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Workshop Report

Digital Twin for Effective Flood Response: Technical Training and Operationalization Workshop Report

International Livestock Research Institute (ILRI) Campus, Addis Ababa, Ethiopia | June 23–25, 2026

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November 2026



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Acknowledgments

This work was conducted as part of the CGIAR Accelerator for Digital Transformation and the International Water Management Institute's Digital Innovations for Water Secure Africa (DIWASA) project. We gratefully acknowledge the generous financial support of The Leona M. and Harry B. Helmsley Charitable Trust. We would also like to thank all funders who supported this research through their contributions to the CGIAR Trust Fund (www.cgiar.org/funders/).

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Suggested citation

Gebre, Eden Seifu, Alemseged Tamiru Haile, and Hugo Retief. 2026. *Digital Twin for Effective Flood Response: Technical Training and Operationalization Workshop Report.* International Water Management Institute (IWMI).

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Front cover photo: Digital Twin training participants (photo by IWMI).
Back cover photo: Digital Twin training participants (photo by IWMI).

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Acronyms

DT Digital Twin

DRM Disaster Risk Management

EMI Ethiopian Meteorology Institute

HEC-HMS Hydrologic Engineering Center – Hydrologic Modeling System

HEC-RAS Hydrologic Engineering Center – River Analysis System

IWMI International Water Management Institute

LULC Land Use/Land Cover

MoWE Ministry of Water and Energy

WFP World Food Programme

Executive Summary

The International Water Management Institute (IWMI) organized a three-day training workshop on “Introduction to Digital Twin for Effective Flood Response” from 23–25 June 2026 at the ILRI Campus in Addis Ababa. The workshop was designed to strengthen the capacity of government and humanitarian stakeholders involved in flood forecasting, preparedness and emergency response, with particular focus on the operational context of Dollo Ado district, Somali Region. The workshop content and discussions documented in the training draft are organized in this report thematically.

The training introduced Digital Twins (DT) as virtual replica of the Dolo Ado floodplain. In the Digital Twin, hydrological and hydrodynamic models, multiple data sources, automated forecasting workflows and visualization tools have been used to support flood early warning and response. Learning combined technical presentations, live demonstrations, hands-on data integration and exploration of the Digital Twin environment, and structured discussion. The training therefore linked technical understanding with practical questions of use, adoption and sustainability.

A central technical theme was the end-to-end relationship between data, models and Digital Twin visualization. Participants were introduced to DT input data preparation, the HEC-HMS and HEC-RAS model components, data integration into the DT database, 3D visualization and the automated hydrological workflow from rainfall forecast acquisition through model execution and output generation. Discussions also considered model calibration, bias correction, data quality and the potential use of sensor observations to support continuous updating and recalibration.

The workshop also highlighted that operationalizing the DT is not only a technical issue. Recurrent discussion focused on access to rainfall forecast data from national institutions, expansion and automation of hydro-meteorological monitoring, clear institutional ownership and governance, and the need to simplify the DT interface and outputs for regional and local Disaster Risk Management (DRM) users. Participants also emphasized dedicated operational training and concise reference material so that DT outputs can be understood and used without advanced technical expertise.

Overall, the workshop moved from a shared understanding of Digital Twin concepts and technical architecture toward practical consideration of data integration, modelling, visualization, forecasting and institutional adoption. The resulting priorities are to clarify ownership and governance, strengthen data-sharing arrangements, expand monitoring networks, improve data quality, simplify user-facing products and continue hands-on capacity building.

1 Workshop Context and Purpose

Flood risk in the Somali Region of Ethiopia, particularly in Dollo Ado, creates a need for reliable, timely and actionable early warning information. In response to this need, IWMI developed a Digital Twin (DT), which is a virtual replica, of the Somali Region in collaboration with the World Food Program (WFP) and other key stakeholders at district, regional and national levels. It uses historical flood scenarios with socio-economic impact layers so that decision-makers can explore inundation extent and its consequences for people, infrastructure and livelihoods in 3D, supporting anticipatory action in flood risk management. Hydrological and hydrodynamic modelling, multiple data sources and visualization tools have been used to support flood forecasting, early warning and decision-making.

