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

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Executive Summary

The Ethiopian Space Science and Geospatial Institute (SSGI), in collaboration with the Ministry of Planning and Development (MoPD) under the UNDP-funded Forest, Land Use and Restoration (FOLUR) Project, conducted a refresher training on Geospatial-based Integrated *Land Use Planning (GILUP) approximately one year after the initial regional capacity-building program. The training aimed to assess participants' retention and application of previously acquired Geographic Information Systems (GIS) and Remote Sensing knowledge while strengthening practical competencies through project-based learning. The practical component focused on flood susceptibility mapping using GIS, Remote Sensing, and Multi-Criteria Decision Analysis (MCDA), incorporating watershed delineation, terrain analysis, supervised image classification, rainfall analysis, weighted overlay, and professional map production. Participants worked with Digital Elevation Models (DEM), Landsat 9 imagery, CHIRPS rainfall data, ArcGIS, and ERDAS IMAGINE. Qualitative feedback indicated that participants had applied their previous training in land use and land cover mapping, forest management, cadastral registration, Green Legacy initiatives, FOLUR activities, and spatial planning at regional and woreda levels. However, broader implementation of GIS-enabled GILUP remained constrained by inadequate computing facilities, unreliable internet connectivity, limited access to licensed software, shortages of skilled personnel, weak institutional coordination and data sharing, and limited opportunities to apply acquired skills following staff reassignment. Competency-based post-training assessments demonstrated improved understanding of GIS and Advanced Remote Sensing concepts and applications. Participants generally demonstrated moderate to good competency in spatial data management, coordinate systems, GIS analysis, image processing, and classification, while advanced techniques such as weighted overlay, watershed delineation, proximity analysis, and complex image processing required further practice. Overall, the training reinforced technical competencies and highlighted the need for continuous capacity development, technical support, institutional collaboration, improved infrastructure, and stronger policy commitment to scale up GILUP under the FOLUR Project.*

1. Introduction

Integrated Land Use Planning (ILUP) is a strategic approach for achieving sustainable development by balancing environmental conservation, agricultural production, infrastructure development, biodiversity protection, and socio-economic growth through evidence-based decision-making. The effective implementation of ILUP relies on accurate spatial information, making Geographic Information Systems (GIS) and Remote Sensing indispensable tools for mapping natural resources, monitoring environmental change, assessing land suitability, and supporting informed planning decisions.

Under the Forest, Land Use and Restoration (FOLUR) Project, the Ethiopian Space Science and Geospatial Institute (SSGI), in collaboration with the Ministry of Planning and Development (MoPD), has been strengthening institutional and human capacity in Geospatial-based Integrated Land Use Planning (GILUP). Following a capacity assessment that identified significant gaps in technical expertise, institutional capacity, and access to modern geospatial technologies, SSGI delivered a regional training program in March 2025 for experts from Oromia, Sidama, South Ethiopia, and Southwest Ethiopia Regional States. The training covered Integrated Land Use Planning, Geographic Information Systems (GIS), and Advanced Remote Sensing through a combination of theoretical sessions and practical exercises using ArcGIS and ERDAS IMAGINE.

Recognizing that capacity development is a continuous process, SSGI organized a refresher training approximately one year after the initial program to reinforce participants' knowledge and practical skills, assess the application of the competencies acquired, and address emerging technical needs. Unlike the initial training, the refresher program adopted a project-based learning approach centered on flood susceptibility mapping using DEM, Landsat 9 imagery, CHIRPS rainfall data, GIS, and Remote Sensing techniques. The training also provided a platform for participants to share implementation experiences, discuss institutional challenges, and identify strategies for strengthening the implementation of GIS-enabled Integrated Land Use Planning across Ethiopia.

Participants reported that the knowledge gained from the previous training has been applied in activities such as land use and land cover mapping, forest management, cadastral registration,

Green Legacy initiatives, FOLUR implementation, regional atlas preparation, and spatial planning. However, they also identified persistent challenges, including inadequate ICT infrastructure, limited access to licensed geospatial software, shortages of skilled professionals, weak institutional coordination, and insufficient policy support, that continue to constrain the wider implementation of GIS-based Integrated Land Use Planning. These findings reaffirm the importance of sustained capacity-building, institutional collaboration, and continuous technical support to advance evidence-based land use planning and sustainable natural resource management in Ethiopia.

