Refresher Training Completion Report: Refresher Training in Remote Sensing and GIS for Geospatial-based Integrated Land Use Planning for Federal Institutions Experts

Project Name: Preventing Forest Loss, Promoting Restoration, and Integrating Sustainability into Ethiopia's Coffee Value Chains and Food Systems

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Contents

1. Background of the Refresher Training 4

2. Training Objectives 5

3. Training Overview 6

3.1 Location of the Training 6

3.2 Trainers and Participants 6

4. Pre-Refresher Training Qualitative Assessment Report 7

4.1 Introduction 7

4.2 Assessment Approach 7

4.3. General Feedback from Participants 9

4.4 Application of Knowledge and Skills 9

4.5 Practical Applications and Deliverables 9

4.6. Challenges Affecting Implementation 10

4.7. Lessons Learned 11

4.8. Conclusions and Recommendations 11

5. Refresher Training 12

5.1. Background Information 12

5.2. Training Objectives 13

5.3. Training Methodology 13

5.4. Training Modules Delivered 13

5.5 Key Achievements 16

5.6 Challenges Observed 16

5.7 Participant Feedback 17

5.8 Conclusions 17

6. Post-Refresher Training Assessment Report 18

6.1 Introduction 18

6.2 Objectives of the Assessment 18

6.3. Assessment Methodology 19

6.4. Post-Training Knowledge Assessment Areas 19

6.5. General Observations 23

6.6. Strengths Identified 24

6.7. Areas for Further Capacity Development 24

6.8. Conclusions 24
6.9. Recommendations 25
Annex I: Attendance Sheet (signed by participants) 26
Annex II: Photos During the Referesher-Training Session 27
Annex III: Post-Refresher Training Assessment Questionnaire 30
A. For GIS for Integrated Land Use Planning 30
B. For Remote Sensing for Integrated Land Use Planning 30

1. Background of the Refresher Training

Ethiopia is globally recognized for its rich biodiversity and unique coffee genetic resources, making coffee cultivation a cornerstone of the country's economy, culture, and rural livelihoods. The coffee sector supports millions of smallholder farmers and contributes significantly to national agricultural development. However, increasing agricultural expansion, deforestation and unsustainable land management practices continue to threaten forest ecosystems, biodiversity and the long-term sustainability of coffee production.

To address these challenges, the project "Preventing Forest Loss, Promoting Restoration and Integrating Sustainability into Ethiopia's Coffee Value Chains and Food Systems" has been implemented at both federal and regional levels. The project aims to strengthen integrated land use planning (ILUP) by enhancing institutional capacity, promoting sustainable land management, reducing forest loss, and supporting restoration efforts within Ethiopia's coffee landscapes. Central to achieving these objectives is the adoption of modern geospatial technologies that improve the accuracy, efficiency, transparency and evidence-based decision-making required for sustainable land use planning.

As part of the project's capacity development activities, a 3-day refresher training program was conducted from July 23 to 25, 2026 for experts drawn from key federal institutions involved in integrated land use planning and natural resource management. The refresher training comprised three modules: Geospatial-based Integrated Land Use Planning, Remote Sensing for ILUP and Geographic Information Systems (GIS) for ILUP. Following the successful completion of the initial training, a refresher training was organized to assess participants' knowledge retention, reinforce practical skills, address emerging technical needs, and monitor the application of acquired competencies in their respective institutions.

This report presents the outcomes of the refresher training on Geospatial-based Integrated Land Use Planning, jointly organized by the Ethiopian Space Science and Geospatial Institute (SSGI) and the Ministry of Planning and Development (MoPD) under the Forest, Land Use and Restoration (FOLUR) project funded by the United Nations Development Programme (UNDP). The refresher training was developed in response to a comprehensive capacity needs assessment conducted by SSGI, which identified significant institutional, human resource, and technological

gaps in the implementation of ILUP across federal institutions. By strengthening participants' competencies in geospatial technologies, the program contributes directly to the FOLUR project's broader objective of promoting sustainable land management and evidence-based planning.

The refresher training was organized around three complementary modules: i) Geospatial-based Integrated Land Use Planning, ii) Geographic Information Systems for ILUP, and iii) Advanced Remote Sensing for ILUP. Through hands-on practical exercises using ArcGIS Pro, ERDAS IMAGINE, and other geospatial tools, participants enhanced their capacity to acquire, analyze, and apply geospatial information for integrated land use planning, natural resource management, environmental monitoring, and sustainable development. The knowledge and practical skills gained are expected to strengthen institutional capacities and support more informed, coordinated, and sustainable land use planning and decision-making across Ethiopia.

2. Training Objectives

The general objective of the refresher training was to reinforce and expand the technical capacity of federal experts involved in Integrated Land Use Planning by strengthening their knowledge and practical skills in Geographic Information Systems (GIS), Remote Sensing (RS), and geospatial analytical techniques, while assessing learning outcomes through pre-and-post-training evaluations. Accordingly, the performance orientated detailed objective breakdowns of the refresher training were:

- To strengthen participants' theoretical knowledge and practical competencies in applying geospatial technologies, spatial analysis, and decision-support tools for sustainable integrated land use planning and management.
- To enhance participants' capacity to acquire, process, analyze, and interpret satellite imagery and other Earth Observation data for land use/land cover mapping, environmental monitoring, resource assessment, and evidence-based integrated land use planning.
- To develop participants' practical skills in using GIS for spatial database management, geospatial analysis, suitability assessment, watershed analysis, map production, and spatial decision support for integrated land use planning and
- To evaluate participants' knowledge and skill improvements following the training, assess the achievement of the learning objectives, measure the effectiveness of the training program, and identify areas requiring further capacity development and technical support.

3. Training Overview

3.1 Location of the Training

The refresher training was held at Adama Town, Ethiopia, from June 24 to 26, 2026. The training was organized by Ethiopian Space Science and Geospatial Institute (SSGI) in collaboration with the FOLUR Project Team Coordinators, Ministry of Planning and Development (MoPD).

3.2 Trainers and Participants

Lead and Assistant Trainers: The lead and assistant trainers who were facilitated this training are listed below. These trainers have extensive expertise in their respective fields and possess substantial experience in delivering technical training, capacity-building programs and hands-on practical sessions. Throughout the training, they were responsible for delivering lectures, facilitating discussions, guiding practical exercises, providing technical support, and responding to participants' questions. Their combined academic, research and professional experience ensured that the training is delivered effectively, promotes active learning, and enables participants to acquire the knowledge and practical skills required to achieve the intended learning objectives and expected training outcomes.