The training workshop was organized in response to a request by stakeholders during the project progress workshop organized in December 2025. It was organized for technical staff and decision-makers from key government and humanitarian partners, including the Ministry of Water and Energy (MoWE), Ethiopian Meteorology Institute (EMI) and regional and local Disaster Risk Management (DRM) offices. The workshop was built on prior co-creation and consultation activities undertaken during development of the Digital Twin. Its purpose was therefore broader than transferring technical information: it also provided a setting for participants to examine how the DT could be understood, adopted and eventually operated within the Dollo Ado DRM context.

1.1 Workshop objectives

The main objective of the training workshop was to enhance participants’ capacity to understand, use and contribute to the Digital Twin platform as a practical decision-support tool for early warning in Dollo Ado. The specific objectives were to enhance the participants’ capacity to:

- Understand and explain Digital Twin concepts, terminology and system architecture.
- Demonstrate the end-to-end Digital Twin workflow, from data acquisition and model integration to automated forecasting.
- Perform hands-on data entry and integrate datasets from multiple sources into consistent DT inputs and explore the DT interactive visualization environment.

- Configure real-time sensors and manage data flows feeding timely, reliable information into the DT.
- Set up and use 3D Digital Twin environments, including integrating additional models in the platform

1.2 Workshop participants and institutional context

The training brought together a diverse group of participants with complementary expertise and institutional mandates. Trainees included representatives from disaster risk management offices at district and regional levels, the Dolo Ado municipality, the Ethiopian Meteorology Institute, the Ministry of Water and Energy, sector offices, humanitarian agencies including WFP and UNHCR, as well as researchers from IWMI, local research centres, and universities.

This mix reflected both technical expertise in hydrology, meteorology, flood risk analysis, modelling, and research, and operational responsibilities in preparedness, early warning, emergency response, local planning, and humanitarian support. The diversity of mandates enriched the training by linking data and modelling discussions with practical decision-making and institutional use. Figure 1 shows the workshop participants exploring the DT of Dolo Ado.

2 Training Design

The workshop adopted a highly interactive learning approach. Short technical presentations were combined with live demonstrations, hands-on exercises, participant reflections and open plenary discussions. The format was designed to move beyond one-way technical instruction by enabling participants to draw on their professional experience, question technical workflows, share institutional practices and collectively explore operational challenges in flood forecasting and early warning (Table 1).



Figure 1. Workshop participants exploring the Digital Twin of Dolo Ado. Source: IWMI

The training also maintained a clear connection with the co-creation process that preceded it. The opening recap revisited the co-creation steps undertaken in developing the Digital Twin, while subsequent exercises allowed participants to interact directly with the DT environment and consider how available institutional data could contribute to the system. Discussions on usability5, language, data sharing, ownership and operational responsibilities further connected technical learning with stakeholder requirements.

Table 1Thematic training areas and intended learning emphasis

Thematic area	Learning emphasis
Shared DT understanding	Concepts, terminology, architecture and the end-to-end workflow linking models and sensor integration.
Data integration	DT environment, database organization, data provision and hands-on integration of participant-held data.
Modelling	DT input preparation, HEC-HMS and HEC-RAS components, model outputs, calibration and data-quality considerations.
Visualization	DT interface, transformation of organized datasets into visual products, and 3D visualization.
Operationalization	Rainfall forecast acquisition, automated hydrological modelling, model interaction and output generation.

3 Digital Twin Technical Architecture and Workflow

The training presented the Digital Twin as an integrated environment in which multiple data sources, hydrological and hydrodynamic models, automated workflows and visualization components work together to support flood preparedness, early warning and decision-making. The technical demonstrations helped participants understand how individual components contribute to the wider DT workflow rather than treating models, datasets and visualization as separate entities. Figure 2 shows the key DT concepts being explained to the participants.



Figure 2. Introducing the key concepts of the Digital Twin. Source: IWMI

3.1 Integration of data, models and visualization

The training demonstrated a workflow in which input data are prepared and organized, hydrological and hydrodynamic models are integrated, model outputs are generated through an automated workflow, and results are presented through the Digital Twin environment. Participants were introduced to both the technical components and the way these components interact within the overall system.

3.2 Sensor integration, calibration and updating

Participants questioned how sensor observations could be integrated into HEC-HMS and how continuous updating and recalibration could improve model accuracy over time. The discussion suggested the development of mechanisms to use sensor data to correct rainfall and flood forecasts and support longer-term model improvement. Participants also raised the data storage and infrastructure requirements that would accompany such continuous-updating functions.