2. Objectives of the Refresher Training

2.1 General Objective

The overall objective of the refresher training was to reinforce and strengthen the knowledge and practical competencies acquired during the previous Geospatial-based Integrated Land Use Planning training while promoting effective application of GIS and Remote Sensing technologies in regional land use planning activities.

2.2 Specific Objectives

The refresher training specifically aimed to:

- Assess the extent to which participants retained the knowledge and practical skills acquired during the previous training.
- Evaluate the application of GIS and Remote Sensing technologies in participants' routine institutional activities.
- Strengthen participants' competencies through project-based practical training using real geospatial datasets.
- Enhance participants' abilities in watershed delineation, spatial analysis, image classification, and flood susceptibility mapping.
- Facilitate experience sharing among participants from different regional states regarding implementation of Integrated Land Use Planning.
- Identify institutional, technical, and policy challenges affecting implementation of GIS-enabled ILUP.

- Assess post-training competency improvement through structured evaluation questionnaires.
- Generate recommendations for strengthening future capacity-building initiatives and institutional implementation of Integrated Land Use Planning.

3. Training Overview

The refresher training on Geospatial-based Integrated Land Use Planning (GILUP) was conducted as a follow-up capacity-building intervention approximately one year after the initial regional training organized under the Forest, Land Use and Restoration (FOLUR) Project. The training was organized by the Ethiopian Space Science and Geospatial Institute (SSGI) in collaboration with the Ministry of Planning and Development (MoPD) to reinforce technical competencies in Geographic Information Systems (GIS) and Remote Sensing while assessing the extent to which participants had retained and applied the knowledge and skills acquired during the previous training. The original training targeted experts from Oromia, Sidama, South Ethiopia, and Southwest Ethiopia Regional States and focused on strengthening institutional, human, and technological capacities for Geospatial-based Integrated Land Use Planning.

Unlike the initial training, which emphasized broad theoretical foundations together with practical exercises, the refresher training adopted a highly application-oriented approach for the same trainees. The training integrated technical discussions, experience-sharing sessions, competency assessment, and intensive hands-on practical exercises based on real geospatial datasets and actual planning problems. The overall objective was not only to refresh participants' knowledge and skill but also to deepen their practical skills and improve their confidence in implementing geospatial technologies within their respective institutions. The refresher training was delivered at three training centers (Table 1).

Table 1. Number of Participants in GIS-Integrated Land Use Planning.

Training Center	Participants	Lead trainer	Assistant trainer
Adama	17	Dr. Berhan Gessesse & Dr. Gizachew Kabite	Mr. Wondimu Haimanote and Mr. Galana Daba
Hawassa	41	Dr. Berhan Gessesse	Mr. Galana Daba
Jimma	32	Dr. Gizachew Kabite	Mr. Wondimu Haimanote
Total	**90**	**4**	**2**

The participants represented technical experts from Oromia, Sidama, South Ethiopia, and Southwest Ethiopia Regional States who are directly involved in land administration, natural resource management, environmental protection, agricultural development, and integrated land use planning. Experts from Southwest and western zones of Oromia were trained at Jimma center while experts from Sidama, South Ethiopia and Eastern and southern parts of Oromia were trained at Hawass center whereas experts from head office of Oromia regional states were trained at Adama center.

4. Training Methodology

The refresher training was designed using a competency-based and learner-centered approach that emphasized practical problem solving rather than classroom lectures alone. Building on participants' previous exposure to GIS and Remote Sensing, the training combined four complementary learning components:

4.1 Experience Sharing

The program commenced with a structured discussion session that enabled participants to reflect on their experiences following the original training. This session provided an opportunity to assess:

- the extent to which participants had applied acquired knowledge;
- institutional achievements;
- challenges encountered during implementation;
- capacity gaps requiring additional support; and
- recommendations for improving future training programs.

The discussion also encouraged participants from different regions to exchange experiences and learn from each other's successes and challenges.

4.2 Hands-on Practical Training

The major component of the refresher program consisted of intensive computer-based practical hand on exercises. Participants worked individually and in groups using ArcGIS and ERDAS IMAGINE software to complete an end-to-end geospatial workflow for flood susceptibility mapping.

Instead of isolated software demonstrations, the training followed a project-based learning approach in which each practical exercise contributed to producing a complete flood susceptibility map for a selected watershed.

