

Government of the Republic of Malawi

Malawi Watershed Services Improvement Project (MWASIP)

Biophysical and Ecological Monitoring System (BEMS)

Capacity Building Report

December 2025

Executive summary

Background and context

The Malawi Watershed Services Improvement Project (MWASIP) seeks to improve the governance and management of priority watersheds while enhancing the flow of ecosystem services to downstream users. As part of this effort, the Government of Malawi is establishing the Biophysical and Ecological Monitoring System (BEMS) to provide a unified, digital platform for monitoring soil health, hydrology, forestry, land use, socio-economic trends, and restoration outcomes. Prior to BEMS, data collection across ministries and districts was highly fragmented, inconsistent, and largely manual, limiting the ability to track watershed restoration progress and inform policy decisions. Task 5 was therefore designed to build the technical, institutional, and ICT capacities required to operationalize BEMS, embed it within Government systems, and ensure long-term sustainability beyond the life of MWASIP.

Purpose of capacity building

Capacity building activities aimed to ensure that Malawi develops the human, technical, and institutional capabilities necessary to operate, manage, and sustain the Biophysical and Ecological Monitoring System (BEMS). As a core component of MWASIP, the capacity-building programme was designed to equip the Ministries, Departments or Agencies (MDAs) and district-level officers with the skills required to monitor biophysical, ecological, hydrological, socio-economic, and land-use changes in the project's watersheds. The overarching purpose was to strengthen monitoring systems, standardize indicator methodologies and enable evidence-based reporting on Sustainable Land Management (SLM) outcomes at national and district levels.

Capacity building framework

The BEMS capacity-building framework followed a structured, iterative approach that combined capacity needs assessments, targeted technical training, multi-sector engagement, and progressive system familiarization. The framework recognized capacity building not as an event but as a process - beginning with foundational assessment work under Tasks 1 and 2, advancing through thematic technical training under Task 5, and culminating in practical exposure to BEMS workflows through system demonstrations and end-to-end workflow sessions. This stepwise approach ensured that technical and institutional learning evolved in tandem with system development.

Capacity needs identified

During the project implementation, several capacity gaps were identified at the national and district levels. These included limited competencies in soil, forestry, hydrology, and socio-economic data collection; weak digital literacy for tablet-based data entry; inconsistent metadata and data preparation standards; insufficient ICT infrastructure and helpdesk support; and limited

system administration capabilities relating to microservices, user management, data ingestion, and troubleshooting. Institutional gaps were also evident, including the absence of Standard Operating Procedures (SOPs) and unclear governance structures for BEMS.

Training implemented (2022–2025)

Capacity-building activities were delivered through multiple phases. Baseline-linked training (2023–2024) strengthened practical skills for soil, forestry, socio-economic, and hydrological data collection. System demonstration workshops in 2023 and 2024 introduced stakeholders to the prototype, dashboard, and core system functionalities. The July 2025 Salima training deepened technical understanding of indicator methodologies, while the October-November 2025 IT sessions strengthened backend competencies related to hosting, microservices, data preparation, and troubleshooting. The December 2025 Zomba and Chingale workflow training consolidated these gains by demonstrating the full BEMS workflow - from field data collection to ingestion and visualization.

Key achievements

The programme significantly strengthened MWASIP's multi-sector monitoring capabilities. Participants across the involved departments are now able to apply improved skills in sampling methodologies, digital data management, survey design, forest inventory, hydrological monitoring, GIS and remote sensing, indicator interpretation, and BEMS data ingestion. Officers also demonstrated stronger ICT and system administration abilities through hands-on work with microservice management, ingestion workflows, and backend troubleshooting.

Collaboration among MDAs was visibly improved, with participants showing increased ownership of system processes and a clearer appreciation for integrated monitoring approaches. The training brought together DLRC, the Department of Forestry, the Department of Water Resources, the Ministry of Agriculture, the National Water Resources Authority, the Department of Surveys, and the MWASIP PMU, reinforcing cross-sector coordination. The December 2025 workshop marked a major milestone by giving officers hands-on experience with the full BEMS workflow, enabling them to complete the process independently and directly connect field practices with the system's digital outputs.

The capacity-building programme was comprehensive, multi-phased, and responsive to MWASIP's evolving requirements. It included baseline-linked training, prototype demonstrations, thematic monitoring sessions, IT-focused technical instruction, and full workflow exercises. These activities strengthened competencies across biophysical, ecological, socio-economic, hydrological, forestry, ICT, and data management functions required to operationalize the BEMS.

During project implementation, the consultant trained more than 50 officers from key monitoring institutions in BEMS indicator data collection, data ingestion, data visualization, and system management. These institutions included:

- Department of Land Resources Conservation
- Department of Forestry
- Ministry of Agriculture, Irrigation and Water Development
- National Water Resources Authority
- Department of Water Resources
- Department of Surveys
- MWASIP Project Management Unit
- Department of Agricultural Planning Services

Strategic recommendations

The report recommends prioritizing the institutionalization of BEMS within MDAs through clear roles, SOPs, and integration into sector plans and District Development Plans. ICT systems should be strengthened through LAN configuration, increased bandwidth, stable hosting environments, and a dedicated BEMS Helpdesk. Standardized data workflows, indicator SOPs, and seasonal monitoring calendars should be adopted. Long-term financing for monitoring equipment, ICT maintenance, and refresher training must be secured. Continuous capacity development through mentorship, refresher training, and decentralized resource centers will be essential for sustaining system performance.

Next steps

Priority actions include strengthening cross-sector collaboration, establishing a BEMS-specific Monitoring and Evaluation framework, and aligning BEMS operations with national strategies such as the National Forest Landscape Restoration Strategy (NFLRS) and National Climate Change Management Policy (NCCMP). At regional and continental levels, integration with Southern African Development Community (SADC), African Forest Landscape Restoration Initiative (AFR100), African Union Agenda 2063, and African Development Bank high 5s frameworks will enhance resource mobilization and strategic positioning. Sustaining capacity development through ongoing training cycles, mentorship programmes, and district resource hubs will be critical to ensuring that BEMS becomes a fully operational and nationally owned system supporting Malawi's restoration and watershed management agenda.

Acknowledgement

The consultant wishes to express sincere appreciation to the Government of Malawi, through the Ministry of Agriculture, Irrigation and Water and Sanitation Development, for its leadership and guidance in the implementation of the Biophysical and Ecological Monitoring System (BEMS) under the Malawi Watershed Services Improvement Project (MWASIP). Special thanks are extended to the Project Management Unit (PMU) for its consistent coordination, timely facilitation, and technical oversight throughout the capacity-building process.

The Consultant gratefully acknowledges the valuable contributions of the Department of Land Resources Conservation, the Department of Forestry, the Department of Water Resources, the National Water Resources Authority, the Department of Surveys and all collaborating Ministries, Departments, and Agencies whose officers actively participated in the training and shared their expertise and experience. Their commitment to strengthening Malawi's monitoring systems has been instrumental to the success of this initiative.

Sincere appreciation is also extended to the District Councils and their technical teams for their enthusiastic participation and for providing logistical and field support during the practical sessions. The involvement of community institutions and local stakeholders. including Village Natural Resources Management Committees (VNRMCs), water user structures, and community leaders greatly enriched the practical components of the training and ensured that the exercises reflected real field conditions.

The Consultant recognizes and appreciates the efforts of the MWASIP Technical Team Lead, along with all technical specialists, trainers, and facilitators who contributed to the design and delivery of the training modules across soil, forestry, hydrology, socio-economic assessment, GIS, digital data management, and ICT/system administration. Their dedication ensured a coherent, well-integrated, and impactful learning experience.

Finally, we extend gratitude to all participants for their active engagement, thoughtful insights, and willingness to embrace new digital and technical approaches. Their enthusiasm and professionalism demonstrate Malawi's strong commitment to operationalizing BEMS and enhancing national capacity for monitoring watershed health and restoration outcomes.

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Acronyms/Abbreviations

ABO	Agribusiness Officer
ACO	Agriculture Communications Officer
AEDC	Agriculture Extension Development Coordinator
AEDO	Agriculture Extension Development Officer
AFR100	African Forest Landscape Restoration Initiative
AGCOM	Agricultural Commercialisation Project
AGRESO	Agriculture Gender Roles Extension Services Officer
AU	African Union
BEMS	Biophysical and Ecological Monitoring System
CAO	Chief Agriculture Officer
CSV	Comma-Separated Values
DC	District Commissioner
DCCMS	Department of Climate Change and Meteorological Services
DESC	District Environmental Sub-Committee
DLO	District Labour Officer
DLRC	Department of Land Resources Conservation
DPC	District Project Coordinator
DPW	Director of Public Works
DRA	Disaster Recovery Arrangement
DWDO	District Water Development Officer
EDO	Environmental District Officer
EPA	Extension Planning Area
FAO	Food and Agriculture Organization
FRIM	Forestry Research Institute of Malawi
GBV	Gender-Based Violence
GIS	Geographic Information System
GoM	Government of Malawi
GPS	Global Positioning System
ICT	Information and Communication Technology
IT	Information Technology
KII	Key Informant Interview
LAN	Local Area Network

LIMS	Land Information Management System
LUANAR	Lilongwe University of Agriculture and Natural Resources
LULC	Land Use and Land Cover
MASDAP	Malawi Spatial Data Platform
MCHF	Modern Cooking for Healthy Forests
MDA	Ministry, Department or Agency
M&E	Monitoring and Evaluation
MEPA	Malawi Environment Protection Authority
MoA	Ministry of Agriculture
MoAIWD	Ministry of Agriculture, Irrigation and Water Development
MoNREM	Ministry of Natural Resources, Energy and Mining
MRDRMP	Malawi Resilient and Disaster Risk Management Project
MWASIP	Malawi Watershed Services Improvement Project
NAMIS	National Agriculture Management Information System
NBSAP	National Biodiversity Strategy and Action Plan
NCCMP	National Climate Change Management Policy
NDC	National Data Centre
NDVI	Normalized Difference Vegetation Index
NFLRS	National Forest Landscape Restoration Strategy
NGO	Non-Governmental Organization
NWRA	National Water Resources Authority
PAHLDO	Principal Animal Health and Livestock Development Officer
PMU	Project Management Unit
QA/QC	Quality Assurance / Quality Control
RRO	Relief and Rehabilitation Officer
SADC	Southern African Development Community
SLM	Sustainable Land Management
SOP	Standard Operating Procedure
TA	Traditional Authority
TNM	Telekom Networks Malawi
UPS	Uninterruptible Power Supply
VFA	Village Forest Area
VM	Virtual Machine
VNRMC	Village Natural Resources Management Committee

WB	World Bank
ZIP	Compressed Data File (ingestion package)

1 Introduction

This report documents the comprehensive capacity development strategy implemented to ensure the effective operation and long-term sustainability of the Biophysical and Ecological Monitoring System (BEMS) for the Malawi Watershed Services Improvement Project (MWASIP).

The report first addresses the existing capacity gaps and institutional constraints in natural resources management in Malawi, which informed the necessity for targeted capacity-building initiatives. It then presents the core capacity-building activities carried out during the project, detailing the development and execution of training programs. These initiatives were explicitly designed to enable key stakeholders, including national ministries, departments, and community-level committees to utilize, manage, and sustain the BEMS effectively.

2 BEMS project overview

The BEMS project is a component of the larger Malawi Watershed Services Improvement Project (MWASIP), which is the first in a series of projects that support the implementation of the National Forest Landscape Restoration Strategy (NFLRS). The objective of the BEMS project is to establish a multi-level system for tracking and reporting on the progress of Sustainable Land Management (SLM) outcomes of landscape restoration interventions. Specifically, the project aims to develop and operationalize a GIS-based information system that can:

- Capture, analyze, and visualize spatially-referenced data on bio-physical, ecological and socio-economic changes occurring in target watersheds due to the project interventions;
- Track key project indicators, such as SLM adoption rates, land area under SLM, and data on improved watershed services;
- Provide a platform for identifying land degradation hotspots and soil health constraints to inform targeted interventions to restore degraded areas;
- Meet the reporting requirements of funding institutions, enabling policymakers to better coordinate restoration-related programmes.