3.3 Monitoring and temporal resolution

The training discussion noted that the hydrological and hydrodynamic models currently use daily rainfall and streamflow data. With additional sensor availability, participants suggested moving toward sub-daily inputs. Regional DRM representatives also emphasized expanding river station coverage, particularly upstream of the Genale and Dawa rivers, and prioritizing automatic rainfall stations in the downstream parts of the basins.

3.4 End-to-end workflow

Figure 3 presents a thematic synthesis of the technical workflow explored during the training, illustrating the progression from monitoring and data acquisition through data ingestion and cataloguing, hydrological and hydrodynamic modelling, and visualization of model outputs. The workflow demonstrates how data from multiple sources are systematically collected, quality-controlled, standardized, and organized before being processed through modelling and automated workflows to generate flood forecasts and related information products. These outputs are subsequently integrated into the Digital Twin environment for interactive visualization and interpretation, supporting flood preparedness, early warning, situational awareness, and evidence-based decision-making at different levels.

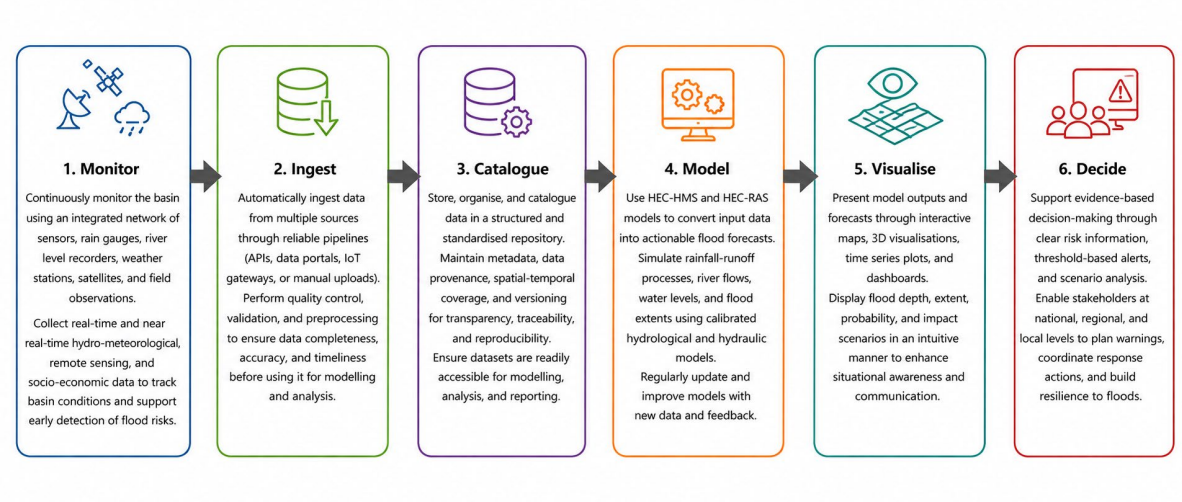


Figure 3. Digital Twin workflow demonstrated through the training (Source: Authors)

4 Data Integration, Modelling and Visualization

4.1 Data preparation and integration

Participants were introduced to the process of integrating data into the Digital Twin. The data must be ready for DT before integration and 'ready' just means four simple things. First, everything is written down the same way every time same layout, same column names, one reading per line. Second, the numbers say what they mean: the right units, the right reference points, the right locations. Third, the timing is clean — one time zone, one date format, and gaps shown as gaps instead of zeros. And fourth, we know the story behind each number: who measured it, with what, how, and how reliable it is. It was highlighted to get those four right, and everything we build on top of the data can be trusted as DT-ready.

A live demonstration showed the DT environment and walked participants through data integration step by step. Participants then identified data available to them and considered which datasets could be useful for the DT, before practicing the integration process. The exercise provided direct experience with data provision, data evaluation and helped participants explore how different datasets connect within the DT.

The workshop also surfaced questions about why institutions and individuals would upload data to the DT. This led to broader discussion of institutional data-sharing challenges and the need to improve the arrangements that enable useful datasets to be made available within the system.