Table 1: Lists of lead and assistant trainers involved in the training.

No	Name	Educational level	Field of study	Organization	Position
1	Berhan Gessesse	PhD	Remote Sensing, GIS and Land use planning	SSGI	Senior Researcher and Lead Executive of Remote Sensing Department (Lead Trainer)
2	Gizachew Kabite	PhD	Remote Sensing	SSGI	Senior Researcher (Lead Trainer)
3	Gelana Daba	MSc	Remote sensing	SSGI	Assistant Trainer
5	Wondimu Haimanot	MSc	Geomatics	SSGI	Assistant Trainer

Training Target Participants: The training on Geospatial-based Integrated Land Use Planning (ILUP) targeted land use planning and management professionals, consultants, middle-level decision-makers and early-career experts working in forestry, agriculture, environmental science, geography, rural development, landscape ecology, land use planning and other natural resource management disciplines. Specifically, the program was designed for technical experts, senior professionals, and government officials who are directly involved in the planning, implementation, and management of ILUP initiatives. Participants were drawn from key national institutions, including the Ministry of Planning and Development, Ministry of Agriculture, Ministry of Urban and Infrastructure, Ministry of Water and Energy, Ethiopian Biodiversity Institute, Ethiopian Forestry Development, Ethiopian Environmental Protection Authority and Ethiopian Meteorological Institute engaged in land administration, environmental management, and sustainable development. Based on the training attendance, all 22 participants were male, with no female representation. This distribution is consistent with the current staffing profile of many Integrated Land Use Planning (ILUP)-related institutions, where female professionals remain underrepresented. The finding highlights the need for continued efforts to promote gender balance and increase women's participation in ILUP-related technical roles.

4. Pre-Refresher Training Qualitative Assessment Report

4.1 Introduction

A Geospatial-based Integrated Land Use Planning Refresher Training was conducted for participants from the Federal Government. Prior to the commencement of the refresher training, a qualitative assessment was conducted to evaluate the extent to which participants had applied the knowledge and skills gained from the previous training. The assessment also explored the practical application of GIS and remote sensing technologies, identified implementation challenges and collected recommendations for improving future capacity-building programs. The assessment included 22 federal participants were participated during the pre-refresher training.

4.2 Assessment Approach

The assessment was conducted using a participatory and experience-sharing approach to evaluate the extent to which participants had applied the knowledge and practical skills acquired from the previous Geospatial-based Integrated Land Use Planning (ILUP) training. Rather than relying

solely on questionnaires, the assessment emphasized guided discussions that enabled participants to reflect on their experiences, identify achievements and discuss challenges encountered during the implementation of geospatial technologies within their respective institutions. The discussion sessions were facilitated using a structured set of guiding questions designed to assess the effectiveness, relevance, and practical application of the training. The key discussion leading questions included:

- Have you applied the knowledge and skills gained from the previous Geospatial-based Integrated Land Use Planning training?
- How frequently have you applied GIS, remote sensing, and other geospatial technologies, and for what specific purposes?
- What outputs, products, or institutional deliverables have been produced using the acquired knowledge and skills?
- What technical, organizational, financial, or institutional challenges have limited the effective implementation of the acquired knowledge and skills?
- What lessons have been learned from the application of the training, and what recommendations can be provided to improve future capacity-building programs?

Participants were encouraged to share practical examples from their daily work, including the planning and implementation of integrated land use planning activities, spatial data collection and management, land suitability analysis, environmental monitoring, natural resource assessment, decision support, and map production. This discussion provided valuable insights into how geospatial technologies have been integrated into institutional workflows and contributed to evidence-based planning and decision-making processes. The assessment also explored participants' confidence in using geospatial software and datasets, the availability of institutional resources required for implementation, opportunities for collaboration among organizations, and the additional technical support or advanced training needed to strengthen future applications. The interactive nature of the discussion enabled participants to exchange experiences, identify common implementation challenges, and propose practical solutions for improving the adoption and sustainability of geospatial technologies within Integrated Land Use Planning initiatives. The findings generated through this assessment served as an important source of information for evaluating the effectiveness of the previous training program, documenting good practices,

identifying capacity gaps, and informing the design and delivery of future Geospatial-based Integrated Land Use Planning training and capacity development initiatives.

4.3. General Feedback from Participants

All participants highly appreciated the refresher training program and recognized its importance in updating their technical knowledge and practical skills. Participants noted that the training provides an excellent opportunity to refresh previous knowledge, learn updated geospatial techniques, and exchange experiences with professionals from different institutions. Approximately 40% of the participants reported that they have actively applied the knowledge and skills gained from the previous training in their daily work. The remaining 60% indicated that although they had limited opportunities to directly implement the acquired skills, the previous training significantly improved their understanding of geospatial technologies and enhanced their readiness to apply GIS and remote sensing in future assignments. Many participants stated that the refresher training further motivated them to strengthen their technical competence.

4.4 Application of Knowledge and Skills

The previous Geospatial based Integrated Land Use Planning training significantly enhanced the technical capacity of participants from both federal and regional institutions. However, the level of application varied depending on institutional mandates and availability of resources. Many participants regularly use GIS and remote sensing technologies in their routine planning and decision-making activities, while others apply the knowledge whenever project requirements arise. Several participants reported that the previous training served as a foundation for expanding their geospatial analysis capabilities. Some participants further enhanced their expertise by adopting cloud computing platforms for spatial analysis, demonstrating continuous professional development beyond the original training.