4.3 Problem-Based Learning

Participants solved realistic land management problems using actual datasets including:

- Digital Elevation Model (DEM)
- Landsat 9 satellite imagery
- CHIRPS rainfall data
- Ethiopian administrative boundaries

This approach strengthened participants' analytical skills while demonstrating how multiple spatial datasets can be integrated for evidence-based Integrated Land Use Planning.

4.4 Competency Assessment

The effectiveness of the refresher training was evaluated through structured post-training assessments for both GIS and Advanced Remote Sensing modules. Participants self-assessed their level of understanding using competency-based questionnaires designed to evaluate both conceptual understanding and practical skills.

5. Refresher Training Contents

Unlike the previous training, which introduced the complete framework of Geospatial-based Integrated Land Use Planning, the refresher training concentrated on one integrated practical project that combined GIS analysis, Remote Sensing, and Multi-Criteria Decision Analysis (MCDA) to produce flood susceptibility maps.

The practical project simulated a real-world planning scenario in which participants developed flood susceptibility maps using multiple spatial datasets and geospatial analytical techniques.

The refresher training was organized into five practical modules.

Module I: Watershed Delineation and Topographic Analysis

The first module focused on hydrological analysis using Digital Elevation Models (DEM). Participants learned to derive watershed boundaries and topographic variables that influence flood susceptibility.

Major practical activities included:

- DEM preparation
- Watershed delineation
- Sink filling
- Flow direction analysis
- Flow accumulation
- Stream network generation
- Watershed extraction
- Slope generation
- Euclidean distance analysis
- Stream proximity mapping
- Reclassification of topographic factors

At the completion of the module, participants produced:

- Watershed boundaries
- Stream networks
- Slope maps
- Reclassified slope maps
- Stream proximity maps
- Reclassified stream distance maps

These outputs provided the topographic inputs required for subsequent flood susceptibility analysis.

Module II: Land Use/Land Cover Mapping

The second module introduced participants to satellite image processing using Landsat 9 imagery within ERDAS IMAGINE.

The practical exercises covered:

- image visualization;
- false color composite generation;
- image subsetting;
- supervised image classification;
- land use/land cover map generation; and
- reclassification of land cover according to flood susceptibility classes.

Participants classified land cover into categories such as forest, grassland, cropland, bare land, urban areas, and water bodies before converting these classes into flood susceptibility factors. The module demonstrated how satellite-derived land use information contributes to evidence-based planning and disaster risk assessment.

Module III: Rainfall Analysis

The third module focused on the preparation of precipitation layers using CHIRPS rainfall data.

Participants learned how to:

- preprocess rainfall raster datasets;
- clip precipitation data using watershed boundaries;
- classify rainfall into susceptibility classes;
- prepare rainfall conditioning factors for weighted overlay analysis.

This module demonstrated the importance of rainfall intensity in determining flood hazard and illustrated how climatic datasets can be incorporated into Integrated Land Use Planning.

Module IV: Flood Susceptibility Mapping

After preparing all flood conditioning factors, participants integrated the datasets through weighted overlay analysis.

The flood susceptibility model combined:

- slope;
- stream proximity;
- land use/land cover;
- rainfall intensity;
- additional environmental factors derived during previous modules.

Participants learned the principles of Multi-Criteria Decision Analysis (MCDA), assigning weights to each conditioning factor before generating the final flood susceptibility map.

The exercise illustrated how GIS-based decision-support tools can be applied to support land use planning, disaster risk reduction, watershed management, and climate adaptation planning.

Module V: Cartographic Presentation

The final module focused on transforming analytical outputs into professional cartographic products suitable for planning and decision-making.

Participants learned how to prepare standardized maps containing:

- title;

- legend;
- scale;
- north arrow;
- coordinate grid;
- map projection;
- inset map;
- metadata; and
- appropriate layout design.

This final exercise emphasized effective communication of spatial information to planners, decision-makers, and stakeholders through high-quality cartographic outputs.

6. Practical Learning Outcomes

By the end of the refresher training, participants had successfully completed a comprehensive GIS and Remote Sensing workflow from raw spatial data preparation to final map production. Compared to the original training, which introduced individual GIS and Remote Sensing techniques separately, the refresher training enabled participants to integrate these techniques into a complete geospatial decision-support framework.

Specifically, participants demonstrated improved competencies in:

- watershed delineation using DEM;
- hydrological terrain analysis;
- satellite image preprocessing and classification;
- generation of land use and land cover maps;
- rainfall data processing;
- spatial reclassification techniques;
- weighted overlay analysis;
- flood susceptibility modelling;
- GIS-based decision support; and
- professional cartographic map production.