4.2 HEC-HMS and HEC-RAS model components

The training presented the model components, input data sources, preprocessing procedures, modelling process and model outputs associated with the DT. The purpose and scope of HEC-HMS and HEC-RAS were explained, including data acquisition, data pre-processing and the calibration steps applied to the models. Participants raised specific questions concerning rainfall input selection, including the why the Climate Hazards Center Infrared Precipitation (CHIRP) product was bias corrected using local data instead of using the globally available with CHIRPS (with station) product, the LULC classification and calibration process, and the source and resolution of the Digital Elevation Model (DEM).

4.3 Data quality, bias correction and forecast reliability

Data quality emerged as a consistent technical concern. Participants emphasized the need for quality measures throughout the modelling and forecasting chain, from data fetching through automated forecasting. They also asked about bias-correction procedures used to improve the reliability of model forecast outputs. The discussion linked data quality directly to uncertainty in model results and confidence in the information used for early warning. The importance of communicating flood forecast uncertainties was also suggested.



Figure 4. Workshop participants discussing the Digital Twin features. Source: IWMI

4.4 Visualization and the 3D environment

The training demonstrated how diverse datasets can be organized within a DT database and transformed into intuitive visual products. The demonstration walked through DT-Somali end to end. Participants worked with catalogue layers adding, ordering, styling and toggling them on the map. They opened monitoring stations to read time series and compare periods and stations. They placed forecast and scenario layers beside current conditions to compare outcomes, then saved views and exported maps and charts for reports and briefings.

The 3D component of the Digital Twin was also demonstrated, including its purpose and configuration. Adding 3D puts the Twin in real terrain: high-resolution elevation makes valleys, floodplains and drainage visible at a glance.

Flood depth draped over that terrain shows what "flooded" actually means for a village or road, not just extent. Settlements, roads and infrastructure placed in the scene reveal exposure directly. And a fly-through of a forecast flood is understood instantly, by everyone.

Overall, participants explored the platform interface and discussed the importance of user-friendly presentation, particularly for local communities and decision-makers. They noted that effective visualization can improve communication during flood emergencies.

4.5 User-oriented presentation of technical information

The participants repeatedly highlighted the need to simplify complex technical information. They suggested that the DT could be used directly by decision-makers if supported by a concise, one-page PDF manual explaining what the DT does and how to use it. The interface and outputs were also expected to use language that local DRM experts can readily understand rather than overly technical terminology.

5 Operationalization and Flood Early Warning

The operational dimension of the Digital Twin became increasingly prominent as the training progressed. The technical workflow was examined in relation to rainfall forecasting, automated model execution, forecast products and the institutional responsibilities required to turn technical outputs into operational early warning information.

5.1 Automated forecasting workflow

The training provided a detailed view of the automated hydrological modelling workflow, from rainfall forecast acquisition through model execution and output generation. Participants were shown how the hydrological and hydrodynamic models interact and feed into one another as part of the end-to-end pipeline.

5.2 Rainfall forecast data

Participants discussed the selection and evaluation of rainfall forecast data sources and questioned the bias-correction procedures used to improve forecast reliability. A strong preference was expressed for accessing rainfall forecast data directly from EMI rather than relying solely on global forecast data. At the same time, existing constraints around EMI data access and data-sharing policies were identified as a significant challenge, indicating that operational use of nationally sourced forecasts would require institutional and policy engagement.

5.3 From technical output to early warning action

The workshop emphasized that the value of the Digital Twin depends on whether its outputs can support timely decisions. Participants therefore connected model outputs with early warning interpretation and dissemination, anticipatory action, and the responsibilities of agencies that would use and communicate the information. This reinforced the need for clear operational ownership and simplified outputs alongside technical system development.



Figure 5. Describing the impacts of the simulated flood for Dolo Ado. Source: IWMI

5.4 The immersive Digital Twin

This training introduced an immersive flood digital twin for Dolo Ado, delivered live through VR and on-screen viewing. It demonstrated that while 2D maps convey flood extent and web-based 3D models show depth from an aerial view, only immersive, first-person presence within the simulated environment communicates the true human impact of flooding. The system's value lies in realistic water behaviour, human-scale spatial awareness, scenario rehearsal capability, and a unified shared visualization for stakeholders.

The architecture separates physics from rendering: HEC-RAS 2D handles all hydraulic depth computations, while the rendering engine solely visualizes these outputs. Applications include stakeholder convening, anticipatory action planning, and disaster preparedness.