4.5 Practical Applications and Deliverables

Participants from federal institutions reported a wide range of practical applications of GIS and remote sensing. The Ministry of Planning and Development has used geospatial technologies to support Integrated Land Use Planning activities and coordinate capacity-building programs across regions. A participant from the Ministry of Agriculture indicated that the knowledge gained from

the previous training enabled him to organize several Training of Trainers (TOT) programs for experts from regional, zonal, and woreda offices on the fundamentals of GIS for Integrated Land Use Planning. Participants also reported using GIS and remote sensing for:

- Land Mapping Unit (LMU) delineation
- Investment land suitability mapping
- Land valuation
- Land Use/Land Cover (LULC) change detection
- Integration of spatial and socioeconomic datasets for planning
- Urban and rural land use planning
- Watershed delineation and upstream catchment analysis
- Water source identification
- Upstream and downstream watershed management

4.6. Challenges Affecting Implementation

Despite the positive impacts of the previous training, participants identified several constraints limiting the practical application of GIS and remote sensing technologies. The most frequently reported challenges include:

- Limited availability of computers, licensed software, internet connectivity, and other ICT infrastructure.
- Insufficient financial resources to implement Integrated Land Use Planning activities.
- Limited institutional attention and commitment toward Integrated Land Use Planning implementation.
- Weak coordination among government institutions responsible for land administration, planning, natural resources, and environmental management.
- Limited availability of standardized national spatial datasets.
- Inadequate access to high-resolution satellite imagery and other supporting datasets, including demographic information.
- Lack of national policies and institutional frameworks for spatial data sharing and standardization.

- Software compatibility issues, particularly differences between QGIS and proprietary GIS software used during training.
- Limited policy support for integrated land use planning and spatial data management and
- Challenges associated with integrating urban and rural planning systems.

4.7. Lessons Learned

The pre-refresher training assessment demonstrated that the previous training successfully strengthened participants' technical knowledge and confidence in applying geospatial technologies. Participants also recognized the importance of continuous practical application to maintain and further develop their technical skills. Several participants emphasized that conducting Training of Trainers programs significantly expanded the impact of the original training by transferring knowledge to experts at regional, zonal, woreda, and kebele levels. The discussions further highlighted that sustained institutional support, improved access to geospatial data, and stronger collaboration among government organizations are essential for successful implementation of Integrated Land Use Planning.

4.8. Conclusions and Recommendations

The pre-refresher training qualitative assessment confirmed that the previous Geospatial-Based Integrated Land Use Planning training has generated substantial positive impacts on the technical capacity of participants from both federal institutions. Most participants have successfully integrated GIS and remote sensing technologies into their professional activities, producing valuable outputs that support land use planning, environmental management, forest monitoring, investment planning, watershed management, and spatial decision-making. Nevertheless, institutional, financial, technical, and policy-related constraints continue to limit the full implementation of Integrated Land Use Planning. The refresher training provides an important opportunity to reinforce participants' knowledge, introduce updated geospatial methodologies, encourage experience sharing among institutions, and further strengthen the practical application of GIS and remote sensing technologies in support of sustainable land use planning in Ethiopia. It is believed that challenges continue to constrain the wider institutional adoption of Geospatial-based Integrated Land Use Planning despite the improved technical capacity of trained personnel. Accordingly, participants proposed several recommendations to strengthen future Geospatial-Based Integrated Land Use Planning capacity-building programs:

- Develop practical mini-projects with measurable outputs as part of future training programs.
- Conduct regular post-training follow-up and mentoring to monitor the application of acquired knowledge.
- Strengthen continuous learning opportunities through real-world GIS and remote sensing projects.
- Expand Training of Trainers programs to increase institutional capacity at regional and local government levels.
- Enhance collaboration among federal institutions, regional governments, universities, and development partners.
- Promote the adoption of advanced geospatial technologies, including cloud computing platforms.
- Consider commonly used GIS software platforms during training and address software compatibility issues.
- Improve national spatial data availability, accessibility, standardization, and sharing mechanisms.
- Strengthen institutional coordination and policy support for Integrated Land Use Planning implementation.
- Increase government investment in ICT infrastructure, geospatial data acquisition, and technical resources required for GIS implementation.

5. Refresher Training

5.1. Background Information

A five-module refresher training on site-suitability analysis of Infrastructure for Integrated Land Use Planning, Flood Susceptibility Mapping using Geographic Information Systems (GIS), Remote Sensing (RS) and Multi-Criteria Decision Analysis (MCDA**)** was successfully conducted during the reporting period. The training aimed to strengthen participants' technical capacity in developing scientifically sound flood susceptibility maps through the integration of topographic, hydrological, climatic and land use information. The refresher training combined theoretical presentations with intensive hands-on practical exercises using real geospatial datasets and industry-standard software. Participants gained practical experience in watershed delineation,

terrain analysis, satellite image processing, precipitation analysis, weighted overlay modeling, and professional cartographic map production. Throughout the refresher training, participants independently completed practical exercises and produced flood susceptibility maps for selected watersheds using standardized analytical procedures.

5.2. Training Objectives

The overall objective of the refresher training was to enhance participants' technical knowledge and practical skills in applying geospatial technologies for flood susceptibility assessment and mapping. The specific objectives were to enable participants to:

- Develop watershed boundaries from Digital Elevation Model (DEM) data.
- Process Landsat 9 satellite imagery for land use/land cover mapping.
- Generate flood conditioning factors using GIS spatial analysis tools.
- Prepare precipitation layers from CHIRPS rainfall datasets.
- Apply Multi-Criteria Decision Analysis (MCDA) using Weighted Overlay techniques.
- Produce standardized flood susceptibility maps suitable for planning and decision-making.
- Develop professional cartographic products following accepted mapping standards.

5.3. Training Methodology

The training adopted a competency-based and hands-on learning approach. Each module consisted of short theoretical presentations followed by instructor-led demonstrations and guided practical exercises. Participants worked individually using real datasets while receiving continuous technical support from the trainers. The practical sessions emphasized problem-solving, independent analysis, and application of GIS and remote sensing techniques to real-world flood hazard assessment scenarios. Continuous discussions, question-and-answer sessions, and practical evaluations were conducted throughout the training to reinforce learning outcomes. The software packages used during the training included ArcGIS 10.8 with the Spatial Analyst Extension and ERDAS IMAGINE Version 16 for satellite image processing.