The project-based approach substantially strengthened participants' practical understanding of how GIS, Remote Sensing, and Multi-Criteria Decision Analysis can be integrated to solve real-world planning problems. Furthermore, the training enhanced participants' confidence in applying geospatial technologies within their institutions and provided a practical framework that can be adapted to other Integrated Land Use Planning applications, including land suitability analysis, watershed management, forest monitoring, and environmental planning.

7. Pre-Training Reflection and Experience-Sharing Discussion

Prior to the commencement of the refresher training, an unstructured qualitative discussion was conducted to assess the extent to which participants had retained and applied the knowledge and skills acquired during the previous Geospatial-based Integrated Land Use Planning (GILUP) training. The discussion also sought to document institutional achievements, identify implementation challenges, and gather recommendations for improving future capacity-building initiatives. A total of 90 participants representing Oromia, Sidama, South Ethiopia, and Southwest Ethiopia Regional States attended the refresher training at the Adama, Hawassa, and Jimma training centers.

The discussion was guided by key questions focusing on: (i) the application of knowledge and skills gained from the previous training; (ii) the frequency and purpose of GIS and Remote Sensing applications; (iii) outputs and deliverables produced using geospatial technologies; (iv) challenges affecting implementation; and (v) lessons learned and recommendations for strengthening future training programs. Participants also shared their institutional experiences in applying geospatial technologies to support planning and natural resource management activities.

Overall, participants highly appreciated both the previous and this refresher training programs, recognizing their significant contribution to strengthening technical capacity in GIS and Remote Sensing for Integrated Land Use Planning. Participants emphasized that the previous training had improved their understanding of geospatial technologies and enabled many of them to apply the acquired knowledge in their daily work. They further noted that the refresher training provided an excellent opportunity to update their knowledge, deepen practical skills, learn advanced geospatial techniques, and exchange experiences with professionals from different institutions.

The discussion indicated that approximately 60% of participants had actively applied the knowledge and skills gained from the previous training in their routine professional activities. These participants reported using GIS and Remote Sensing for land use and land cover mapping, forest management, cadastral registration, environmental monitoring, Green Legacy initiatives, FOLUR project implementation, and spatial planning at regional, zonal, and woreda levels. The remaining 40% reported limited opportunities to directly apply the acquired skills, mainly because of institutional constraints, limited resources, or reassignment to responsibilities unrelated to Integrated Land Use Planning. Nevertheless, they acknowledged that the previous training substantially improved their understanding of geospatial technologies and enhanced their readiness to apply GIS and Remote Sensing in future assignments.

Participants also appreciated the practical, project-based design of the refresher training. Unlike the previous program, which provided broad theoretical and practical foundations, the refresher training emphasized solving real-world planning problems through integrated GIS and Remote Sensing workflows. Participants indicated that this approach improved learning efficiency, strengthened analytical skills, and enhanced their confidence in applying geospatial technologies for Integrated Land Use Planning.

The discussion further revealed that participants had diverse educational backgrounds and varying levels of GIS and Remote Sensing experience. While some participants had become regular users of geospatial technologies over the past year, others had limited opportunities to practice because of institutional limitations. Consequently, participants recommended that future refresher training programs adopt differentiated learning approaches to accommodate beginners, intermediate users, and advanced practitioners while providing introductory sessions for participants who did not attend the previous training.

7.1 Application of Knowledge and Skills After One Year

One of the primary objectives of the refresher training was to evaluate whether participants had successfully transferred the knowledge and practical skills acquired during the initial training into their routine professional activities. The feedback discussion demonstrated encouraging evidence

that many participants have been applying GIS and remote sensing technologies within their respective institutions.

Participants reported using geospatial technologies for a wide range of planning and natural resource management activities. These included land use and land cover mapping, forest resource management, cadastral registration, Green Legacy implementation, FOLUR project activities, and regional planning exercises. GIS has increasingly become an important decision-support tool for spatial planning and environmental management within several regional institutions.

Regional experiences demonstrated varying levels of implementation.

South West Ethiopia Region

Participants from Southwest Ethiopia Regional State reported that GIS and remote sensing technologies have become routine components of planning and natural resource management activities. The technologies are regularly used not only at regional offices but also at woreda and kebele administrative levels, demonstrating encouraging institutional adoption of geospatial technologies.