Planned extensions include a conversational Water Co-Pilot, browser-based streaming access, replication across additional river basins, and decision-grade exposure analytics.

6 Institutional Adoption, Governance and Capacity

A major outcome of the training was recognition that technical functionality alone will not ensure sustained use of the Digital Twin. Participants repeatedly raised questions concerning who should understand the outputs, who should operate the system, who should host and maintain it, and how institutional responsibilities should be defined.

6.1 Ownership and governance

Participants called for clarity on which agency would be responsible for understanding DT model outputs and for interpreting and disseminating early warning information. A related concern was who would operate the DT for Dollo Ado to support anticipatory action. The discussion emphasized that without a clearly designated operational owner, the DT could become a technology that is developed but not practically used.

6.2 Data-sharing responsibilities

Data-sharing was identified as both a technical and institutional requirement. The challenge of accessing rainfall forecast data from EMI was particularly prominent. Participants favored nationally sourced forecast information but recognized that this would require engagement on current data access and sharing arrangements.

6.3 Capacity development and usability

Regional and local DRM participants emphasized a significant capacity gap before the DT can be fully understood and used by operational staff, and before it can become accessible to the wider community. The training therefore highlighted the need for dedicated, hands-on operational training, simplified reference materials and interfaces and outputs that can be understood without advanced technical expertise.

6.4 Sustainability beyond project development

The workshop considered the long-term sustainability of the DT after project completion. Participants emphasized that sustained operation will depend on coordinated institutional collaboration, clearly defined operational responsibilities and a governance framework that supports system hosting, maintenance, data access and coordinated decision-making.

7 Key Messages

Participant feedback confirmed that the Digital Twin is understood as an integrated system linking data, models, and visualization tools for flood early warning. Participants highlighted the importance of reliable, high-quality data and interoperable models as the technical backbone of the system. Equally, they emphasized that visualization, user-specific access, and clear risk communication are what determine whether technical outputs can actually be understood and acted on. Together, these messages show that participants valued both the technical rigor of the Digital Twin and its practical usability for real-time decision-making. The key messages are summarized as follows:

- Digital Twins combine real-time and historical data, hydrological and hydraulic models, and geospatial information into a shared platform to support flood early warning and anticipatory action.
- Reliable input data, model interoperability, and seamless integration were flagged as the essential technical foundation for a functioning system.
- Hands-on demonstrations with tools like HEC-HMS and HEC-RAS gave participants practical understanding of forecasting workflows, beyond theory.
- Clear dashboards, maps, legends, color-coded alerts, and user-specific views were identified as key to making outputs understandable across different users.
- Mobile access and actionable risk communication were emphasized so technical experts, decision-makers, and communities can interpret hazards and respond quickly during real flood events.
- Coordinated, well-defined institutional roles were seen as necessary to turn the Digital Twin from a technical platform into an operational decision-support system.

8 Recommendations and Way Forward

Building on the lessons from this training, participants offered concrete recommendations for how future Digital Twin trainings should be designed and delivered. These recommendations fall into two broad groups: strengthening the technical and data foundations that trainings should cover, and improving how Digital Twin outputs are visualized and communicated so different users can act on them. Taken together, they point toward more hands-on, locally grounded, and user-tailored future trainings. These recommendations should guide the design of follow-up training sessions and future phases of Digital Twin capacity building.

Strengthening technical and data foundations in future training

- Future training should place greater emphasis on real-time hydrometeorological data and exposure/vulnerability datasets, alongside stronger interoperability among participating institutions.
- Training should include more hands-on technical sessions, giving participants direct practice with the tools and workflows rather than relying primarily on demonstrations.
- Regular model validation using field data should be built into training content, so participants learn how to check and calibrate outputs against real conditions.

- Follow-up training should include dedicated capacity building for local stakeholders, ensuring skills are sustained at the regional and community level, not just among technical staff.
- Training materials should be translated into local languages and supported by practical communication tools, and future sessions should link training content with better sensor networks and ground observations in practice.

Improving visualization and usability in future training

- Future training and Digital Twin visualization should be simplified for different user groups, using clear color-coded risk levels, interactive GIS maps, icons, and legends.
- User-specific dashboards should be introduced and practiced during training, so each type of user leaves knowing how to access the views relevant to their role.
- Training should cover real-time alerts and mobile-friendly access, ensuring participants understand how to receive and act on time-critical information.
- Layered impact maps, trend charts, and 3D simulations should be introduced as part of future training to help participants visualize flood risk more intuitively.
- Clearer explanations of outputs should be a core training component, so technical experts, decision-makers, and communities can act quickly and effectively during flood events.