3 Capacity building framework for the BEMS

3.1 Understanding capacity building

Capacity building refers to the process of developing and strengthening the skills, knowledge, resources, and abilities of individuals, organizations, and systems to effectively perform their functions and achieve their goals. It involves identifying gaps in existing capacity, designing and implementing strategies to address those gaps, and continuously learning and adapting to improve performance. Capacity building covers several activities such as training, mentoring, knowledge sharing, and institutional development. The goal of capacity building is to enhance

the overall effectiveness, efficiency, and sustainability of individuals and organizations in achieving their objectives (McCance et al., 2007; Kacou et al., 2022; Hanlon et al., 2019; Mery et al., 2017).

3.2 Capacity building framework design

The capacity-building framework for the BEMS is designed to systematically address the needs associated with tracking and reporting on Sustainable Land Management (SLM) outcomes. This framework employs a stepwise approach that includes several critical components: conducting a comprehensive capacity needs assessment, developing tailored training programs, establishing collaborative networks, implementing robust monitoring and evaluation mechanisms, fostering institutional support and policy alignment, and sustaining capacity development efforts over time. Each of these steps is essential for the successful implementation of the BEMS and its integration into broader national and regional development frameworks.

3.3 Objectives of capacity building under BEMS

The primary objective of the capacity-building task was to ensure the sustainable implementation of the BEMS, covering all aspects from data acquisition to system operation. The initial step involved conducting a capacity needs assessment to identify the necessary training for effective implementation. The activities focused on enhancing human, technical, and institutional capacities, which included topic-specific training and recommendations related to existing monitoring systems and management structures.

4 Capacity needs assessment

Capacity needs assessment refers to the systematic process of identifying and evaluating the existing capacities and resources of individuals, organizations, or systems, as well as determining the gaps that hinder effective performance. This assessment was crucial for informing the development of strategies aimed at enhancing capabilities and ensuring that stakeholders can effectively achieve their objectives.

In the context of the BEMS, capacity needs assessment played a vital role in establishing a framework for monitoring and reporting on Sustainable Land Management (SLM) outcomes. Since the BEMS project aims to develop a GIS-based information system that captures, analyzes, and visualizes spatially-referenced data on biophysical, ecological, and socio-economic changes in target watersheds resulting from restoration interventions, capacity needs assessment entailed evaluating the current technical skills, data management capabilities, and institutional frameworks necessary for implementing this system effectively.

4.1 Approach to capacity needs assessment

The approach to assessing in-country training needs was designed as an ongoing process throughout the project, rather than as isolated training sessions. This method aimed to address gaps identified through comprehensive gap analysis and stakeholder engagement, following an iterative cycle of design, application, learning, and adjustment in accordance with agile principles.

The activities were structured to be flexible and responsive to the project's evolving needs, with objectives that encompassed identifying training requirements, developing training materials, and prioritizing capacity development interventions.

Capacity needs were identified on a task-by-task basis, which enhanced collaboration and engagement among key stakeholders, ensuring that their diverse needs, from local to national levels, were effectively addressed. In the inception phase of the project, BEMS expert team interacted with relevant stakeholders for each indicator to ensure their interests were represented while simultaneously building awareness of the project. The complete list of consulted stakeholders is shown in Annex 8.1.

During the Development of the framework for biophysical and ecological monitoring (Task 1) activities, the consultant mapped out the relevant stakeholders and used interviews as a tool to identify their capacity needs.

During the stakeholder meetings and training interactions for the Collection of Spatially Referenced Baseline Data for the BEMS (Task 2) activities, the consultant identified several indicator-specific core capacity needs among the trainees, who were primarily stakeholders involved in the project. These needs encompassed various aspects of data management, including data collection, data entry, data cleaning, and data analysis. The observations made during these interactions highlighted the necessity for targeted training and support to enhance the stakeholders' competencies in these critical areas, ensuring the effective implementation of the monitoring system.

To understand the capacity needs for modern ICT equipment and tools for data management related to Task 3 activities, a mapping exercise was conducted with several key objectives. First, the exercise aimed to establish the current state of ICT infrastructure and services at the proposed implementation site, including an assessment of existing systems and personnel. Second, it involved taking an inventory of current hardware, software, and network resources to prevent duplication in the procurement plans for the Biophysical and Ecological Monitoring System (BEMS). Additionally, the mapping exercise sought to explore opportunities for data exchange and integration with other existing systems within Government Ministries, Departments, and Agencies (MDAs). Finally, it aimed to investigate operational and sustainability models of existing systems within these government entities, thereby ensuring that the proposed ICT solutions are both effective and sustainable.

To achieve these objectives, the mapping exercise covered the following:

- Stakeholder engagement
- Survey of existing ICT infrastructure and services at the proposed site of deployment i.e. the Department of Land Resources Conservation
- Survey of existing ICT infrastructure and services at the MWASIP site
- A survey of the available resources at the Malawi National Data Centre, located in Blantyre

- Review of similar systems, including the Land Information Management System (LIMS) implemented by the Ministry of Lands, the National Agriculture Management Information System (NAMIS) under the Ministry of Agriculture and the Malawi Spatial Data Platform (MASDAP) at the Department of Surveys (Ministry of Lands)

A critical aspect of the Biophysical and Ecological Monitoring Systems (BEMS) consultancy project involved the assessment of capacity needs for the use of the BEMS. This assessment was conducted in close collaboration with relevant stakeholders to ensure that their specific needs were accurately identified. Throughout the Task 4 activities, the consultant prioritized the evaluation of capacity gaps during each meeting with stakeholders, ensuring that these gaps were documented and addressed. The insights gathered from these discussions informed the consultant's definition of necessary training requirements aimed at enhancing the existing technical capacities related to the specific GIS, interface, and data management tools essential for the effective operation and maintenance of the BEMS.

4.2 Capacity gaps and needs identified

4.2.1 Task 1: Framework for bio-physical, ecological and socio-economic monitoring

In August 2022, a two-person team of consultants conducted several sensitization meetings with the seven district councils implementing the Malawi Watershed Services Improvement Project (MWASIP). The primary objectives of these meetings were to introduce the development of the BEMS and to gather high-level information on the status of monitoring of selected biological, physical and ecological indicators in the districts. The consultative approach involved presenting the BEMS activity, including its core objective, proposed approach, thematic areas, and team expertise, to representatives of the District Environmental Sub Committees (DESC). Where possible, the team also briefed the District Commissioner (DC) before engaging the DESC. The consultations took the form of group discussion guided by a series of questions focused on six themes: land use management, conservation of biological diversity, forest area restoration, irrigation development, crop production and productivity, sustainable land management and watershed management benefits.

District-level engagement findings:

- All seven impact districts are actively collecting data to monitor certain indicators; however, significant gaps exist in the monitoring of specific biophysical and ecological indicators. These gaps are primarily attributed to limited human, technological and financial resources.
- There is a lack of clear methodologies and frameworks to provide consistent and comprehensive guidance on indicator-specific data collection and monitoring procedures.
- Some proposed indicators for the BEMS, such as the Normalized Difference Vegetative Index (NDVI) and soil, water and forest monitoring parameters are not currently monitored

at the district level. Monitoring of species diversity and Land Use and Land Cover (LULC) occurs only when national entities have a vested interest, often fulfilling project requirements rather than as part of routine efforts. Consequently, districts are involved only periodically in data collection for national initiatives, and results are seldom shared back with them.

- The use of modern technology for data collection is limited. Many indicators that require technology measurement, such as GIS and remote sensing, and soil and water quality analysis, pose a challenge for the districts, which primarily rely on manual data collection methods, such as observation and estimation. This reliance increases the risk of human error and inaccuracies in the data collected. Most data are recorded in monthly, quarterly and annual reports shared with national sector entities as required, while other data is archived on personal computers, leading to potential data loss due to inadequate storage and backup systems.

National-level engagement findings:

During the initial BEMS consultations with the Department of Forestry (DoF), it was noted that data is collected across various categories, including tree species composition, carbon stock, biomass stock, deforestation rates, afforestation and reforestation efforts, natural regeneration in degraded areas, endangered and invasive species, charcoal and firewood production, forest related crime, forest landscape restoration (FLR), forest fires, and revenue collection from log sales and licenses.

It was emphasized that, given the project's focus on improving watersheds, there should be an expectation of enhanced surface water quality due to reduced soil losses and improved groundwater levels from increased rainfall infiltration and recharge. Monitoring sediment yield analysis will provide insights into soil loss and sedimentation in rivers and reservoirs. Additional key indicators will focus on groundwater levels and water quality, with the final list of indicators being determined based on practicality for periodic monitoring, data availability and relevance to assessing the impact of watershed management and improvement interventions.

Summary of Task 1 capacity identification

Existing capacity strengths:

- Evidence of ongoing data collection monitoring for the majority of BEMS indicators.
- Gaps in monitoring data do not stem from a lack of knowledge about data collection but rather from resource availability across departments, which often limits factor data collection efforts.

Areas for capacity building:

- Establishing a clear methodology and framework for data collection and monitoring will enhance the quality and consistency of data across national and district-level stakeholders.

- Introducing indicator-specific data collection, particularly for hydrological and soil-related indicators, is essential to support effective watershed monitoring.
- There is a need to improve the use of modern technology for data collection, storage and analysis to enhance overall monitoring capabilities.

This structured approach was important to facilitate the effective implementation of the BEMS and contribute to the overarching goals of the MWASIP.

4.2.2 Task 2: Data collection, entry, cleaning and analysis

To identify the core competency requirements for data collection, entry, cleaning and analysis, relevant stakeholders were actively involved in the data collection fieldwork, which included both training and implementation. This engagement aimed to assess current capacities in key areas such as numeracy, statistics, sampling methodologies, digital data collection, and data management. Given that methodologies for data collection varied across the four groups of indicators - socio-economic, soil, forestry and hydrological - the capacity building needs also differed accordingly. The primary format of capacity building in this task was through direct participation. The overall approach and key steps taken to achieve this are summarized below and illustrated in Figure 4-1.

1. **Stakeholder engagement:** The consultant conducted a series of in-person consultations with relevant stakeholders to discuss existing data collection and monitoring activities. These discussions focused on data collection methods, outputs (including data formats and usage) and reporting requirements. The objective of this step was to identify specific data collection needs, output expectations, and training requirements.
2. **Theoretical training:** In-person training sessions were designed and delivered by the consultant to ensure stakeholders understood the project's objectives and methodologies. These sessions aimed to build capacity in core aspects of data collection, including sampling methodologies, survey design and best practices. The training covered the following topics:
   - An introduction to the aims and objectives of the project;
   - A discussion of the indicators to ensure participants understood what data was being collected and the rationale behind it.
   - Demonstration by key experts on field data collection techniques and an introduction to best practices.

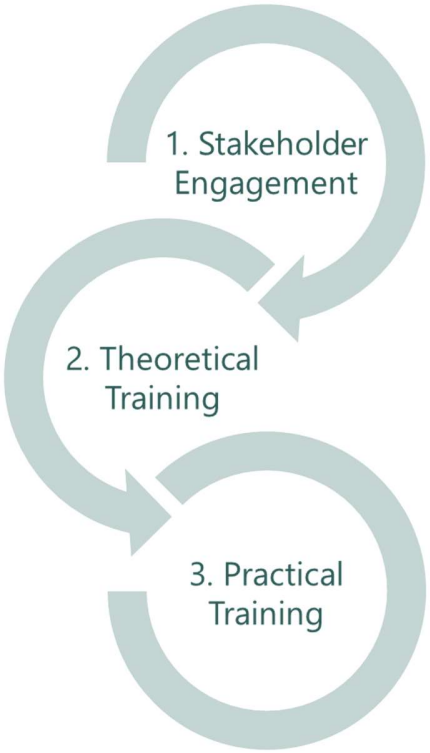


Figure 4-1: A three-pronged approach to developing capacity during BEMS Task 2 data collection activities.