Oromia Regional State

Participants from Oromia Regional State demonstrated extensive application of the knowledge and skills acquired from the previous training. Experts from the Oromia Planning Bureau reported regularly using GIS and remote sensing technologies to support planning activities, while participants from the Oromia Land Bureau applied the training to update spatial databases and implement pilot Integrated Land Use Planning (ILUP) activities at the kebele level. Experts from the Oromia Forest and Wildlife Enterprise indicated that GIS and remote sensing are widely used for forest mapping, monitoring, management, and cadastral registration. Similarly, participants from the Oromia Environmental Protection Authority reported applying geospatial technologies for environmental monitoring and forest resource assessment.

The training has also generated broader capacity-building impacts beyond the participating institutions. In collaboration with Farm Africa and Wondo Genet College of Forestry and Natural Resources Development, the Oromia Environmental Protection Authority independently

organized and delivered GIS and remote sensing training across 21 zones in Oromia, with plans to further expand these initiatives to additional zones and woredas. These experiences demonstrate that the previous training has significantly strengthened technical capacity and promoted the practical application of GIS-enabled Integrated Land Use Planning across the region. However, participants emphasized that broader institutional integration and the mainstreaming of geospatial technologies into planning and decision-making processes at decentralized administrative levels remain necessary to fully realize the benefits of GIS-based ILUP.

South Ethiopia Region

Participants from South Ethiopia Regional State reported significant institutional progress since the previous training. GIS technologies have been incorporated into routine government activities across several sectors. The region has established a Memorandum of Understanding with the Ethiopian Space Science and Geospatial Institute to strengthen technical collaboration. In addition, a regional geospatial coordination team has been established to facilitate GIS implementation across multiple sectors including urban development, road authority, planning offices, health services, and natural resource management. Participants further reported that land use plans have already been endorsed for fifteen kebeles and that a regional atlas has been prepared using geospatial information. These achievements demonstrate substantial institutional commitment toward evidence-based planning and effective application of GIS technologies.

Overall, participants agreed that the previous training had significantly improved their ability to collect, manage, analyze, and utilize spatial information for planning purposes. Nevertheless, they emphasized that wider institutional support remains necessary before the full potential of Geospatial-based Integrated Land Use Planning can be realized across all administrative levels.

7.2 Institutional Collaboration and GIS Integration

The discussion highlighted encouraging progress in institutional collaboration since completion of the original training. Several regional institutions have initiated efforts to integrate GIS into sectoral planning processes, recognizing the value of spatial information for evidence-based decision-making.

Participants emphasized that GIS applications are no longer confined to specialized geospatial units but are increasingly supporting broader development sectors including agriculture, forestry, environmental protection, water resources management, road infrastructure, urban development, planning commissions, and natural resource management. The establishment of cross-sectoral geospatial teams in some regions has improved coordination among government institutions and strengthened information sharing.

Despite these positive developments, participants observed that institutional collaboration remains inconsistent across regions. Data sharing among organizations is often limited, resulting in duplication of effort, inconsistent datasets, and inefficient planning processes. Participants therefore recommended strengthening inter-sectoral collaboration mechanisms and developing common geospatial data standards that facilitate information exchange among planning institutions.

8. Post-Refresher Training Assessment Results

To evaluate the effectiveness of the refresher training, structured competency-based post-training assessments were administered for both Geographic Information Systems (GIS) and Advanced Remote Sensing modules. Participants rated their level of understanding using a five-point Likert scale ranging from Very Low Understanding to Excellent Understanding.

8.1 GIS Module Assessment

The post-training assessment of the GIS module indicates that the refresher training effectively enhanced participants' knowledge and practical understanding of Geographic Information Systems (GIS). Across the ten assessment questions, the majority of participants rated their understanding as Good (22.73–53.41%) or Moderate (23.86–44.32%), while Excellent understanding ranged from 13.64% to 23.86%. Responses indicating Low understanding were generally limited (3.41–13.64%), and Very Low understanding was almost absent, being reported only for one assessment question (1.14%) (Table 2).

The results suggest that participants developed a solid understanding of core GIS concepts, including GIS fundamentals, spatial data sources, coordinate systems, geographic data

representation, ArcGIS tools, and basic spatial analysis techniques. In most of these topics, more than half of the participants reported either Good or Excellent understanding, demonstrating that the refresher training successfully reinforced knowledge acquired during the original capacity-building program and improved participants' confidence in applying GIS within the framework of Geospatial-based Integrated Land Use Planning (GILUP).

