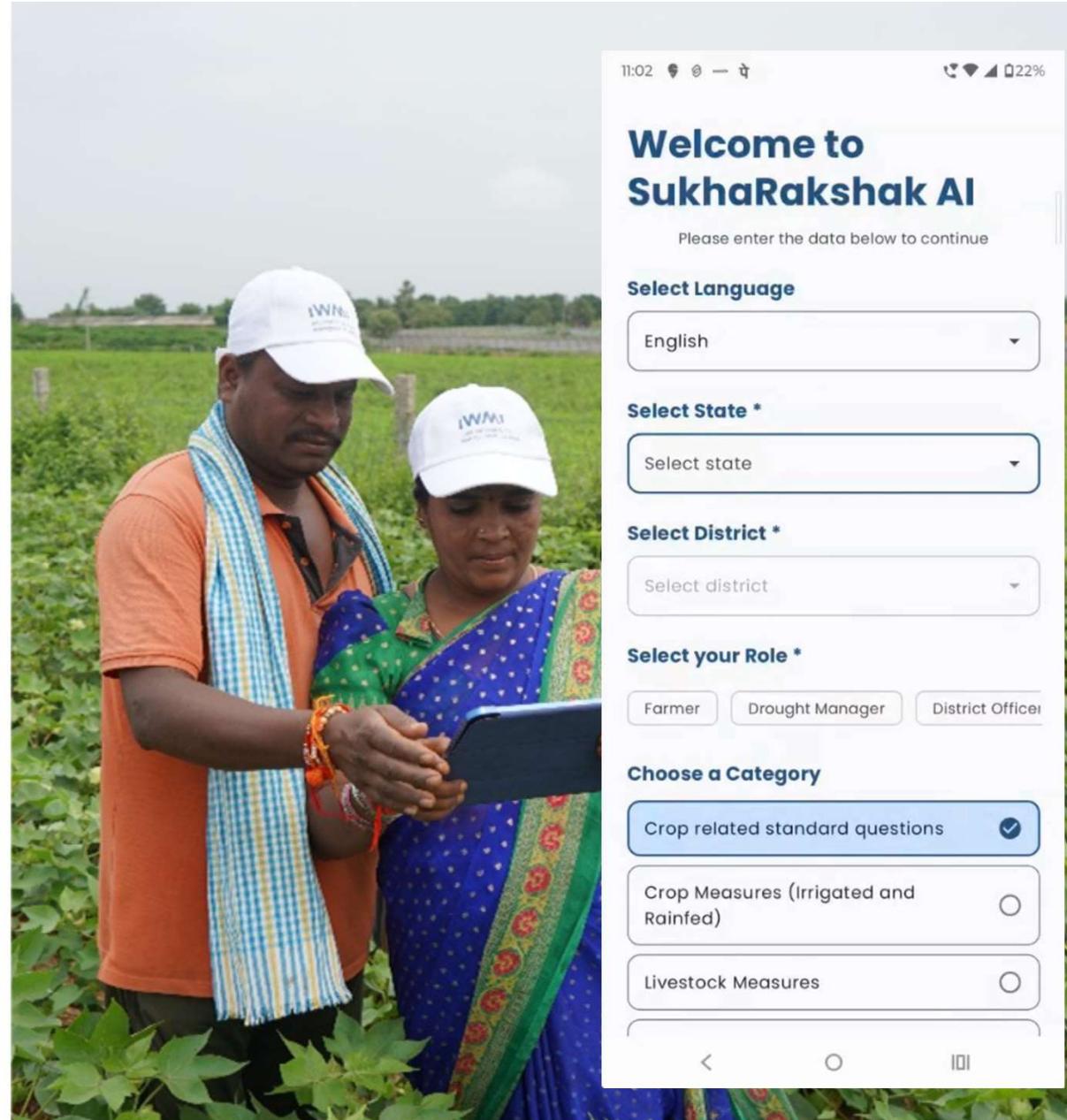
SukhaRakshak AI: Drought Advice When Farmers Need It Most

What Farmers Access

- Real-time, district-specific drought forecasts
- Tailored crop and water management advice
- Early warning alerts for local conditions
- Proactive risk mitigation strategies

How to Use the Tool

Simply chat via **text or voice** in your native language. Ask about drought risks, irrigation tips, or contingency plans—and receive instant, context-aware guidance.

No technical skills required—just conversation.

22+ Indian Languages

Powered by AI4Bharat and Sarvam AI, delivering personalised advisories in farmers' mother tongues—overcoming literacy and language barriers.

Optimise Irrigation

Adjust watering schedules based on AI recommendations to conserve water and maximise crop yield during dry spells.

Select Resilient Crops

Receive guidance on drought-tolerant varieties suited to your soil and climate—reducing risk and improving resilience.

Actions Enabled by SukhaRakshak AI

Adjust Sowing Dates

Time planting to align with rainfall predictions and minimise drought exposure

Water Conservation

Implement storage and efficiency measures recommended by the chatbot

Contingency Planning

Prepare alternative strategies for severe drought scenarios with AI support

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Digital Twin for the Limpopo River Basin

Digital Twin for Water Management

A 3D representation of the basin that integrates diverse datasets and existing resources/technologies to understand the current basin dynamics, offering monitoring, forecasting, and scenario analysis for informed decision-making..

- seasonal water availability forecast
- operationalization of environmental flows

Citizen Science Data Integration
AI-Powered Virtual Assistant (research)
Multi-Stakeholder Collaboration/Investments

iwmi-digitaltwins@cgiar.org

IWMI's Water Copilot

Mobile App

Multilinguals Capabilities

Multiple Users Personas
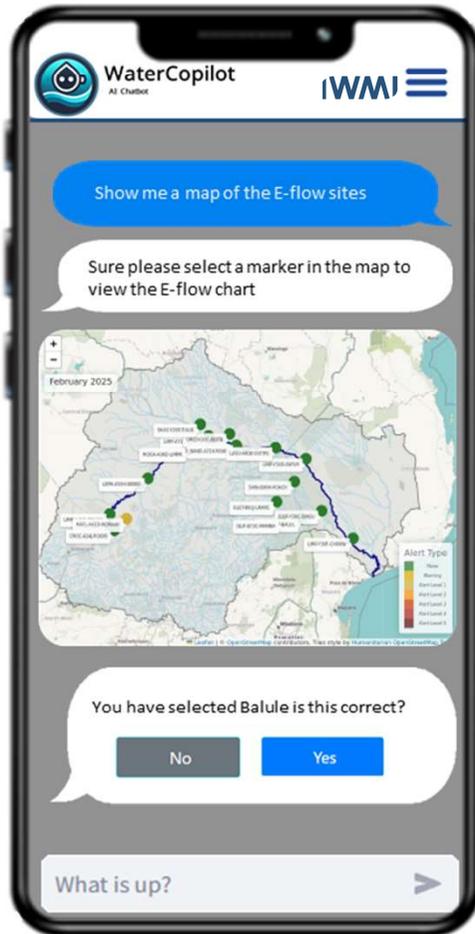
Automated Reports

Alert Systems

Feedback Capabilities

Speech to text Text to Speech

Direct Interaction with digital twin platform

Data Mobilization Module

Water Availability

Water Use

Environmental Compliance

Water Governance

Natural Basin Characteristics

Risk Assessment

Citizen Science Module + GESI + Circular economy