5.4. Training Modules Delivered

Module 1: Watershed Delineation and Topographic Factor Generation

The first module introduced participants to hydrological analysis using Digital Elevation Models (DEM). Participants learned how to prepare elevation data and generate hydrological layers required for flood susceptibility analysis. The practical exercises covered:

- DEM preprocessing
- Sink filling
- Flow direction analysis
- Flow accumulation generation
- Stream network extraction
- Watershed delineation
- Slope analysis
- Euclidean distance analysis
- Stream proximity mapping
- Raster reclassification

Participants successfully produced:

- Watershed boundaries
- Stream network maps
- Slope and Reclassified slope maps
- Stream proximity maps
- Reclassified stream distance maps

Module 2: Land Use/Land Cover Mapping Using Landsat 9 Satellite Imagery

This module focused on extracting land use information from satellite imagery for flood susceptibility assessment. Participants learned how to:

- Prepare Landsat 9 imagery
- Generate False Color Composites
- Subset imagery using watershed boundaries
- Perform supervised image classification
- Produce land use/land cover maps
- Reclassify land cover according to flood susceptibility classes

At the end of the practical session, every participant generated a complete LULC map and corresponding flood susceptibility layer.

Module 3: Rainfall Analysis and Flood Conditioning Factor Preparation

This module focused on preparing rainfall information using CHIRPS precipitation datasets. Participants completed the following practical exercises:

- Loading rainfall raster datasets
- Clipping rainfall data using watershed boundaries
- Reclassifying rainfall intensity into flood susceptibility classes
- Preparing precipitation layers for integration with other conditioning factors
- Participants gained practical understanding of incorporating climatic variables into flood hazard analysis.

Module 4: Flood Susceptibility Modeling Using Multi-Criteria Decision Analysis (MCDA)

This module integrated all previously prepared flood conditioning factors into a comprehensive flood susceptibility model. Participants learned:

- Principles of Multi-Criteria Decision Analysis
- Weighted Overlay Analysis
- Raster standardization
- Weight assignment
- Model development
- Flood susceptibility classification

Module 5: Cartographic Map Production

The final module focused on professional map preparation and presentation. Participants learned cartographic design principles and prepared publication-quality flood susceptibility maps containing:

- Title
- Legend
- Scale bar
- North arrow
- Coordinate grid
- Projection information
- Data sources
- Map layout
- Institutional logo
- Author information

Special emphasis was given to producing maps that meet national and international cartographic standards for technical reports and planning documents. By the completion of the training, participants had successfully generated the following outputs:

- Watershed boundaries
- Hydrological stream networks
- Slope maps
- Reclassified slope layers
- Stream proximity maps
- Reclassified stream distance layers
- Landsat False Color Composite images
- Land Use/Land Cover maps
- Reclassified LULC susceptibility layers
- CHIRPS rainfall maps
- Reclassified precipitation layers
- Integrated Flood Susceptibility Maps
- Professional cartographic layouts

Each participant completed a full flood susceptibility mapping workflow from raw spatial datasets to final map production.

5.5 Key Achievements

The training achieved its intended objectives by:

- Strengthening institutional capacity in GIS and Remote Sensing applications.
- Enhancing participants' practical skills in flood susceptibility modeling.
- Improving participants' understanding of hydrological spatial analysis.
- Building competency in satellite image processing and land cover mapping.
- Demonstrating practical application of MCDA techniques.
- Producing complete flood susceptibility maps using standardized workflows.
- Promoting evidence-based decision-making through geospatial technologies.
- Increasing participants' confidence in applying GIS tools to real-world environmental and disaster management challenges.

5.6 Challenges Observed

During the practical sessions, several challenges were observed:

- Differences in participants' prior GIS and remote sensing experience resulted in varying learning speeds.
- Some computers experienced limited processing capacity when handling large raster datasets.
- Data preprocessing required additional guidance for participants with limited experience in raster analysis.
- Time constraints limited opportunities to explore advanced flood susceptibility validation techniques and sensitivity analysis.
- Despite these challenges, all participants completed the practical exercises with guidance from the training team.

5.7 Participant Feedback

Participants expressed strong satisfaction with the overall quality of the training. They particularly appreciated the practical, hands-on nature of the sessions, the use of real-world datasets, and the clear step-by-step demonstrations provided by the trainers. Many participants indicated that the acquired skills are directly applicable to their ongoing work in watershed management, environmental assessment, disaster risk reduction, and integrated land use planning. Participants also recommended extending the duration of future trainings to allow for more advanced topics, including machine learning approaches for flood susceptibility mapping, model validation techniques, automation using Python and ModelBuilder, and the application of cloud-based geospatial platforms such as Google Earth Engine.

5.8 Conclusions

The refresher training successfully enhanced participants' knowledge and practical skills in flood susceptibility mapping using GIS, Remote Sensing and Multi-Criteria Decision Analysis. Through a structured sequence of practical exercises, participants developed complete flood susceptibility maps from raw geospatial datasets and produced professional cartographic outputs suitable for planning and decision-making. The training strengthened technical capacity in spatial data processing, hydrological analysis, land use mapping, rainfall analysis, and spatial modeling, thereby contributing to improved institutional capability for evidence-based flood risk assessment and integrated land use planning. Based on the outcomes of the training, the following recommendations are proposed:

- Organize periodic refresher trainings and mentorship programs to reinforce technical competencies.

- Promote institutional adoption of standardized geospatial workflows for flood hazard assessment and integrated land use planning.
- Strengthen collaboration among government institutions to facilitate data sharing, technical support, and the wider application of geospatial technologies in disaster risk management and environmental planning.

6. Post-Refresher Training Assessment Report

6.1 Introduction

Following the successful completion of the Refresher Training on Geospatial-Based Integrated Land Use Planning (ILUP), a post-training assessment was conducted to evaluate participants' perceived knowledge and understanding of the concepts, tools, and practical skills delivered during the training. The assessment formed an integral component of the training evaluation process and provided valuable feedback on the effectiveness of the training program, the relevance of the course content, and participants' readiness to apply the acquired knowledge in their respective institutions. The assessment focused on both Geographic Information Systems (GIS) and Remote Sensing competencies that are essential for integrated land use planning and evidence-based decision-making.

6.2 Objectives of the Assessment

The post-training assessment was conducted to:

- Evaluate participants' understanding of the GIS and Remote Sensing concepts presented during the refresher training.
- Assess improvements in participants' technical knowledge related to Integrated Land Use Planning.
- Identify areas where participants demonstrated strong competency.
- Identify topics requiring additional technical support or future capacity-building interventions.
- Obtain participant feedback to improve future training programs.