Despite these positive outcomes, the assessment also highlighted areas requiring additional capacity development. Questions associated with more advanced GIS applications—particularly weighted overlay analysis, watershed delineation, hydrological modelling, and proximity analysis—received relatively higher proportions of Moderate and Low understanding compared with the other topics. These findings suggest that while participants have acquired a strong foundation in GIS, advanced spatial analytical techniques would benefit from additional hands-on exercises, mentoring, and follow-up training to strengthen practical competence.

Table 2. Post-training assessment response to GIS Module.

GIS Regional Participants' Responses						
Post-GIS Training Participants' Understanding Levels (%)						
AQ	1	2	3	4	5	Total
Q1		4.55	23.86	53.41	18.18	100
Q2		3.41	27.27	53.41	15.91	100
Q3		5.68	27.27	44.32	22.73	100
Q4		11.36	26.14	40.91	21.59	100
Q5		5.68	35.23	35.23	23.86	100
Q6		13.64	44.32	22.73	19.32	100
Q7	1.14	3.41	35.23	46.59	13.64	100
Q8		4.55	30.68	50.00	14.77	100
Q9		9.09	40.91	36.36	13.64	100
Q10		9.09	30.68	42.05	18.18	100

Note: AS=Assessment questionnaire; 1=Very low understanding; 2=Low understanding; 3=Moderate understanding; 4=Good understanding; 5=Excellent understanding.

Figure 1 presents the distribution of participants' post-training understanding levels across the ten GIS assessment questions. Overall, the results demonstrate that the refresher training effectively strengthened participants' understanding of GIS concepts and their practical application. Across all assessment topics, the majority of responses were concentrated in the Moderate Understanding, Good Understanding, and Excellent Understanding categories, while Low Understanding responses were relatively few and Very Low Understanding was virtually absent.

Good Understanding was the most frequently reported level for Questions 1–4, 7, 8, and 10, accounting for approximately 41–53% of responses. Excellent Understanding ranged from 13.64% to 23.86%, with the highest proportions observed for Questions 3, 4, and 5. These findings indicate that participants gained strong knowledge of fundamental GIS concepts, including spatial data, coordinate systems, geographic representation, ArcGIS tools, and basic spatial analysis, while also increasing their confidence in applying GIS for Geospatial-based Integrated Land Use Planning (GILUP).

The figure also highlights areas requiring further capacity development. Questions 6 and 9 recorded the highest proportions of Low Understanding responses (13.64% and 9.09%, respectively), and Question 6 showed the highest proportion of Moderate Understanding (44.32%), suggesting that participants were less confident in more advanced GIS applications. These topics, which include weighted overlay analysis, watershed delineation, hydrological modelling, and proximity analysis, require additional practical exercises, hands-on mentoring, and advanced training to strengthen technical competency.