- A paper-based review of the survey content, questions and expected outputs.
- A theoretical introduction to digital survey data collection and best practices.

3. **Practical training:** This component of the training was two-fold. Before the actual data collection in the field, participants visited appropriate pilot sites to test the digital data collection tools in a realistic scenario. These sessions also focused on practical data collection methods specific to soil, forestry and hydrological indicators. The objective of this step was to equip stakeholders with the necessary tools and knowledge to replicate the data collection process in the field, ensuring the quality and consistency of the data collected.

This structured approach to capacity building enhanced the stakeholders' ability to effectively collect, manage, and analyze data, thereby contributing to the overall success of the BEMS project.

4.2.2.1 Capacity needs for socio-economic indicators

The capacity needs assessment for the socio-economic baseline assessment revealed several critical areas requiring enhancement to ensure effective data collection and analysis. These needs were identified during the process of selecting socio-economic indicators in consultation with government stakeholders, particularly those involved with the Malawi Watershed Services Improvement Project (MWASIP).

- **Data collection methodologies**: There is a need for improved understanding and application of various data collection methodologies, including sampling techniques and survey design. Training in these areas is essential to ensure that data collected is representative and reliable.
- **Digital data management skills**: As the BEMS relies on digital tools for data collection, there is a significant capacity gap in the use of tablets and other digital devices among enumerators. Training programs should focus on enhancing digital literacy and proficiency in using these tools for effective data entry and management.
- **Quality Control Procedures**: Establishing robust quality control measures is critical for ensuring the integrity of the data collected. Training should emphasize the importance of data verification processes and the implementation of standardized protocols to minimize errors during data collection.

The identification of these training needs was emphasized during the initial stakeholder consultations in Task 1 and continued through ongoing discussions in Task 2. The consultant's extensive experience in implementing socio-economic and spatial surveys both nationally and internationally played a crucial role in shaping the training content to address the specific capacity gaps identified.

4.2.2.2 Capacity needs for soil indicators

Engagements with relevant stakeholders were conducted to assess the capacity needs for soil indicators. Key stakeholders included officers from Chitedze Research Station, the Department of

Land Resources Conservation, the Department of Water Resources, the Department of Surveys, and the Lilongwe University of Agriculture and Natural Resources (LUANAR). A site visit and consultation at Chitedze Research Station highlighted the existing capacity to conduct a range of physio-chemical assessments to extract indicator-relevant data from field samples.

From these engagements, existing capacities and areas for building capacity were identified at both the district and national levels. The core areas highlighted for capacity building included:

- Identification of soil sampling sites: Training on selecting appropriate sites based on land use and soil variability.
- Mobilization of soil sampling equipment and tools: Addressing resource constraints and ensuring the availability of necessary tools.
- Preparation of soil sampling pits: Standardizing pit design and depth measurement.
- Collection of soil samples: Enhancing practical skills for field officers in handling and storing samples.
- Treatment and management of soil samples: Establishing protocols for sample preservation and transportation.
- Pre-treatment of soil samples before analysis: Training in drying, sieving, and chemical treatment of samples.
- Analysis and collation of soil data: Strengthening data recording techniques and ensuring compatibility with BEMS.
- Interpretation of soil analysis results: Building capacity to correlate soil test results with land productivity and health indicators.
- Comparative analysis with remote sensing data: Training on validating soil conditions using remote sensing and GIS tools.
- Soil data entry into BEMS: Establishing a structured process for inputting field and lab data into the monitoring system.

4.2.2.3 Capacity needs for forestry indicators

Capacity needs for forestry inventory were identified through discussions with officials from the Forestry Department's National Forestry Inventory section, the Forestry Research Institute of Malawi (FRIM), the Modern Cooking for Healthy Forests (MCHF) project, and the Malawi Watershed Services Improvement Project (MWASIP). Additional needs were highlighted during theoretical and practical training sessions. The main capacity needs identified included:

- Basic capacity in plant identification and forest inventories: Strengthening the ability of staff to identify tree species, record forest composition, and assess biomass.
- Use of remote sensing and GIS for data analysis: Training in satellite imagery interpretation, GIS-based forest mapping, and georeferencing for inventory planning.
- Digital data collection: Transitioning from paper-based to tablet-based forestry inventory data collection to improve efficiency and accuracy.

4.2.2.4 Capacity needs for hydrological indicators

The capacity assessment focused on identifying gaps and needs in two key areas: first, related to hydrological data collection and analysis for relevant field personnel (data collectors); and second, related to the water quality monitoring and analysis capabilities within the Department of Water and Sanitation. Discussions with representatives from the Department of Water Quality were instrumental in understanding the hydrological data indicators pertinent to the BEMS, as well as the methodologies employed for data collection. The assessment revealed several key capacity needs, which are outlined below:

- Technical competencies: There is a need to enhance expertise in hydrological data collection techniques, suspended sediment sampling, and water quality analysis among personnel.
- Equipment availability: Resource constraints were identified concerning the availability of essential sampling tools, laboratory testing kits, and field monitoring devices.
- Data management processes: Improvements are needed for data entry, storage, quality control, and the integration of data into the BEMS framework.
- Institutional framework: Strengthening collaboration between national and district water quality laboratories is crucial to ensure standardized procedures and practices.

The hydrological data indicators relevant to the BEMS project were categorized into two primary types: suspended sediments and water quality indicators. These indicators were selected in direct consultation with the Department of Water Quality during Task 1, ensuring that the team involved in hydrological data collection was familiar with them.

An institutional capacity assessment was conducted at the Lilongwe Central Water Quality Laboratory and the Blantyre Water Quality Laboratory to evaluate their capabilities in testing water samples effectively. Meetings with the Ministry's Deputy Director underscored critical gaps in laboratory capacity and highlighted the necessary equipment required to enhance testing efficiency. Detailed findings from the gap and needs assessment are presented in Annex 8.2.

4.2.3 Task 3: Purchase of modern ITC equipment and tools for data management

The successful operation and sustainability of the Biophysical and Ecological Monitoring System (BEMS) are critically dependent on a robust Information and Communication Technology (ICT) infrastructure, efficient support systems, and comprehensive data management capabilities. This ICT needs assessment was conducted to evaluate existing resources, identify gaps, and propose recommendations for strengthening ICT capabilities at the Department of Land Resources Conservation (DLRC) and the Malawi Watershed Services Improvement Project. Additionally, the assessment explored potential hosting solutions at the Malawi National Data Centre (NDC).

The assessment focused on several key ICT components:

- **ICT infrastructure (hardware and network)**: Evaluating the availability and condition of servers, networking capabilities, and power solutions.

- **ICT support and personnel:** Reviewing the availability and effectiveness of ICT staff.
- **System hosting and business continuity**: Assessing existing hosting arrangements and disaster recovery planning.
- **Internet and connectivity**: Analyzing internet stability and network efficiency.
- **Physical security and environmental control**: Examining security measures, access control, and fire suppression systems.

The needs assessment was conducted through a combination of methods:

- On-site surveys at DLRC and MWASIP offices.
- Consultations with ICT personnel at both institutions to understand existing support structures.
- Evaluation of hosting capabilities at the Malawi National Data Centre (NDC).

4.2.3.1 ICT Infrastructure (hardware and networking)

The Malawi Watershed Services Improvement Project (MWASIP) has a well-equipped server room with multiple functional processing and storage servers. However, the facility lacks redundant power solutions, which could impact system availability during power outages. In contrast, the Department of Land Resources Conservation operates with a single processing server, which is insufficient for large-scale data management. Additionally, storage capacity at DLRC is inadequate, and no structured server maintenance plan is in place to ensure system reliability.

The **key identified gaps** include limited functional storage capacity at DLRC, which restricts data management capabilities, and the need for additional backup storage solutions at MWASIP to maintain uninterrupted operations of the BEMS. Addressing these challenges will be crucial for ensuring system resilience, data integrity, and operational efficiency.

4.2.3.2 ICT support and personnel

The Department of Land Resources Conservation lacks dedicated ICT support, relying on external assistance from the Ministry of Agriculture or E-Government for technical troubleshooting and maintenance. This dependence on external support significantly limits timely issue resolution and system maintenance. On the other hand, MWASIP employs two ICT personnel to support 79 users, but it lacks a formal help desk or a structured support framework, making user support inefficient and inconsistent. The absence of an in-house ICT help desk at both locations hinders rapid response to technical challenges, while DLRC remains severely under-resourced in ICT expertise, making it reliant on external personnel for even basic support functions.

4.2.3.3 System hosting and business continuity

In terms of system hosting and business continuity, DLRC does not host any systems on-premises or in the cloud, and it lacks a disaster recovery plan, creating significant risks for data management and accessibility. MWASIP, however, hosts multiple systems, including Tompro GRM and IVMS,

which are critical to its operations. However, it also lacks a structured disaster recovery plan, leaving mission-critical data vulnerable to system failures or power disruptions. The absence of a dedicated hosting solution at DLRC makes data storage unreliable. At the same time, MWASIP's lack of a formal business continuity plan exposes critical project data to security and operational risks.

4.2.3.4 Internet and local connectivity

Regarding internet and local connectivity, DLRC staff primarily rely on personal 4G routers for internet access, even though the facility has a 100Mbps LAN and Wi-Fi infrastructure that remains unused due to configuration issues. MWASIP, in contrast, has a stable 2Mbps TNM fiber connection and an active 100Mbps LAN with Ethernet and Wi-Fi access, allowing for relatively stable connectivity. The underutilization of high-speed networking at DLRC and the growing bandwidth limitations at MWASIP pose significant challenges to effective system integration and data exchange.

4.2.3.5 Security and environmental control

Security and environmental control remain key concerns. DLRC's server room has minimal security measures and has experienced past vandalism incidents, raising concerns about equipment safety and system integrity. Meanwhile, MWASIP's server room is physically secure but lacks electronic access controls and surveillance systems, making it vulnerable to unauthorized access. Additionally, both locations lack fire suppression systems, exposing critical ICT infrastructure to fire hazards. Given these risks, DLRC requires improved physical security, while MWASIP should install access control mechanisms and surveillance cameras to strengthen data security and system reliability.

4.2.3.6 Technical development and deployment milestones

During the BEMS project implementation, a phased and iterative development approach was followed, ensuring continuous consultation with the Client to refine features, aesthetics, and user experience (UX). Key technical phases, from prototype (v0.1) to the final version (v1.12), focused on creating a resilient, secure, and locally hosted system:

1. Platform development and migration to secure protocol: The system architecture was finalized, defining development, staging, and production environments, with the BEMS core components developed as microservices. Critical changes included establishing the official government domain (bems.agriculture.gov.mw), completing the setup of a CI/CD pipeline, and the migration of the BEMS User Interface (UI) to a secure HTTPS protocol with dedicated SSL certificates. This provided a foundational security layer. Furthermore, the development of the data model and the finalization of the six core modules (map, dashboard, indicators, analytics, reports, and messages) ensured BEMS 1.0 and subsequent releases met the functional requirements for a Minimum Viable Product (MVP).

2. Local infrastructure and on-premise deployment at DLRC: A major institutional change was the physical setup of the BEMS production environment at the client's site, the Department of Land Resources Conservation. The process involved verifying the installation of the required hardware - two (2) processing servers and one (1) storage server - and the configuration of four (4) virtual machines to host the system. The chosen platform for container orchestration, Kubernetes/vMware Tanzu, was installed, enabling robust management of the microservices. This on-premise deployment, followed by extensive testing of BEMS v1.12 on the DLRC's Local Area Network (LAN) and the Government Wide Area Network (GWAN), ensured the system's operational readiness and local control.