6.3. Assessment Methodology

The assessment was administered immediately after the completion of the refresher training using a structured self-assessment questionnaire. Participants rated their level of understanding for each competency using a five-point Likert scale ranging from 1 (Very Low Understanding) to 5 (Excellent Understanding). The questionnaire consisted of two sections. These are Geographic Information Systems (GIS) for Integrated Land Use Planning and Advanced Remote Sensing Applications for Integrated Land Use Planning. The assessment focused on participants' confidence in understanding the concepts and practical techniques covered during the training rather than evaluating them through a formal examination.

6.4. Post-Training Knowledge Assessment Areas
A. Geographic Information Systems (GIS)

To evaluate the effectiveness of the GIS for Integrated Land Use Planning (ILUP) Refresher Training, participants completed a post-training assessment questionnaire comprising ten competency-based questions covering both theoretical concepts and practical GIS applications. Participants were evaluated their understanding of the following competencies:

- Fundamentals of GIS for Integrated Land Use Planning.
- GIS data sources and applications.
- Coordinate systems and map projections.
- Spatial querying using attribute and location-based methods.
- Watershed delineation and stream network generation.
- Weighted overlay analysis.
- Geographic data representation.
- Spatial data analysis and map production using ArcGIS.
- Proximity analysis.
- Professional cartographic map design and production.

The assessment measured participants' perceived level of understanding using a five-point Likert scale: Very Low, Low, Moderate, Good, and Excellent. The results of the assessment are presented in **Figure 1**, which summarizes participants' responses across the ten learning objectives. Overall,

the findings indicate that the training substantially improved participants' understanding of GIS concepts and analytical techniques relevant to Integrated Land Use Planning.

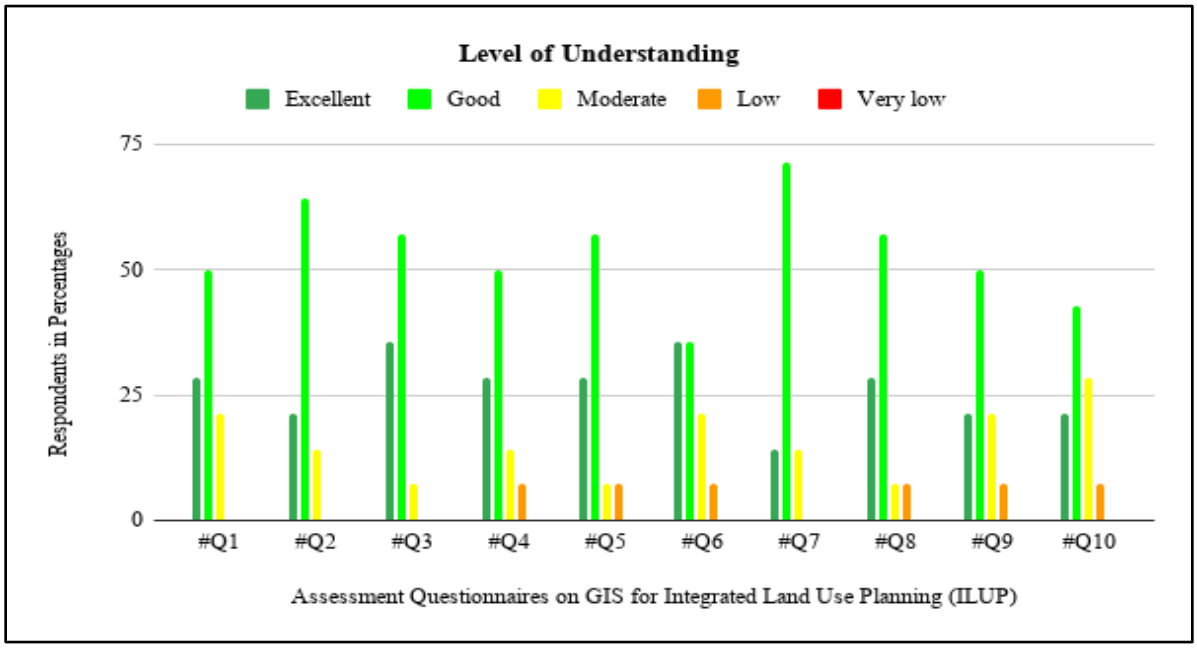


Figure 1: *Distribution of participants' level of understanding in percentage across the ten post-training assessment questions. The chart shows that Good and Moderate understanding levels dominate across all assessment items, while Low and Very Low responses are relatively infrequent, indicating the overall effectiveness of the refresher training in improving participants' knowledge of GIS applications for Integrated Land Use Planning.*

Across all assessment items, the majority of responses were concentrated in the Good Understanding category, followed by Excellent Understanding, while only a few participants rated their understanding as Low or Very Low. This distribution demonstrates that the refresher training effectively achieved its intended learning objectives. The post-training assessment demonstrates that the GIS for Integrated Land Use Planning Refresher Training was highly successful in enhancing participants' knowledge and practical competencies. Across all ten learning objectives, Good Understanding consistently represented the largest proportion of responses, while Excellent Understanding formed the second largest category. The relatively small number of Moderate responses and the very limited occurrence of Low understanding indicate that participants generally achieved the expected learning outcomes. Particularly strong performance was observed in understanding GIS fundamentals, GIS data sources, coordinate systems and map projections, representation of geographic phenomena, and ArcGIS-based spatial analysis. These topics

recorded consistently high levels of Good and Excellent understanding, reflecting the effectiveness of the theoretical presentations and practical demonstrations delivered during the training.

Although the overall performance was highly satisfactory, topics involving watershed delineation, weighted overlay analysis, and professional map design exhibited slightly greater variation in responses. These subjects require multiple analytical steps and greater technical experience, suggesting that future refresher programmes should allocate additional time for practical laboratory exercises, real-world case studies, and independent problem-solving activities. Overall, the assessment findings demonstrate that the refresher training successfully strengthened participants' technical capacity to apply GIS techniques in Integrated Land Use Planning and provided them with the practical knowledge required for evidence-based spatial planning and decision-making.