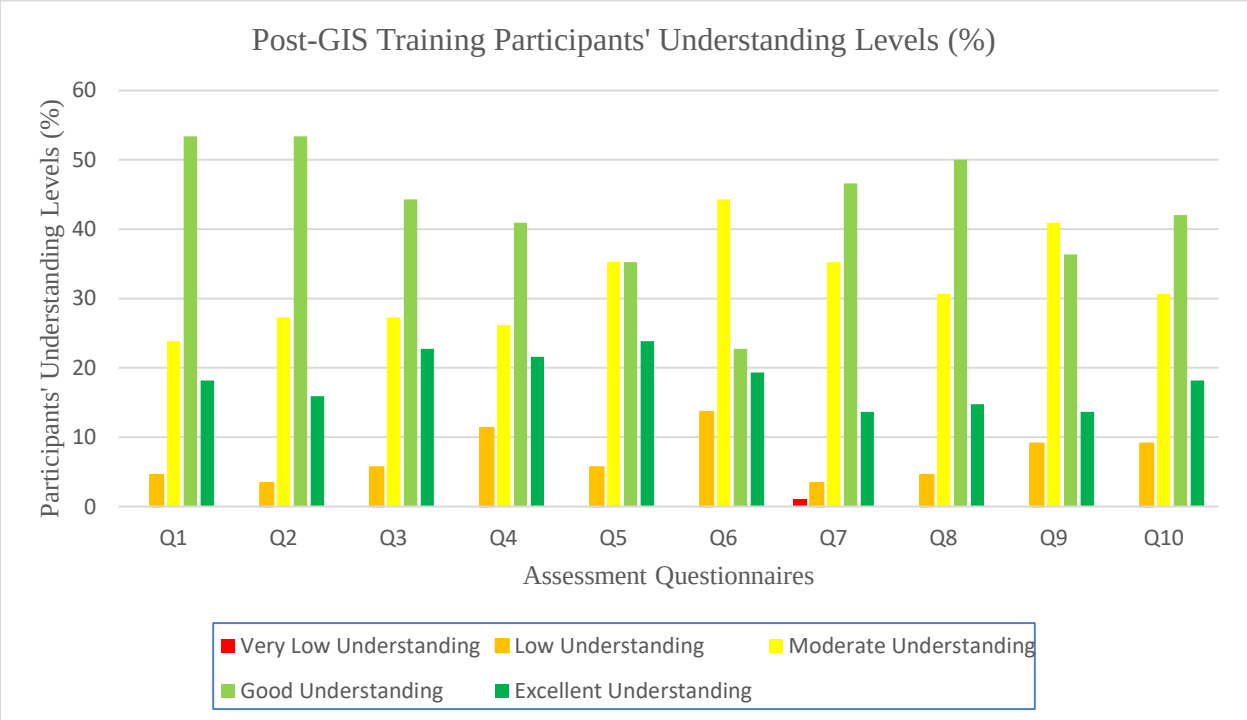


Figure 1. Post GIS training participants understanding levels in %.

Overall, Figure 1 confirms that the GIS refresher training successfully enhanced participants' knowledge retention and practical GIS skills. The predominance of Moderate, Good, and Excellent understanding across all assessment topics demonstrates the effectiveness of the training in reinforcing GIS competencies for Integrated Land Use Planning. Future refresher programs should place greater emphasis on advanced spatial analytical techniques to further improve participants' capacity to apply GIS in complex land use planning and evidence-based decision-making.

8.2 Advanced Remote Sensing Assessment

Results from the Advanced Remote Sensing assessment similarly demonstrated positive learning outcomes. The majority of participants reported Moderate or Good Understanding across all assessment topics, while a substantial proportion indicated Excellent Understanding following completion of the refresher training. Only a small percentage reported Low Understanding, and Very Low Understanding responses were minimal.

Participants demonstrated improved understanding of:

- remote sensing principles;
- satellite image interpretation;
- digital image processing;
- image classification;
- remote sensing applications;
- integration of remote sensing with GIS; and
- practical use of satellite-derived information for Integrated Land Use Planning.

Table 3. Advanced remote sensing Regional Participants' Responses.

Advanced Remote Sensing Regional Participants' Responses						
Post-Advanced Remote Sensing Training **Participants' Understanding Levels** (%)						
AQ	1	2	3	4	5	Total
Q1		4.41	32.35	45.59	17.65	100
Q2		5.88	27.94	55.88	10.29	100
Q3		8.82	30.88	38.24	22.06	100
Q4		11.76	29.41	50.00	8.82	100
Q5	2.94	17.65	38.24	33.82	7.35	100
Q6		10.29	44.12	39.71	5.88	100
Q7		5.88	39.71	36.76	17.65	100
Q8		8.82	39.71	38.24	13.24	100
Q9		8.82	36.76	39.71	14.71	100
Q10		7.35	32.35	45.59	14.71	100

Note: AS=Assessment questionnaire; 1=Very low understanding; 2=Low understanding; 3=Moderate understanding; 4=Good understanding; 5=Excellent understanding.

Table 2 presents the post-training assessment results for the Advanced Remote Sensing module, showing participants' self-reported understanding levels across ten competency-based assessment questions. Overall, the results indicate that the refresher training effectively enhanced participants' knowledge and practical understanding of advanced remote sensing concepts and applications.

Across all assessment questions, the majority of participants rated their understanding as Moderate or Good, indicating satisfactory learning outcomes. Moderate Understanding was the most frequently reported response for most questions, ranging from 36.76% to 55.88%, while Good Understanding ranged from 5.88% to 33.82%. A notable proportion of participants also reported Excellent Understanding, particularly for Question 3 (22.06%), Question 1 (17.65%), and Question 7 (17.65%), reflecting a high level of confidence in some of the topics covered during the training.