3. Network resilience and quality assurance: System institutionalization required significant network enhancements to guarantee high availability. The primary connection was verified through the GWAN Fiberlink, but to mitigate risk and ensure continuity of service, a vital change was the installation of a secondary internet router at DLRC. This change paved the way for the deployment of a secondary GWAN/ESCOM fiber link to provide essential network redundancy. Concurrently, the consultant performed additional quality assurance and security assessments of BEMS v1.0, implemented a more robust authentication system, and refined the system's usability (UI/UX), ensuring the final deployment was secure and highly reliable for long-term government operation.

4.2.4 Task 4: Design and test the BEM system

A comprehensive Training Needs Assessment (TNA) was executed to ensure that capacity-building efforts were precisely aligned with the specific operational requirements of BEMS users and the project's sustainability goals.

Assessment methodology and scope

This assessment was initiated and conceptualized during the BEMS prototype and dashboard workshop held on December 8, 2023, and was subsequently refined during a broader stakeholder consultation workshop conducted in Mponela in July 2024. To effectively tailor the capacity-building curriculum, the consulting team deployed a targeted online questionnaire in May 2024 to a sample of 21 prospective users.

The assessment’s primary objectives were to:

- Identify existing training gaps across various user roles.
- Delineate the competencies necessary for effective system utilization.
- Ascertain preferred methods for delivering training.

A total of 21 respondents participated in this assessment, representing a diverse array of institutions, including the Department of Land Resources Conservation, the MWASIP Project, the Department of Forestry, the Department of E-Government, and the Machinga District Council.

Respondents classified their roles into the four intended BEMS operational categories: End-Users, Data Managers, Data Collectors, and System Administrators.

Key findings and gaps

The detailed findings from the questionnaire were instrumental in informing the final training design and revealed critical operational gaps across the user spectrum. The full results of this assessment are provided in Annex 8.3 of this report.

Specifically, the assessment highlighted:

- End-users: A general unfamiliarity with BEMS concepts and limited experience in interpreting environmental data, despite most being environmental scientists.
- Data managers: A lack of experience in advanced data quality control and data cleaning procedures for large datasets, as well as poor exposure to data security best practices (e.g., access control and user authentication).
- Data collectors: Limited exposure to modern data ingestion tools and API-based data transfer, alongside limited experience with data quality control procedures for environmental data.
- System administrator: The sole administrator representative, while confident in basic security, represents a single point of failure and requires focused training on Linux and complex system maintenance.

These findings ensured that the subsequent capacity-building activities were targeted precisely to overcome these identified constraints, thereby guaranteeing the long-term operational viability of the BEMS platform.

5 Capacity building implementation and details of training programme

5.1 Approach to capacity building

The consultant's approach to capacity building on the utilization and management of the BEMS was to conduct capacity building as an iterative process throughout the project, rather than stand-alone training exercises. The flow of capacity building includes (see Figure 5-1):

- Engagement
- Design
- Application
- Learning

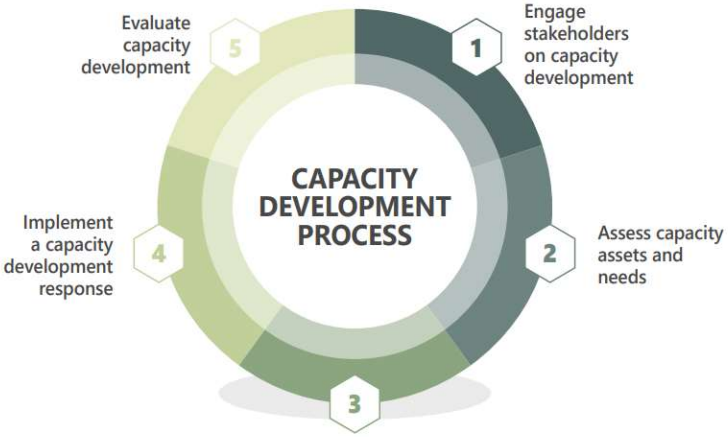


Figure 5-1: Capacity development process

- Adjustment

On April 25, 2023, the Consultant facilitated a workshop with relevant government stakeholders[1]. During this session, each of the BEMS indicators and the methodologies for data collection were reviewed. This workshop served as an initial capacity-building opportunity, introducing participants to the techniques that would be employed for data collection. It also encouraged open discussions with the client to assess the existing capacity for data collection and to identify key areas for focus in future formal training events aimed at addressing capacity gaps. The insights gained from this engagement informed the development of the subsequent training plan for the remaining BEMS activities.

5.2 Data collection training on socio-economic indicators

5.2.1 Training context and purpose

The socio-economic and geospatial data collection training was conducted as part of the baseline survey for the MWASIP, rather than as a dedicated capacity-building initiative. This training took place from May 15 to May 17, 2023, in Lilongwe and targeted frontline technical staff from several key institutions, including the Department of Forestry, the Forestry Research Institute of Malawi (FRIM), the DLRC, and the Department of Surveys. A total of 24 participants (16 males and 8 females), all with over 10 years of experience in data collection and analysis, attended the training. The primary objective was to equip participants with the skills necessary for high-quality socio-economic and geospatial data collection.

5.2.2 Training content and delivery

The training was delivered through a blend of lectures, workshops, practical exercises, and role-playing simulations, providing participants with hands-on experience in data collection. The program covered several key topics, including:

a. Introduction to socio-economic data and geospatial technologies
   - Overview of socio-economic indicators
   - Introduction to Remote Sensing and Geographic Information Systems (GIS)
b. Data extraction and processing from the BEMS
   - Socio-economic data extraction and processing
   - Remote sensing data processing from online repositories
c. Biophysical analysis using remote sensing
   - Land Use Land Cover (LULC) classification
   - Vegetation indices
   - Change detection techniques
d. Case studies and practical exercises
   - Real-world applications of GIS and remote sensing for socio-economic data analysis

[1] Those in attendance included representatives from Ministry of Water Resources Authority, Department of Land Resources Conservation, the Project Management Unit, Department of Water Resources and MWASIP.

5.2.3 Training participation and engagement

Although the training content was not developed collaboratively with participants, their feedback was actively sought and incorporated during the sessions. The client provided comments and input throughout the training, which were considered for refinement. Engagement levels were rated at 4 out of 5, indicating a high degree of participation.

5.2.4 Training evaluation and impact

The success of the training was assessed based on the quality of the data collected post-training, which was found to be satisfactory. No significant challenges were reported, and participants effectively collected and processed socio-economic and geospatial data. However, it is important to note that pre- and post-training assessments were not conducted, as the primary focus was on achieving data quality rather than enhancing individual competencies.

5.2.5 Participant feedback and recommendations

While the training adequately prepared participants for data collection, there were recommendations for additional training on system functionalities. Future training sessions should include:

- Analyzing socio-economic indicators directly within the BEMS system
- Advanced data processing techniques
- Integration of GIS and remote sensing tools for deeper spatial analysis

5.2.6 Training resource availability

All planned training materials, including PowerPoint presentations and case study documents, were made available. These materials can be updated and utilized for future training sessions tailored to specific target audiences.

5.3 Data collection training on soil indicators

For soil testing, before the fieldwork, all team members underwent training on 9th, 10th and 12th June 2023. The training comprised a theoretical introduction to soil tools and data collection methods on the first day (**Fehler! Verweisquelle konnte nicht gefunden werden.** and **Fehler! Verweisquelle konnte nicht gefunden werden.**). Several representatives participated in the training.



Figure 5-2: Theoretical soil training held at in Lilongwe on Thursday 8th June, led by BEMS Soil Scientist John Mthandi

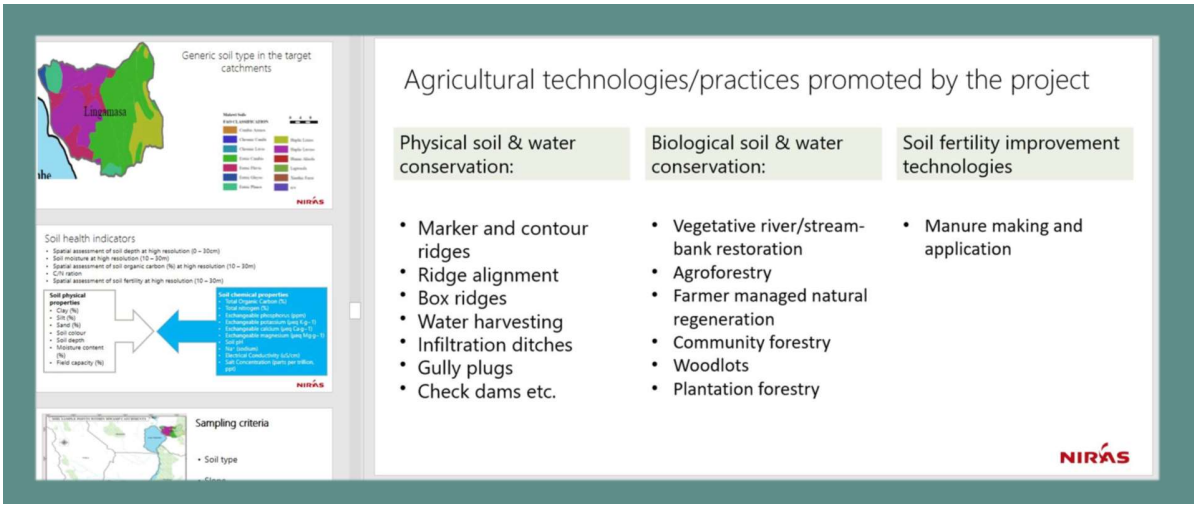


Figure 5-3: Slides from the theoretical soil training held in Lilongwe on Thursday 8th June. This covered agricultural practices expected to see in t ction

The desk-based training was followed by a practical session in a privately-owned field in Lilongwe that was identified through site sampling using criteria of soil type, slope and agricultural activity on the site. This involved a demonstration on how to prepare a site for soil sampling, direction and digging of a 2m soil profile and collection of soil samples.



Figure 5-4: Practical soil training in Lilongwe on Friday 9th June, led by BEMS Soil Scientist John Mthandi

Some of their key observations during this mission were to make sure that the soil profiles were filled up when the soil data collection process was through and to ensure that soil samples were quickly deposited at Chitedze research station laboratory to avoid the sampled soil getting spoiled.

The field teams were set up in a way to encourage ongoing capacity building in the field. This was achieved through the designation of team leaders with sufficient knowledge of a) soil sample collection and b) navigation and geo-referencing data in the field. The field team was also accompanied by a Professor from LUANAR, who conducted on-the-job training specifically for sample collection. Furthermore, the field teams were in regular contact with the consultant, who accompanied the teams at random points during field data collection, to provide support and identify and address any ongoing issues and adapt the process and training accordingly.

The soil data collection team was comprised of a team leader who was responsible for coordination and backstopping services. He was also tasked with leading the team to the pre-identified soil sampling points. The actual exercise of measuring soil profile was coordinated by the consultant and was assisted by two experts with Bachelor's degrees in soil science from LUANAR. Prof. Max Lowole periodically backstopped the technical procedures of soil data

collection and the measurement of physical parameters on site. A soil technician from Chitedze Research Station participated in the data collection exercise. On two occasions while in the field,



Figure 5-5: a) The soil team digging pits in the field, b) Prof. Max Lowole from LUANAR and the Soil Team Leaders conducting in-field training for recording data on soil profiles

the client sent officers from the Government to come and supervise the team. The officers were from the Department of Land Resources, the Department of Surveys and Department of Forestry.