B. Post-training Assessment on Advanced Remote Sensing for Integrated Land Use Planning

Advanced Remote Sensing plays a critical role in Integrated Land Use Planning (ILUP) by providing accurate, timely, and spatially explicit information for sustainable land resource management. Modern Earth Observation technologies enable planners and decision-makers to monitor land use dynamics, assess environmental conditions, evaluate land suitability, and support evidence-based planning processes. Recognizing the increasing importance of geospatial technologies, an Advanced Remote Sensing Refresher Training was delivered to strengthen participants' knowledge and practical understanding of remote sensing applications in ILUP. This section presented participants' understanding of:

- &; Applications of satellite imagery in land use planning.
- &; Land use/land cover classification.
- &; Digital Elevation Model (DEM) applications.
- &; Integration of Remote Sensing and GIS datasets.
- &; Multi-temporal image analysis.
- &; Supervised image classification.
- &; Environmental monitoring applications.
- &; Integration of socio-economic and spatial datasets.
- &; Applications of Remote Sensing in Geospatial-based Integrated Land Use Planning.

Following the training, participants completed a structured assessment questionnaire to evaluate their level of understanding across ten key thematic areas. Responses were categorized into five levels: Excellent, Good, Moderate, Low, and Very Low. The assessment provides valuable insight into the effectiveness of the training and identifies areas requiring additional emphasis in future capacity-building programs.

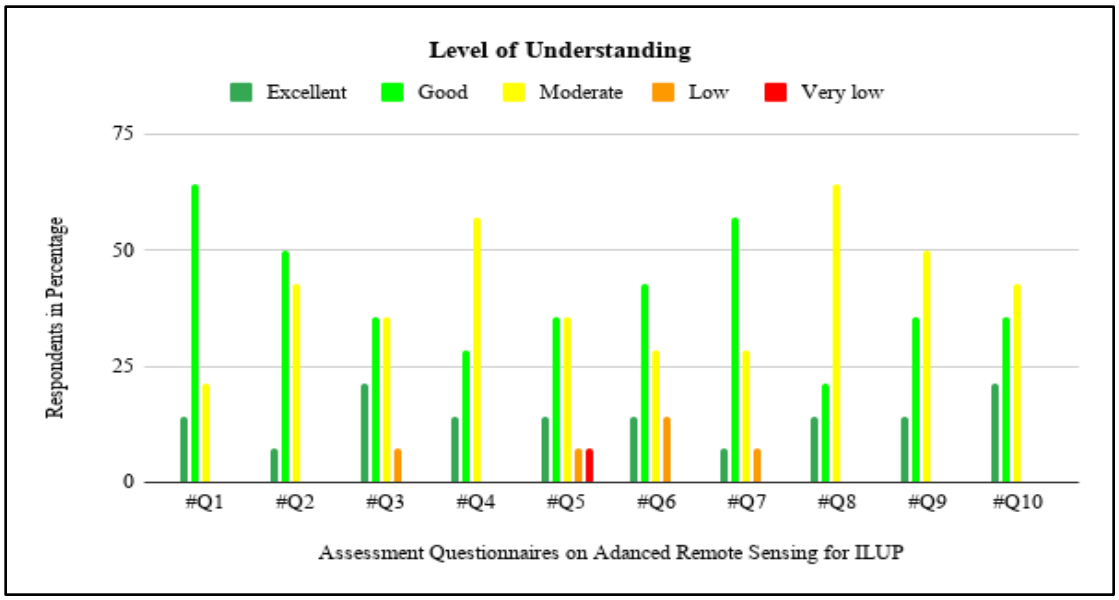


Figure 2. *Distribution of participants' level of understanding in percentage across the ten post-training assessment questions. The chart shows that Good and Moderate understanding levels dominate across all assessment items, while Low and Very Low responses are relatively infrequent, indicating the overall effectiveness of the refresher training in improving participants' knowledge of advanced Remote Sensing applications for Integrated Land Use Planning.*

The assessment results indicate that the training successfully improved participants' understanding of Advanced Remote Sensing concepts relevant to Integrated Land Use Planning. Across all ten assessment areas, the majority of responses fell within the Good and Moderate categories, while Low and Very Low responses were relatively limited. This suggests that the refresher training effectively strengthened participants' foundational knowledge while also highlighting specific topics requiring further reinforcement. The strongest understanding was observed for Q1 (Role and advantages of satellite imagery for ILUP), where the majority of participants rated their understanding as Good, accompanied by a notable proportion reporting Excellent understanding. This demonstrates that participants clearly recognized the importance of satellite imagery as a primary source of spatial information for integrated land use planning. Similarly, Q7 (Application of supervised classification methods for land use and land cover mapping) received a high

proportion of Good responses, indicating that participants gained substantial knowledge of classification techniques commonly used in remote sensing-based land use mapping. Practical demonstrations and examples likely contributed to this positive outcome.

Questions related to Q2 (Land use/land cover classification workflow), Q5 (Vegetation indices such as NDVI and EVI), Q6 (Multi-temporal remote sensing for change detection), Q9 (Integration of socio-economic data with remote sensing and GIS), and Q10 (Applications of remote sensing in geospatial-based ILUP) also demonstrated encouraging results. Most participants rated their understanding as either Good or Moderate, suggesting that the training successfully introduced both conceptual and practical aspects of these topics. The assessment also identified several thematic areas where participants demonstrated relatively lower confidence. Q4 (Integration of remote sensing with other spatial datasets for land suitability assessment) and Q8 (Applications of remote sensing technologies for environmental monitoring) recorded the highest proportions of Moderate responses. Although participants showed a basic understanding of these topics, comparatively fewer respondents reported Good or Excellent understanding. These findings suggest that participants require additional practical exposure to data integration techniques and environmental monitoring applications. For Q3 (Applications of Digital Elevation Models for topographic analysis and watershed delineation), responses were distributed between Good, Moderate, and Excellent, indicating satisfactory comprehension while also highlighting opportunities to strengthen practical exercises involving terrain analysis and hydrological applications. Overall, the assessment demonstrates that participants developed a solid understanding of the core principles and applications of Advanced Remote Sensing for ILUP. However, advanced analytical techniques involving multi-source data integration, environmental monitoring, and land suitability modelling remain areas where further capacity development would be beneficial.

6.5. General Observations

Based on observations made during the practical sessions and discussions, participants demonstrated a substantial improvement in their understanding of GIS and Remote Sensing concepts. Most participants actively engaged in practical exercises involving watershed delineation, spatial analysis, land use/land cover mapping, raster processing, weighted overlay analysis, and cartographic map production. Participants showed increased confidence in using

ArcGIS and Remote Sensing datasets to support land suitability assessment, environmental monitoring, and integrated land use planning activities. The practical nature of the refresher training enabled participants to connect theoretical concepts with real-world planning applications. The assessment also indicated that participants appreciated the use of real datasets and practical workflows, which enhanced their understanding of geospatial analysis and decision-support techniques.