Closing perspective

The training demonstrated that the Digital Twin is being considered not simply as a technical platform but as an operational decision-support system whose effectiveness depends on the interaction of technology, data, users and institutions. The discussions therefore provide a clear basis for the next phase of work: strengthening the technical workflow while simultaneously addressing data access, monitoring, usability, capacity, ownership and governance.

Training workshop of Digital Twin - Program

Day 1

Time	Theme	Actors/Facilitators	Type
8:30 AM – 9:00 AM	**Arrival and Registration**	Rahel M. (IWMI)	
9:00 AM – 9:15 AM	Welcoming and Opening Remark; and about the project	Abdulkarim Seid (IWMI)	
09:15 – 10:00 AM	Key Digital Twin concepts, terminologies, and workflow.	Hugo	Presentation
10:00 – 10:45 AM	Interactive discussions	Participants	Discussion
10:45 AM – 10:15 AM	**Group Photo and Health Break**		
11:15 AM – 11:30 AM	End-to-end DT workflow	Hugo	Presentation
11:30 AM– 12:30 PM	Demonstration of IWMI Digital Twins	Hugo	Demonstration
12:30 AM– 1:00 PM	Interactive discussions	Participants	Discussion
1:00 PM – 2:00 PM	**Lunch Break**		
2:00 PM – 2:30 PM	Preparation of DT input data and Overview of data entry into DT – HEC-HMS	Alemseged, Getahun	Presentation
2:30 PM - 3:15 PM	Preparation of DT input data and Overview of data entry into DT – HEC-RAS	Alemseged, Abel	Presentation
3:15 PM - 3:30 PM	Demonstrate the pipeline of data entry to DT	Hugo	Demonstration
3:30 PM – 4:00 PM	**Health Break**		
04:00 – 05:00 PM	General discussion	Participants	Discussion

Day 2

Time	Theme	Actors/Facilitators	Type
8:30 AM – 9:00 AM	**Arrival and Registration**	Rahel M. (IWMI)	
9:00 AM – 9:15 AM	Recap	Participants	
09:15 – 10:00 AM	Consolidate multiple datasets into a database or an accessible catalogue in the DT	Hugo	Demonstration
10:00 – 10:30 AM	Interactive discussions	Participants	Discussion
10:30 AM – 11:00	**Health Break**		
11:15 AM – 11:30 AM	DT visualization	Hugo	Demonstration
11:30 AM– 1:00 PM	Visualization of DT outputs for analysis and decision making	Participants	Hands-on
1:00 PM – 2:00 PM	**Lunch Break**		
2:00 PM – 2:30 PM	3D configuration of the Digital Twin	Hasindu	
2:30 PM - 3:30 PM	Exercises on 3D configuration	Hasindu	Hands-on
3:30 PM – 4:00 PM	**Health Break**		
04:00 – 05:00 PM	General discussion	Participants	Discussion

Day 3

Time	Theme	Actors/Facilitators	Type
8:30 AM – 9:00 AM	**Arrival and Registration**	Rahel M. (IWMI)	
9:00 AM – 9:15 AM	Recap	Participants	
09:15 – 9:45 AM	Operationalizing hydrological models and integrating the outputs within the DT environment.	Eden and Alemseged	Presentation
09:45 – 10:00 AM	DT hydrological model pipelines	Hugo	Demonstration
10:00 – 10:30 AM	Exercises on hydrological model data integration within the DT environment	Participants	Walk through
10:30 AM – 11:00	**Health Break**		
11:15 AM – 11:30 AM	Demonstrate how to connect and configure real-time sensors	Hugo	Presentation
11:30 AM– 1:00 PM	Interactive discussions	Participants	Discussion
1:00 PM – 2:00 PM	**Lunch Break**		
2:00 PM – 2:30 PM	Ensuring proper data flow into the Digital Twin	Hugo	Presentation
2:30 PM - 3:30 PM	General discussion	Participants	Discussion
3:30 PM - 3:45 PM	Closing remark	IWMI	
3:45 PM – 4:30 PM	Networking		



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