5.3.1 Training evaluation

Engagement levels were rated 4 out of 5, but pre- and post-training assessments were not conducted, limiting the ability to measure learning improvements quantitatively. Participants emphasized the need for more structured and recurring training sessions to reinforce knowledge and skills in soil data handling and digital integration into BEMS.

5.3.2 Recommendations for future training

To address the identified challenges and enhance future training initiatives, the following recommendations were proposed:

- Expand sessions on advanced soil analysis techniques: Provide training on advanced methodologies for soil testing and analysis.
- Improve data structuring for digital integration: Focus on standardizing data entry formats to facilitate smoother integration into BEMS.
- Provide training on linking soil data with GIS: Enhance participants' skills in using GIS for spatial trend analysis.
- Ensure availability of standardized soil testing kits: Prioritize the procurement of necessary equipment for field teams.

The long-term impact of the training is expected to improve soil data collection and management, enhance accuracy in soil quality assessments, and better integrate soil indicators into land management and agricultural planning. Attendance was fully recorded, and all planned training materials, including slides, handouts, and practical exercises, were available.

5.4 Data collection training on hydrological indicators

The Hydrological Data Planning and Collection training was conducted from June 26 to June 29, 2023, in Liwonde, Machinga, targeting middle management staff from the Ministry of Water and Sanitation, Department of Water Resources (Water Quality Division). A total of six participants (five males and one female) attended the training, which aimed to build capacity in hydrological sampling and analysis, focusing on water quality and sediment sampling, hydrological data analysis, and digital data management.

5.4.1 Training delivery

The training was delivered through a combination of lectures, hands-on practical sessions, and field demonstrations. Participants engaged in real-time water sampling at the Shire River mouth using a boat, following standard hydrological sampling procedures. The training content was tailored based on prior consultations to address specific capacity gaps identified within the Ministry. Participants included water chemists and microbiologists responsible for water quality analysis and data processing, along with team leaders involved in hydrological monitoring projects.

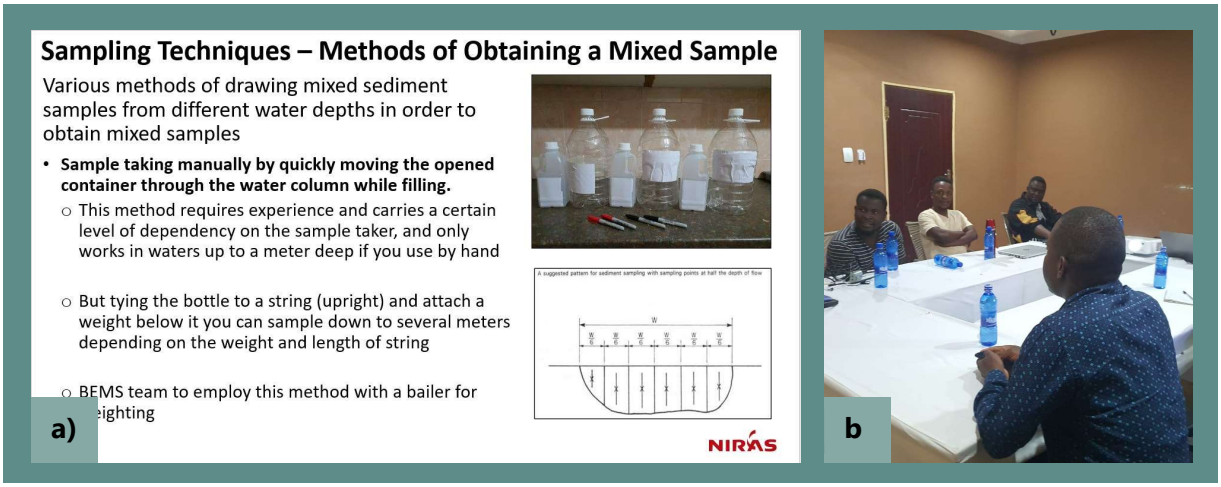


Figure 5-6: a) An extract from the PowerPoint training presentation held in Liwonde on 26th June 2023, b) participants at the training

5.4.2 Key skills and knowledge gained

Participants acquired essential skills and knowledge during the training, including:

- Groundwater sampling techniques
- Integration of remote sensing data with collected hydrological data
- Sediment sampling procedures
- Sample labeling for analysis

Participant engagement was rated highly (5 out of 5), and feedback was overwhelmingly positive, particularly regarding the practical aspects of the training. However, a significant challenge noted

was that the training duration was insufficient for extended practical demonstrations before full-scale data collection.



Figure 5-7: a) Suspended sediment sample collection being done on 5 different points cross-sectionally under Likwenu River Bridge in Machinga District. The river is easily accessible with low flow and low water levels at this time of the year on 27th June 2023. b) Water samples

5.5 Data collection training on forestry indicators

The Forestry Inventory Training was conducted between June 14 to July 11, 2024, in Lilongwe, targeting Forestry Department field staff, community representatives, and private sector actors. A total of 15 participants (12 males and 3 females) attended the training, representing organizations such as the Forestry Department (Headquarters), National Herbarium and Botanic Gardens, and District Forestry Offices. The training aimed to enhance knowledge and skills in planning and implementing forestry inventories, particularly in field data collection, survey planning, and digital data entry for forestry inventory systems.

5.5.1 Training delivery

The training was delivered through a combination of lectures, field practical sessions, and interactive pilot surveys, allowing trainees to actively gather inputs, share experiences, and propose improvements. The approach included mentorship, where trainees were paired with experienced forestry staff to build their confidence in areas such as GIS mapping and plant identification. The training content was tailored to the audience's needs, incorporating participant feedback and field-based observations.

Prior to collecting data in the field, all team members underwent training on 9th, 10th and 12th June 2023. This training comprised a theoretical introduction to forest inventory, tools and data

collection methods on the first day, followed by a practical session in Lilongwe Nature Sanctuary during the second and third day (Figures 5-8 and 5-9). During this practical training session, the teams covered how to record tree height, diameter at breast height, crown diameter and species as well as how to input data into the tablet. District-based personnel and local community members who joined the teams later in the field were given a brief orientation training on-site.

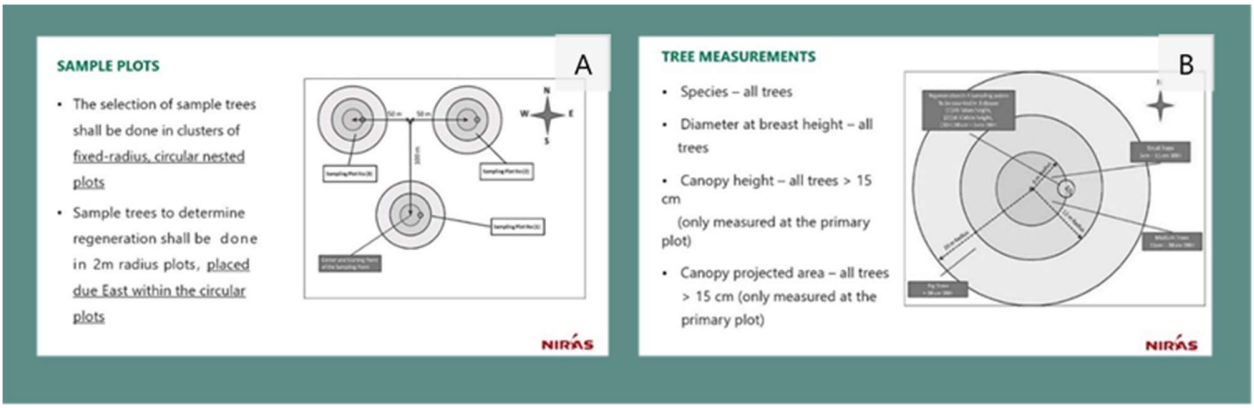


Figure 5-8: Slides from the theoretical forestry data collection training detailing how to collect information in the field (based on guidance provided on Forest Inventory Standard Operating Procedures (DoF, 2018)



Figure 5-9: The Forestry team carrying out the practical session in Lilongwe Nature Sanctuary

5.5.2 Key skills acquired

Participants gained essential skills, including:

- Modern forestry inventory techniques
- Use of digital tools for data collection
- GIS applications in forestry monitoring

- Improved reporting on forest indicators

Despite these successes, several challenges were noted, including:

- Insufficient training equipment and materials
- Gender imbalance among participants
- Limited participation from forestry extension staff and community members
- Difficulties in electronic data input due to system glitches

Nevertheless, the training successfully demonstrated the importance of transitioning from manual to electronic data entry. Participants recognized that the digital system, once fully functional, would significantly improve inventory accuracy and efficiency. In the long term, the training is expected to improve forestry inventory practices, enhance the accuracy of reporting on forest indicators, and better integrate digital tools in data collection. Attendance was fully recorded, and while some equipment was borrowed for a limited period, the available resources were effectively utilized. Although photos and videos were taken, no participant outputs such as case studies or brainstorming charts were documented.

5.5.3 Recommendations for future training

To address the identified challenges and enhance future training initiatives, the following recommendations were proposed:

- Expand training participation: Include more field staff and forestry extension officers to ensure broader community involvement.
- Address technical issues: Resolve technical problems with the electronic data input system to facilitate smoother data entry.
- Conduct refresher courses: Implement refresher courses to reinforce forestry data collection practices and promote the adoption of modern inventory techniques.

A four-day refresher training workshop (see chapter 5.7) was held from 28 to 31 July 2025 to strengthen the capacities of institutions involved in the BEMS. The workshop targeted participants who completed the initial 2023 BEMS training and aimed to reinforce their technical competencies and ensure consistent application of BEMS data-collection protocols.

The programme focused on four thematic areas: socio-economic data collection, soil indicators, forestry indicators, and hydrological/water-quality monitoring. Sessions combined classroom instruction with practical demonstrations, case studies, and group discussions. This approach helped participants consolidate their skills in survey design, sampling procedures, data cleaning, GIS integration, indicator measurement, and data interpretation within the BEMS platform.

The workshop was delivered by experienced subject matter experts in GIS and socio-economic data, soil science, forestry, and hydrology. Participants were drawn from key government

departments, research institutions, and universities directly involved in national monitoring activities.

Each day addressed a specific thematic module:

- 28 July 2025 – Socio-economic data collection: tablet-based surveys, data quality control, and BEMS integration.
- 29 July 2025 – Soil indicators: sampling methods, laboratory analysis, soil–GIS correlation, and interpretation of results.
- 30 July 2025 – Forestry indicators: species identification, forest inventory, biomass measurement, and GIS/remote sensing applications.
- 31 July 2025 – Hydrological and water-quality monitoring: water and sediment sampling, suspended sediment protocols, remote sensing for flow estimation, and data integration.

5.6 BEMS system development and demonstration sessions (Task 4)

Two BEMS System Demonstration sessions were conducted: the first on December 8, 2023, in Dedza focusing on BEMS dashboard and prototype development, and a follow-up session in July 2024 in Mponela, showcasing a refined version of the system. These sessions targeted stakeholders from the Department of Land Resource Conservation, the Ministry of Water and Sanitation, and MWASIP Project Teams. The primary objective of both sessions was to demonstrate the full functionality of BEMS, encompassing system access, navigation, and its application in environmental and resource monitoring, and to solicit stakeholder input.



Figure 5-10: Dashboard and Prototype development workshop Held at the Dedza Mountain View Lodge on 08th December 2023



Figure 5-11: BEMS system demonstration session held at Mponela on 1 July 2024

The demonstration sessions were delivered in a workshop format, utilizing presentations and live demonstrations of the system. The December 2023 session in Dedza introduced the initial BEMS prototype, focusing on indicator mapping, dashboard navigation, and user management processes. Feedback from participants during this session prompted refinements to the system, which were subsequently showcased in the July 2024 session in Mponela, emphasizing the updated system's enhanced functionalities.