6.6. Strengths Identified

The post-training assessment indicated several strengths of the refresher training, including:

- Strong practical orientation with hands-on GIS and Remote Sensing exercises.
- Improved understanding of watershed analysis and hydrological modeling.
- Enhanced skills in land use/land cover mapping.
- Better appreciation of spatial analysis techniques and weighted overlay modeling.
- Increased awareness of the role of geospatial technologies in evidence-based planning.
- Improved competency in professional cartographic map production.

6.7. Areas for Further Capacity Development

Although participants reported improved understanding across most topics, discussions during the assessment suggested the need for additional advanced training in:

- Advanced spatial modeling techniques.
- Machine learning applications in land use planning.
- Google Earth Engine and cloud-based geospatial analysis.
- Spatial database management.
- Python scripting for GIS automation.
- Multi-criteria decision analysis using advanced methods.
- Accuracy assessment and validation of spatial models.
- Change detection using multi-temporal satellite imagery.

6.8. Conclusions

The post-training assessment demonstrated that the refresher training successfully strengthened participants' knowledge and understanding of Geographic Information Systems and Remote Sensing applications for Integrated Land Use Planning. The competency areas assessed were well aligned with the training objectives, and participants reported increased confidence in applying geospatial technologies to land use planning, environmental management, and spatial decision-making. The assessment further confirmed the value of practical, hands-on training using real-

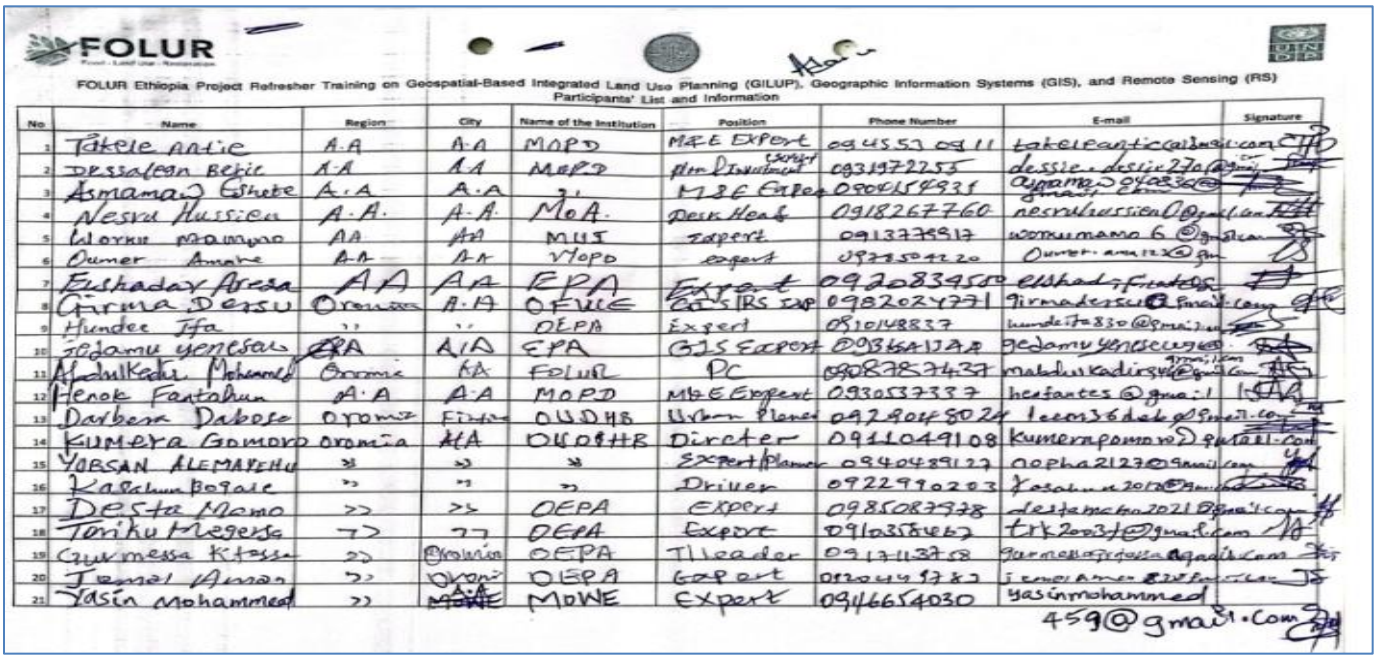
world datasets and highlighted the importance of continuous professional development to maintain and enhance technical competencies in rapidly evolving geospatial technologies.

6.9. Recommendations

Based on the assessment, the following recommendations are proposed:

- Continue providing periodic refresher training to reinforce GIS and Remote Sensing competencies.
- Develop advanced training modules on machine learning, artificial intelligence, and cloud-based geospatial platforms.
- Increase the duration of practical sessions to allow participants to complete more comprehensive case studies.
- Establish post-training mentoring and technical support mechanisms.
- Provide participants with training manuals, datasets, and workflow documentation for continued practice.
- Encourage participants to implement the acquired knowledge within their respective institutions and share experiences through institutional learning platforms.
- Conduct follow-up assessments six to twelve months after training to evaluate knowledge retention and practical application in the workplace.