The demonstration sessions covered six critical topics: (1) General principles of monitoring and evaluation, (2) Components and electronic hardware of BEMS, (3) Techniques for data collection, (4) Best practices for data handling, (5) Operation of the BEMS, and (6) Administration of the BEMS. The sessions employed a combination of presentations, workshops, and live demonstrations to facilitate learning.

The consultant showcased the following features for BEMS operation:

- Navigating the BEMS platform
- Accessing system-generated reports
- Integrating data from different modules
- Conducting system testing for further refinements

The demonstration was well-received, with engagement levels rated at 4 out of 5. However, some participants reported connectivity issues that hindered their ability to interact with the system in real time.

To ensure the sustained effectiveness of the BEMS, the following actions were recommended:

a. System testing and feedback loops: Continue testing the system with end-users to refine usability and identify additional training needs.
b. Expanded training outreach: Ensure broader representation from district-level stakeholders in future training sessions.
c. Ongoing capacity building: Implement periodic refresher training, particularly for system administrators and data managers.
d. Integration with other systems: Align BEMS training with other relevant digital tools and data management platforms to enhance overall effectiveness.
e. Focus on practical applications: Expand training sessions to include advanced system functionalities, data visualization techniques, and integration with GIS and remote sensing tools.
f. Support for decision-making: Ensure that future training emphasizes practical applications of BEMS for decision-making and environmental monitoring.

5.7 Data collection refresher training workshop



Figure 5-12: Gertrude Kambauwa, Director of the Department of Land Resources Conservation (DLRC), delivering remarks during the official opening of the BEMS training session.

5.7.1 Training context and purpose

The July 2025 BEMS training was conducted from 28 to 31 July at Lakeside Hotel in Salima and brought together technical officers from Government departments involved in environmental monitoring, watershed services, and natural resource management. A total of 20 participants completed the evaluation form, with 85 percent being male and 15 percent female, representing institutions such as the Department of Water Resources, the Department of Forestry, the Department of Land Resources Conservation, and the Ministry of Agriculture. The training aimed to strengthen participant's understanding of biophysical, ecological, hydrological, soil, and socio-economic indicators relevant to BEMS, while enhancing their capacity to collect, interpret, and integrate data across sectors. Participants reported very high relevance of the sessions to their day-to-day work, with 70 percent rating the training as "Very relevant" and 30 percent rating it as "Relevant."

5.7.2 Training content and delivery

Training content was delivered through a blend of presentations, technical demonstrations, participatory discussions, and hands-on practical exercises. Subject-matter experts facilitated sessions aligned to their thematic areas: Dr. Clement Chilima led sessions on ecological and biophysical indicators; Dr. John Mthandi facilitated soil sampling and analysis procedures; Ms. Ivy Kasote handled socio-economic and community-related indicators, while Mr. Steve Kumwenda delivered content on hydrological monitoring and water-quality assessments. The training emphasized an integrated approach to indicator monitoring, demonstrating the relationships among soil, water, forestry, and socio-economic dimensions. Participants noted that the training was coherent, logically sequenced, and directly relevant to BEMS requirements. The facilitators received consistently strong ratings for delivery quality, with most evaluations falling between "Good" and "Excellent."



Figure 5-13: Location of the practical training on forest inventory techniques.

5.7.3 Training participation and engagement

Engagement throughout the four-day training was high, with participants actively contributing to group discussions, question-and-answer sessions, and practical demonstrations. The hands-on components were particularly valued, as 80 percent of respondents indicated that these sessions significantly strengthened their understanding of indicator methodologies, while 15 percent reported partial improvement. Participants also demonstrated strong inter-sectoral collaboration during group work, reflecting the multidisciplinary nature of BEMS implementation. Overall engagement was consistently rated between "Good" and "Excellent," reflecting effective facilitation and participant commitment.







Figure 5-14: Clement Chilima and his Team delivering a theory session followed by a practical session on forestry indicators and measurement on Day 3 of the session

5.7.4 Training evaluation and impact

Evaluation results indicate that the July 2025 training achieved meaningful learning gains and enhanced participants' overall capacity to support BEMS-related tasks. Facilitators received favorable ratings, with Dr. Clement Chilima's sessions being rated 50 percent "Excellent" and 50 percent "Good," while Dr. John Mthandi's facilitation received 45 percent "Excellent" and 55 percent "Good." Sessions facilitated by Ms. Ivy Kasote and Mr. Steve Kumwenda were also well rated, though participants suggested allocating more time for complex thematic areas. Practical demonstrations were highlighted as the most impactful aspect of the training, helping participants deepen their technical understanding. Overall facilitation quality was rated as "Good" by 70 percent of respondents and "Excellent" by 30 percent, demonstrating strong participant satisfaction.

5.7.5 Participant feedback and recommendations

Feedback from participants underscored the strengths of the training, particularly the integrated presentation of indicators and the relevance of content to watershed management. Many participants appreciated the clarity and depth of the presentations, noting that the training effectively illustrated the linkages between different monitoring components within the watershed context. However, several logistical challenges were raised, including concerns over venue comfort, meals, and time allocation for practical sessions. Participants recommended extending training time for GIS and remote sensing demonstrations, improving venue arrangements, and strengthening hands-on exercises to enhance mastery of monitoring techniques. Reflections captured during evaluation included statements highlighting the usefulness of integrated component learning and the value of practical engagement.

5.7.6 Training resource availability

Training resources were made fully available throughout the session, including indicator reference materials, presentations, and practical guides. Participants found these materials helpful for understanding indicator methodologies and applying them during demonstrations. Nevertheless, some logistical limitations were reported, particularly around venue setup, equipment readiness, and comfort levels, which affected concentration during some sessions. Participants suggested that future sessions include additional technical demonstrations, particularly in advanced GIS and remote sensing applications, and that logistical planning be strengthened to support a conducive learning environment. Addressing these considerations will help enhance the overall effectiveness of subsequent BEMS capacity-building initiatives.

5.8 BEMS technical & IT sessions (Dowa & Lilongwe)





Figure 5-15: Meeting participants (Top), Opening remarks by Director of DLRC (Bottom Left), Session in Progress (Bottom Right)

5.8.1 Training context and purpose

The BEMS Technical and IT Capacity Building Sessions held in October and November 2025 were designed to strengthen the system administration, data management, and backend technical competencies required to operationalize and sustain the BEMS. The October session, held in Dowa, served as the initial engagement focused on system hosting, backend configuration, and microservices management. Due to system-level challenges experienced during the practical components, particularly authentication failures and unstable microservices, the training was not fully completed. To address these gaps, a follow-up session was convened in November in Lilongwe, specifically to finalize remaining components, resolve previously encountered technical issues, and consolidate understanding of the BEMS infrastructure. Collectively, the two sessions aimed to equip IT officers, data managers, and system administrators with the technical proficiency required to maintain, update, troubleshoot, and scale the BEMS environment in alignment with MWASIP operational needs.

5.8.2 Training content and delivery

Across the two sessions, training content focused on the full ecosystem of BEMS technical operations, beginning with an introduction to system architecture, hosting environments, and the division of responsibilities across microservices. Participants were guided through detailed demonstrations of the virtual machine (VM) environment, including configuration of compute resources, backend file structures, folder hierarchies, and service dependencies. The sessions covered management of ConfigMaps, NodePorts, snapshots, and containerized services, as well as approaches to version control and deployment workflows.

The November follow-up session provided an improved and stabilized environment where participants could successfully practice the components that were disrupted during the October session. This included hands-on execution of ingestion microservices, API interactions, file validation, and troubleshooting ingestion errors. Training delivery relied on demonstrations, guided practice, troubleshooting simulations, and daily reflection sessions, which allowed participants to articulate challenges and consolidate learning progressively.



Figure 5-16: Session in progress at MWASIP Conference Room, November, Lilongwe

5.8.3 Training participation and engagement

Engagement across both sessions was active and sustained. Participants collaborated in small troubleshooting teams, rotated through assigned tasks, and interacted with facilitators to resolve real-time technical issues (Figure 5-17). The daily reflections captured at the end of each day revealed strong participant motivation to understand the full backend functioning of the BEMS system beyond routine operational tasks. The November session in particular benefited from the stabilized technical environment, enabling participants to complete hands-on components that were previously interrupted. Engagement was characterized by detailed discussions, peer support in resolving system errors, and collective interpretation of ingestion logs, error traces, and system performance indicators.

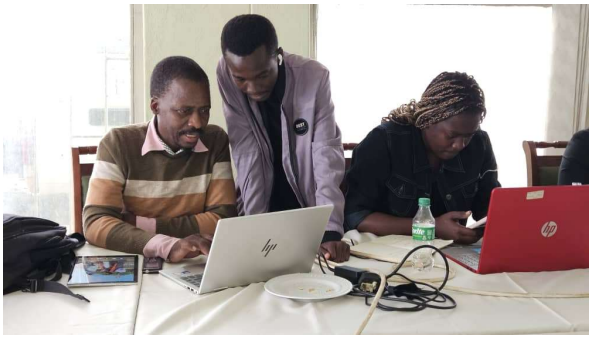






Figure 5-17: The session in progress showing participant discussions and dedicated facilitator support

5.8.4 Training evaluation and impact

Reflections across both sessions indicated measurable improvements in participant confidence and technical competence. Participants reported a deeper understanding of the structure and purpose of microservices, improved familiarity with system hosting environments, and increased ability to diagnose system errors such as authentication failures, service interruptions, and ingestion faults. By the end of the November session, participants expressed satisfaction that all components intended for October had been successfully delivered, noting that the continuity between sessions allowed them to progressively build technical mastery. Participants acknowledged that the ability to replicate ingestion processes, test API functionality, and observe backend workflows in an operational system significantly enhanced their readiness to support BEMS maintenance and long-term sustainability.

5.8.5 Participant feedback and recommendations

Participant reflections highlighted several important themes. Many emphasized that the sessions clarified the interdependencies among BEMS microservices, the importance of accurate file structuring for ingestion, and the need for systematic documentation of backend procedures. The unresolved system issues in October were initially a source of frustration; however, participants appreciated the decision to reconvene in November, acknowledging that the second session provided the technical stability required for meaningful practice. Participants recommended that future sessions allocate longer time for hands-on troubleshooting, provide sandbox environments where officers can experiment without risk to live systems, and ensure that technical documentation is updated to reflect evolving workflows. Participants also stressed the importance

of routine refresher sessions and ongoing collaboration between the PMU, Bintel, and district IT officers.

5.8.6 Training resource availability

Training materials, including system diagrams, workflow descriptions, ingestion scripts, reference sheets, and troubleshooting guides, were made available across both sessions. During the October training, some activities could not be completed due to system instability; however, all required materials and demonstrations were successfully delivered during the November follow-up. Facilitators provided updated configurations, corrected ingestion templates, and live demonstrations of microservice interactions. Participants expressed the need for improved access to documented standard operating procedures (SOPs) and recommended establishing a shared repository where technical guides, FAQs, and workflow updates can be accessed and maintained collectively. Ensuring consistent resource availability will be essential for strengthening district-level technical support for the BEMS.

5.9 December 2025 BEMS workflow practical training (Zomba & Chingale catchment)



Figure 5-18: Day 1 of the Zomba Workflow Training session

5.9.1 Training context and purpose

The December 2025 BEMS Workflow Practical Training was conducted from 1 to 4 December in Zomba and the Chingale Catchment as a consolidating, hands-on session intended to reinforce the full BEMS monitoring workflow. Unlike previous thematic or technical sessions, this training offered participants an end-to-end experience of the entire system - from field data collection to dataset cleaning, preparation, ingestion, visualization, and interpretation. The programme was originally scheduled for 1–5 December but concluded successfully on 4 December following a scheduling adjustment requested by the Client. A total of 48 officers from key MWASIP institutions participated, including the Department of Land Resources Conservation, Department of Forestry, Ministry of Agriculture, Irrigation and Water Development, National Water Resources Authority, Department of Water Resources, Department of Surveys, Department of Agricultural Planning Services, and the MWASIP PMU. The training aimed to build a shared operational understanding of BEMS processes across institutions and to strengthen district and catchment-level monitoring capacity.