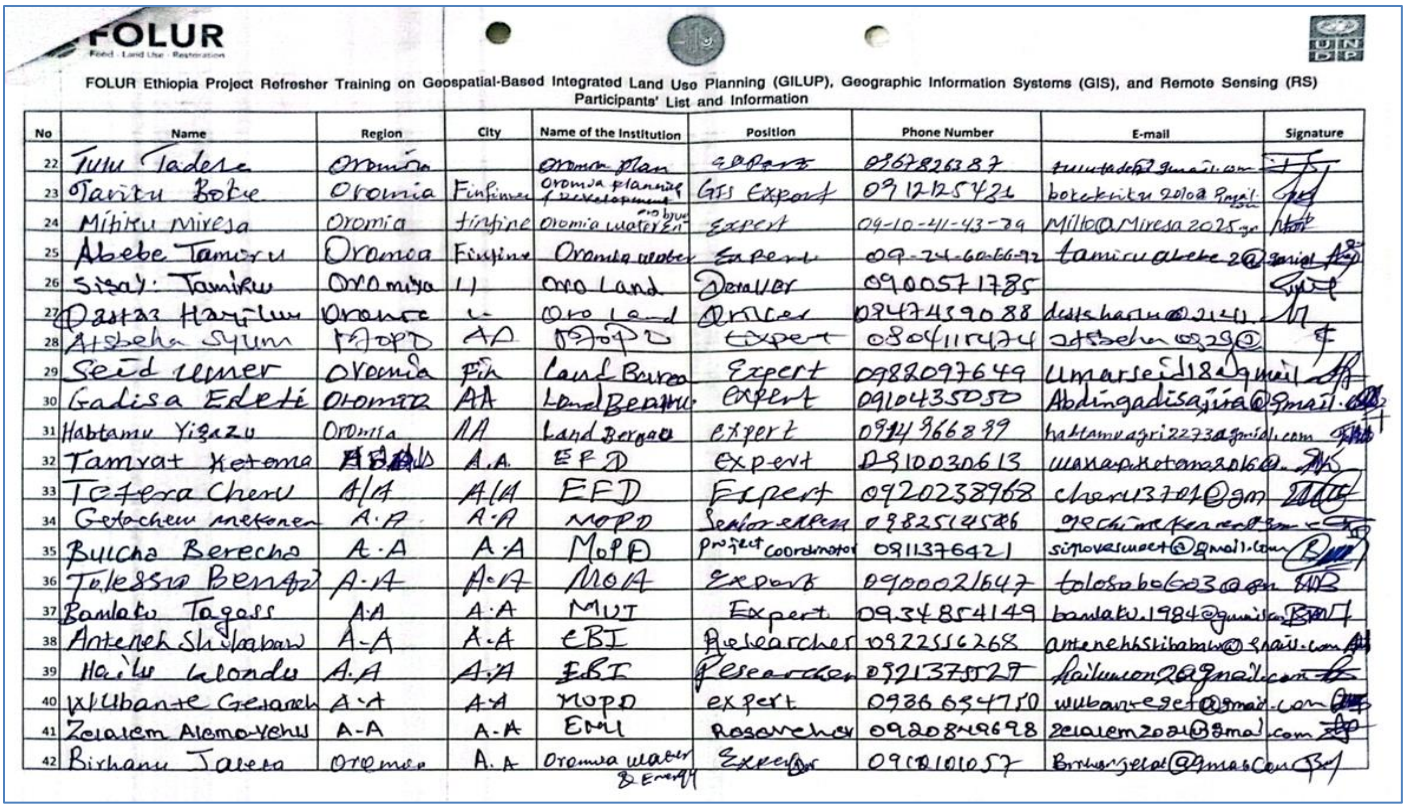
Annex I: Attendance Sheet (signed by participants)



FOLUR

FOLUR Ethiopia Project Refresher Training on Geospatial-Based Integrated Land Use Planning (GILUP), Geographic Information Systems (GIS), and Remote Sensing (RS)
Participants' List and Information

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Annex II: Photos During the Refresher-Training Session






9:55







Annex III: Post-Refresher Training Assessment Questionnaire

A. For GIs for Integrated Land Use Planning

Response Scale (5-point Likert Scale)

Scale	Description
1	Very Low Understanding
2	Low Understanding
3	Moderate Understanding
4	Good Understanding
5	Excellent Understanding

Instructions: *Please indicate your current level of understanding for each of the following topics using the scale provided.*

#	Statement	1	2	3	4	5
1	I understand the fundamentals of Geographic Information Systems (GIS) for Integrated Land Use Planning (ILUP).	☐	☐	☐	☐	☐
2	I understand different GIS data sources and their applications.	☐	☐	☐	☐	☐
3	I understand the importance of coordinate systems and map projections for ILUP data analysis and map production.	☐	☐	☐	☐	☐
4	I can query spatial data using attribute and location-based queries.	☐	☐	☐	☐	☐
5	I understand watershed delineation and stream network generation using GIS.	☐	☐	☐	☐	☐
6	I understand how to perform weighted overlay analysis in GIS.	☐	☐	☐	☐	☐
7	I understand how real-world geographic phenomena are represented in GIS.	☐	☐	☐	☐	☐
8	I understand spatial data collection, analysis and map production using ArcGIS software.	☐	☐	☐	☐	☐
9	I understand how to perform proximity analysis in GIS.	☐	☐	☐	☐	☐
10	I can design and produce professional-quality maps using GIS.	☐	☐	☐	☐	☐

B. For Remote Sensing for Integrated Land Use Planning

Response Scale (5-point Likert Scale)

Scale	Description
1	Very Low Understanding
2	Low Understanding
3	Moderate Understanding
4	Good Understanding
5	Excellent Understanding

Instructions: *Please indicate your current level of understanding for each of the following topics using the scale provided.*

#	Statement	1	2	3	4	5
1	I understand the role and advantages of satellite imagery for integrated land use planning.	☐	☐	☐	☐	☐
2	I understand the principles and workflow of land use/land cover classification and mapping for ILUP.	☐	☐	☐	☐	☐
3	I understand the applications of Digital Elevation Models (DEMs) for topographic analysis, watershed delineation, and land use planning.	☐	☐	☐	☐	☐
4	I understand how to integrate remote sensing data with other spatial data for land suitability assessment.	☐	☐	☐	☐	☐
5	I understand the use of vegetation indices (e.g., NDVI, EVI) for monitoring vegetation condition and supporting agricultural land use planning.	☐	☐	☐	☐	☐
6	I understand the challenges and methods involved in analyzing multi-temporal remote sensing data for land use and land cover change detection.	☐	☐	☐	☐	☐
7	I understand the application of supervised classification methods for land use and land cover mapping.	☐	☐	☐	☐	☐
8	I understand the applications of remote sensing technologies for environmental monitoring.	☐	☐	☐	☐	☐
9	I understand how to integrate socio-economic data with remote sensing and GIS datasets to support integrated land use planning.	☐	☐	☐	☐	☐
10	I understand the applications of remote sensing in Geospatial based integrated land use planning.	☐	☐	☐	☐	☐