5.9.2 Training content and delivery

Training content was delivered through a blended methodology that combined classroom-based demonstrations, field-based practical exercises, hands-on data management, group work, and facilitated reflection. Day 1 focused on orienting participants to the BEMS workflow, indicator sets, device setup, mobile form navigation, GPS calibration, and metadata requirements. On Day 2,

participants travelled to Mdalakamuyanja Village in Chingale EPA (TA Nkapita)**,** where they engaged in sector-specific field stations covering forestry measurements, hydrological observations, soil sampling demonstrations, and socio-economic rapid assessments (Figure 5-19). The site selection provided access to a Village Forest Area, the Linthipe River, household clusters, and crop fields, allowing for a comprehensive demonstration of BEMS indicator collection. Days 3 and 4 shifted to classroom-based data management, including dataset export, cleaning, validation, preparation of ingestion-ready files (CSV and ZIP), ingestion into the BEMS platform, troubleshooting ingestion errors, and visualization of outputs. The programme concluded with interpretation exercises, group presentations, and closing reflections.



Figure 5-19: Field Teams in Action at Mdalakamuyanja Village, Chingale Catchment

5.9.3 Training participation and engagement

Participants demonstrated a high level of engagement throughout the four-day training. The mixed-sector field teams worked collaboratively to apply standard methodologies during the practical sessions, with facilitators providing real-time guidance and troubleshooting support. Engagement remained strong during the more demanding indoor technical sessions, where participants worked collectively to resolve metadata errors, reorganize folder structures, and reconcile inconsistencies within ingestion packages. Daily reflection sessions provided an opportunity for participants to share experiences, raise challenges, and suggest adjustments that were incorporated into the subsequent day's facilitation. The diversity of institutions represented allowed for rich exchanges of field experiences and monitoring insights, contributing to a highly interactive learning environment.

5.9.4 Training evaluation and impact

Evaluation results indicated significant learning gains across BEMS competencies. Participants reported moderate to very high improvements in their understanding of the BEMS objectives, system navigation, data upload procedures, spatial data concepts, GIS interpretation, data quality assurance, and reporting workflows. Most respondents agreed that the training content was clear and relevant, and that the facilitators were knowledgeable and effective. Practical sessions, particularly data ingestion and visualization, were among the most valued components of the programme. Participants expressed increased confidence in applying the workflow in their districts and institutions, although some noted the need for more practice before training others. While feedback on venue logistics (e.g., indoor heat, limited equipment) was mixed, it did not detract from the overall positive perception of the training's effectiveness.

5.9.5 Participant feedback and recommendations

Participants provided detailed feedback reflecting both satisfaction with the training and constructive suggestions for future improvements. Many emphasized the value of hands-on exercises and cross-sector collaboration, noting that the practical nature of the training helped clarify indicator definitions and workflow steps. However, several participants recommended allocating more time for dataset cleaning, ingestion practice, and GIS-based interpretation. Others pointed out the need for better synchronization between MWASIP and BEMS data collection tools, improved venue conditions, and additional reference materials. Participants also highlighted the importance of pre-configured devices, expanded field equipment (e.g., soil testing kits), and clearer guidance on metadata standards. Overall, recommendations centered on enhancing the depth and comfort of technical sessions while sustaining the practical, integrated approach taken during this training.

5.9.6 Training resource availability

All core training materials, including presentations, mobile forms, reference sheets, and ingestion guide, were made available to participants. Field stations were adequately equipped to demonstrate the essential indicator methodologies, though some participants observed equipment limitations that affected full participation in certain groups. Classroom-based activities relied heavily on digital tools, and while facilitators provided continuous support, limitations in venue conditions (heat, connectivity, and computer quality) were noted. Despite these challenges, participants acknowledged that the resources provided enabled them to understand and apply the full BEMS workflow. They recommended expanding user manuals, improving device readiness, and establishing a formal repository where BEMS training documents, troubleshooting guides, and system updates can be accessed consistently.

5.10 Structured BEMS continuous training program

To ensure the longevity of the BEMS capabilities beyond the initial project phase and to address staff turnover, the project developed a Structured BEMS Continuous Training Program in line with the Terms of Reference (ToR) mandate. This program, designed for future implementation in

collaboration with local academic partners, specifically Lilongwe University of Agriculture and Natural Resources (LUANAR), provides a sustainable mechanism for continuous capacity development. The structure is based on the principle of continuous entry (allowing new project staff to join scheduled training cycles) and vertical development (enabling users to progress from basic user to data manager or administrator roles through advanced modules). It includes mandatory annual refresher courses to maintain proficiency and adapt to system updates. A key feature of the program is the designation of a shared Digital Repository (including manuals, SOPs, and recorded sessions) to facilitate self-paced learning and safeguard institutional knowledge continuity. The full framework, detailing the curriculum tiers, duration, and target audience, is provided in Annex 8.4

5.11 BEMS training evaluation framework

To systematically measure the effectiveness and impact of the capacity-building investment, a dedicated BEMS Training Evaluation Framework and Methodology was developed, focusing specifically on improvements to data and numeric literacy. This methodology is anchored in the internationally recognized Kirkpatrick's Four Levels of Evaluation model (Reaction, Learning, Behavior, and Results)

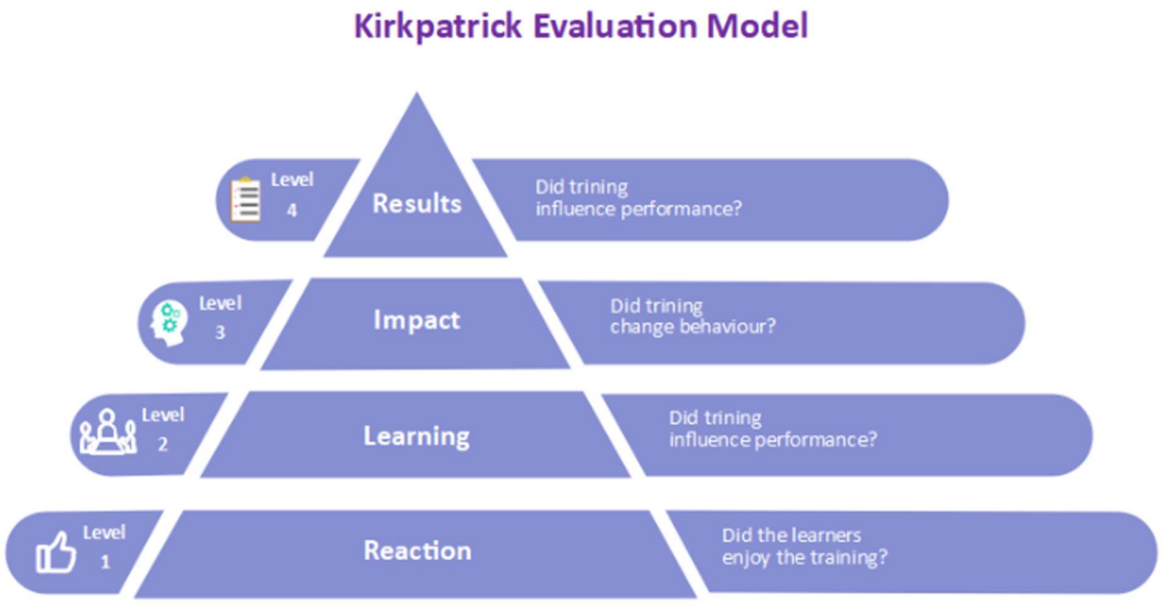


Figure 5-20: Kirkpatrick's Four Levels of Evaluation model

Working with a focus on sustainable outcomes and in partnership with a third-party educational evaluator (as mandated by the ToR), the framework establishes clear, quantifiable metrics, such as a proficiency threshold of 75% or above in post-training assessments, and defines tools, including pre- and post-tests, hands-on assignments, and BEMS usage analytics. The central focus is on assessing the practical application of data analysis, statistical reasoning, and interpretation of

numerical information, directly linking capacity gains to improved BEMS performance and data quality reports. The detailed indicators and the full evaluation methodology are included in Annex 8.5.

5.12 Key knowledge products and user guides

To ensure that the BEMS platform is fully utilized and sustainably managed by all stakeholders, a comprehensive suite of four role-specific and task-oriented User Guides was developed. These guides serve as essential reference materials to support both the formal training sessions and the long-term, self-paced learning necessary for institutional knowledge continuity.

The complete suite of guides addresses the four-core operational and technical workflows of BEMS:

User guide name	Target audience	Primary focus
BEMS field data collection user guide	Field officers, data collectors, enumerators, and supervisors	Step-by-step instructions for collecting quality-assured non-spatial data using ODK Collect on Android devices, covering setup, collection, and submission processes.
BEMS data management user guide	Data managers and project supervisors	Comprehensive guidance on setting up and deploying data collection projects, managing user access, and overseeing the data pipeline from XLSForm design to synchronization with the BEMS ODK Server.
BEMS analytics map viewer user guide	Analysts, M&E specialists, planners, and policy stakeholders	Instructions on accessing the BEMS interface, navigating dashboards, working with key indicators, filtering data, and leveraging the Map Viewer for spatial and non-spatial data interpretation and export.
BEMS technical user guide	System administrators and technical support staff	Overview of the BEMS system architecture, technology stack (e.g., Kubernetes, PostgreSQL, Rancher), system deployment, user login protocols, and key maintenance procedures.

These documentation products are critical for embedding BEMS knowledge within the government structure, providing necessary support for staff turnover, and acting as the official reference for system operations. The full documents are included in Annex 8.6.

6 Conclusion and recommendations

6.1 Conclusion

The capacity-building programme has been comprehensive, multi-phased, and responsive to the evolving needs of MWASIP. It combined baseline-linked training, prototype demonstration workshops, thematic monitoring sessions, IT-focused technical training, and full workflow exercises. These activities collectively strengthened stakeholder competencies across biophysical, ecological, socio-economic, hydrological, forestry, ICT, and data management functions required to operationalize the BEMS.

During project implementation, the consultant trained more than 50 officers from key institutions involved in MWASIP's monitoring functions in BEMS indicator data collection, data ingestion, and system management. The institutions included:

- Department of Land Resources Conservation (DLRC)
- Department of Forestry
- Ministry of Agriculture, Irrigation and Water Development
- National Water Resources Authority (NWRA)
- Department of Water Resources
- Department of Surveys
- Department of Agricultural Planning Services
- MWASIP Project Management Unit (PMU)

6.1.1 Progress in technical competencies and multisector collaboration

Participants across the departments involved are now able to apply improved skills in sampling methodologies, digital data management, survey design, forest inventory, hydrological monitoring, GIS and remote sensing, indicator interpretation, and BEMS data ingestion and vizualization. The integrated training strengthened cross-sector collaboration among DLRC, the Department of Forestry, the Department of Water Resources, the Ministry of Agriculture, the National Water Resources Authority, the Department of Surveys, and the MWASIP PMU. The December 2025 workshop also gave them hands-on experience with the full BEMS workflow, helping them link field practices with the system's digital outputs.

6.1.2 Progress in system administration and ICT competency

The October–November 2025 technical sessions enabled IT officers and system administrators to gain hands-on experience in microservice management, hosting environments, authentication, troubleshooting, dataset preparation, backend configuration, and system deployment. Despite early system errors in October, the November session enabled completion of all outstanding components, improving confidence in system maintenance and backend operations.

6.1.3 Institutional strengths identified

Field officers across sectors demonstrated strong foundational knowledge in indicator monitoring and were able to adapt quickly to digital workflows when equipment and connectivity allowed. There was a clear willingness among institutions to adopt integrated monitoring approaches and to operationalize the BEMS once fully stabilized.

6.1.4 Persistent challenges and systemic gaps

Despite these achievements, several structural challenges remain across the human, technical, and institutional domains. These include limited ICT infrastructure, device shortages, inconsistent metadata practices, system instability, insufficient involvement of frontline extension staff, inadequate SOPs, and the absence of sustainable financing and institutionalized routine training.

6.2 Recommendations

A. Strengthen human capacity across all sectors

The capacity-building effort should be expanded to include wider participation of frontline officers such as AEDOs, Forestry Assistants, Water Monitors, VNRMCs, and EPA-level technical personnel. These officers form the backbone of seasonal data collection and must be uniformly trained in indicator methodologies, data preparation, and digital workflows.

B. Enhance ICT Systems, infrastructure and backend support

To ensure the stable operation of the BEMS platform, continuous ICT upgrades are required across MWASIP and DLRC. Critical priorities include strengthening server infrastructure, improving internet bandwidth and establishing reliable power backup resources. A National BEMS Helpdesk should be formalized to provide first-line technical support, troubleshooting, ingestion assistance, and remote intervention. The system architecture should be supported by clear documentation, SOPs, and updated technical guides.

C. Institutionalize SOPs and standard monitoring protocols

There is a need to develop harmonized Standard Operating Procedures (SOPs) for all BEMS indicators - soil, hydrology, forestry, socio-economic, GIS, and digital ingestion - ensuring consistent methodologies across districts and sectors. Seasonal monitoring calendars should be developed, aligned to hydrological cycles and project reporting requirements. Data management protocols should standardize naming conventions, data formats, metadata structures, folder hierarchies, and ingestion templates.

D. Strengthen coordination, governance, and institutional ownership

Effective implementation of BEMS requires reinforced collaboration among DLRC, Department of Forestry, Department of Water Resources, National Water Resources Authority, Department of Surveys, and the MWASIP PMU. An institutional governance framework should be formalized to establish roles for data collection, analysis, ingestion, reporting, and system maintenance. BEMS

responsibilities should be integrated into sector mandates, DDPs, and routine performance frameworks at national and district levels.

E. Provide adequate resource allocation and logistical support

Sustained BEMS operation requires predictable financing for equipment, software licensing, laboratory testing, ICT maintenance, travel logistics, and routine monitoring. Budget lines for BEMS should be integrated into sector work plans and district budgets. Partnerships with NGOs, research institutions, donors, and private sector actors should be leveraged for resource mobilization, research collaboration, and ecosystem data integration.

F. Strengthening Monitoring, Evaluation, and Learning (MEL) for BEMS

A BEMS-specific MEL framework should be developed to track data quality, system usage patterns, indicator completeness, training effectiveness, and district-level performance. Annual capacity audits should assess staff turnover impacts and emerging training needs. A national BEMS knowledge repository should be established for storing manuals, training videos, troubleshooting guides, updated SOPs, indicator definitions, and workflow tools, ensuring that all sectors can access updated information.

7 Next steps

7.1 Strengthening collaborative networks and partnerships

A coordinated approach among key institutions is essential for the effective operationalization of BEMS. Strengthening collaboration between government agencies, district councils, community institutions, NGOs, academia, and development partners will promote knowledge sharing, harmonization of monitoring practices, and cross-sector integration. Robust stakeholder networks will enable continuous learning, facilitate joint problem solving, and reinforce collective ownership of the system.

7.2 Establish a robust monitoring and evaluation mechanism

To maintain the quality and effectiveness of BEMS capacity-building efforts, a dedicated Monitoring and Evaluation (M&E) framework should be developed. This framework should systematically track training progress, assess participants' application of new skills, monitor data quality improvements, and evaluate system utilization across institutions. Regular assessments will help identify gaps early and inform adjustments to training programmes, technical support, and operational guidelines.

7.3 Secure institutional support and policy alignment

Long-term sustainability of BEMS will require strong institutional commitment and integration into existing national policy frameworks. Aligning capacity-building initiatives with key national strategies - such as the National Forest Landscape Restoration Strategy (NFLRS) and the National Climate Change Management Policy (NCCMP) - will ensure coherence with Malawi's broader environmental and natural resource management agenda. Embedding BEMS in sectoral planning

and reporting frameworks will also facilitate resource mobilization and promote institutional ownership.

7.4 Enhance integration with regional and continental frameworks

Engaging policymakers and aligning BEMS with regional and continental frameworks will broaden opportunities for collaboration and technical support. At the regional level, integration with the Southern African Development Community (SADC) Climate Change Strategy and Action Plan and the African Forest Landscape Restoration Initiative (AFR100) will strengthen cross-border learning and open avenues for financing. At the continental level, alignment with the African Union Agenda 2063 and the African Development Bank (AfDB) Strategy for 2021–2030 (High 5s) will position BEMS within wider climate resilience and restoration initiatives, enhancing its visibility and strategic value.

7.5 Sustain capacity development beyond the project phase

To ensure continuous improvement and institutional memory, the capacity-development process must extend beyond initial project training. This should involve establishing regular refresher trainings, structured mentorship programmes, and district or regional resource centers to support technical officers, data collectors, and system administrators. These centers should serve as hubs for ongoing training, troubleshooting, documentation access, and knowledge exchange, ensuring that all stakeholders maintain the skills and resources necessary to operate and sustain BEMS effectively.

8 Annexes

8.1 A summary of the stakeholder mapping exercise conducted during the project inception phase for assessing capacity building needs

National Stakeholders Consulted

Name	Department / Organisation
Tony Nyasulu	National Water Resources Authority
James Daire Kumwenda	Malawi Watershed Services Improvement Project (MWASIP)
Sydney Kamtukule	Department of Water Resources MWASIP / MRDRMP
Lusungu Sinda	Department of Irrigation
Rodrick Kumkwezu	Department of Water Resources
Owen Phiri	Department of Water Resources (Water Quality)
+ Others	

ICT Stakeholders Consulted

Name	Role	Department / Organisation
Grace Chimowa	Chief Systems Analyst	Department of E-Government
Brown Mphalo	Geospatial Technologist	Department of Surveys
Joseph Kanyangalazi	MWASIP Component 1 Technical Team Leader	Department of Land Resources Conservation
Racheal Theu	ICT Officer	MWASIP
Andrew Kafumbata	IT Specialist	Land Reform Implementation Unit/AGCOM

District Stakeholders Consulted

Name	Designation
MACHINGA	
Andrew Hamuza	Assistant District Forestry Officer (ADFO)
Andrew Semu	Information Officer (IO)
Biston Mawindo	District Commissioner's (DC's) Secretary
Daniel Mandala	Relief and Rehabilitation Officer (RRO)
Feston Kwezani	Chief Agriculture Officer (CAO)
Jarvis Mwenechanya	Environmental District Officer (EDO)
Joshua Mwapeya	Environment
Linda Majamanda	Lands Officer

Luckford Mkudza	Crops Officer
Patricia Yadidi	Agriculture Communications Officer (ACO)
Steve Meja	District Water Development Officer (DWDO)
Tumpale Mwangosi	Agriculture Planning Office
Winston Lupiya	Agriculture Gender Roles Extension Services Officer (AGRESO) (INTERN)
MANGOCHI	
Aggrey Mguna	Seed Malawi
Bruno K. Kamanga	EDO
Enerst Titheranji	District Labour Officer (DLO)
Fellah Kanyenda	Forestry Assistant
Jonas Salim	ADWDO
Kondwani Nyajo	District Aids Coordinator
Majesty Chilimbiro	IO
Mary Kamanga	ADFO
Paul Mwasesa	Wildlife Society of Malawi Chair
Peter Tembo	District Public Works
Taona P. Mandala	Tourism Officer (Intern)
NENO	
Austin Ndengu	Assistant Irrigation Engineer
Bright Nyauti	District Project Accountant - MWASIP
Charlotte Nema	EDO
Daniel Mabala	Principal Animal Health and Livestock Development Officer (PAHLDO)
Denis Kavalo	DPD
Matsautso Dzumani	Agriculture Extension Development Coordinator (AEDC)
Mayamiko Mphatso	Agribusiness Officer (ABO)
Noel Mkwapata	Extension Methodologies Officer (EMO)
Sungani Chilenje	District Information Officer (DIO)
Vincent Sambuka	Land Resources Conservation Officer (LRCO)
BLANTYRE	
Caroline Hillary Thole	M&EO
Cosmas Mangoka	RRO
Davie Dzimbiri	Senior Irrigation Engineer (SIE)
Edna Ndalama	Ag. DFO
Fred Kafakoma	DLO
Joseph Bochole	Director of Public Works (DPW)
Joseph Gama	DAPO
Maxwell Mbulaje	EDO
Mphatso Mbulukwa	CAO
Olive Vokhiwa	District Project Coordinator (DPC) - MWASIP
Tamala Zembeni	OWOO

NTCHEU	
Donnex Mtambo	DFO
Dorothy Nyakwetsa	Liaison Officer
Efford H. Geza	DLO
Emmanuel Develе	DYO
Fransisco Sadyamtambe	DTO
Hellen Nyirenda	EDO
Limbani Mbembe	DIO
BALAKA	
Davis Konondo	Monitoring and Evaluation Officer (M&EO)
Edgar Chihana	Director of Planning and Development (DPD)
James Jambo	ADFO
James Kadaya	Senior Agriculture Land Resources Conservation Officer
Lukresia Matekenya	DWDO
Mary Makhiringa	District Information Officer
McDonald Nyala	District Community Development Officer
Pletan Chiumbuzo	District Labour Officer
ZOMBA	
Alexander Sakala	Planning Officer
Cleopas Lameck	Senior Agriculture Land Resources Conservation Officer
Davie Sato	M&EO
Immaculate Munthali	Assistant Irrigation Engineer
McKenley Dupu	District Project Coordinator (DPC)- MWASIP
Mwamdilanga Kumasala	Irrigation Assistant

8.2 Assessment of the lab equipment

https://u.pcloud.link/publink/show?code=XZIj770ZpYCoFUrCobkI9OexfwDwu5jH566V

8.3 TNA results

https://u.pcloud.link/publink/show?code=XZrHeC5ZBDOCINfI5bbJACaR8tLF48bfERaV

8.4 Structured BEMS continuous training program

https://u.pcloud.link/publink/show?code=XZr8eC5Z1P1B4OyIehBO7Q0uvDKmzLH7Tfj7

8.5 BEMS Evaluation framework for training outcomes

https://u.pcloud.link/publink/show?code=XZo8eC5ZxWRsfKnwmQyLxPQecRiXlYQL5vmV

8.6 Training manuals

https://u.pcloud.link/publink/show?code=XZJQeC5ZF6STfYncRdLTA2yxIKPehFhPcRT7

8.7 Procurement report

https://u.pcloud.link/publink/show?code=XZj5X70ZXKaB3MUgdIbKpOKVuFV37jjMYzGy

8.8 Participants – Salima Training, July 2025

https://u.pcloud.link/publink/show?code=kZzb2C5ZlqR8eJ6G980xyYsB9Ud6wp1u5DAy

8.9 Participants – Technical and IT Session, Mponela & Lilongwe

https://u.pcloud.link/publink/show?code=kZbb2C5ZrLJSgId4S0pt96OuCSRMpVK46yJX

8.10 Participants – Technical and IT Session Part II, Lilongwe (November 2025)

https://u.pcloud.link/publink/show?code=kZ8b2C5Zjm98Io3Obj7FQQzudcPRLkMpbwpk

8.11 Participants – BEMS Workflow session, Zomba & Chingale

https://u.pcloud.link/publink/show?code=kZSb2C5ZjvFWIkDn6Q7Tm2OtfF8huH8jpGkX

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