Responses indicating Low Understanding were relatively higher for Question 6 (44.12%), followed by Questions 7 and 8 (39.71% each) and Question 9 (36.76%), suggesting that these topics were comparatively more challenging and may require additional practical exercises or follow-up training. Very Low Understanding responses were minimal and were reported only for Question 5 (2.94%), demonstrating that very few participants experienced substantial difficulty with the assessed competencies.

Figure 2 illustrates participants' self-assessed understanding levels across the ten Advanced Remote Sensing assessment topics following the refresher training. Overall, the results indicate that the training effectively enhanced participants' knowledge and practical understanding of advanced remote sensing concepts and their applications for Integrated Land Use Planning. For most assessment questions, Moderate Understanding and Good Understanding were the dominant responses. Good Understanding was the highest-rated category for Questions 1, 2, 4, 9, and 10, while Moderate Understanding was the most common response for Questions 5, 6, 7, and 8. A considerable proportion of participants also reported Excellent Understanding, particularly for Question 3 (22.1%), followed by Questions 1 and 7 (17.7% each), indicating that many participants gained strong confidence in applying the knowledge and skills covered in these topics.

Responses indicating Low Understanding were generally limited but were comparatively higher for Question 5 (17.7%) and Question 6 (10.3%), suggesting that these topics were relatively more challenging. Very Low Understanding was almost absent across the assessment and was reported only for Question 5 (2.9%), demonstrating that very few participants experienced significant difficulty with the training content.

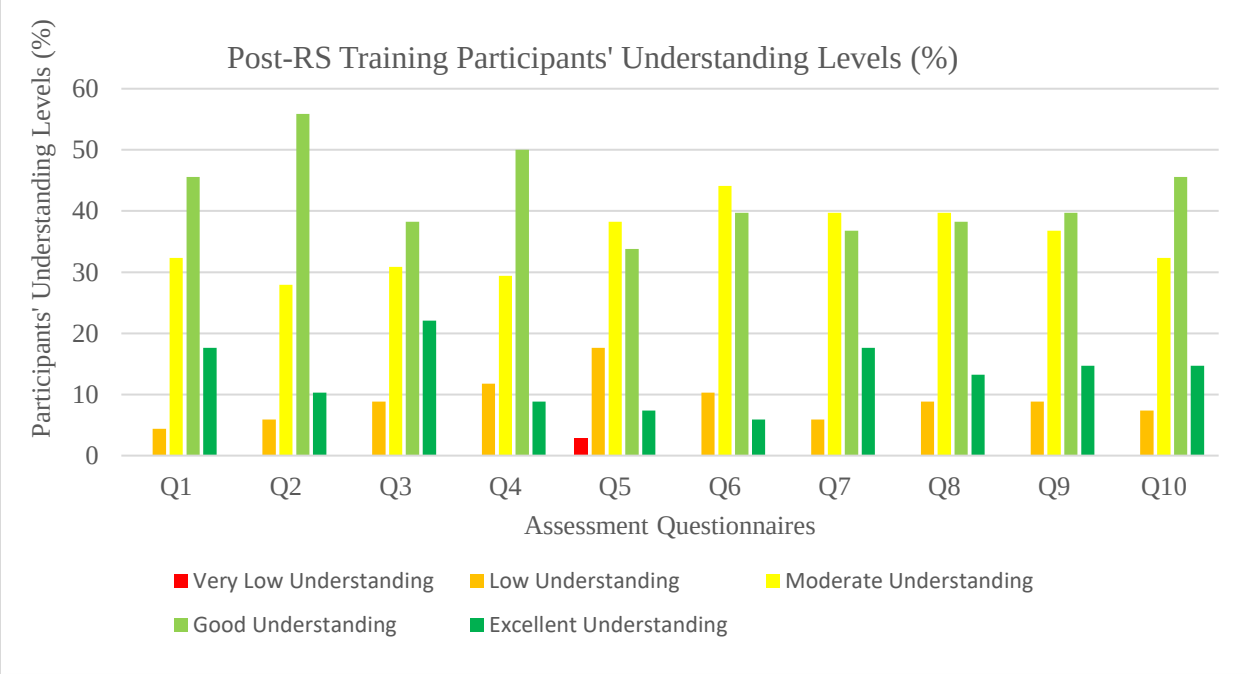


Figure 2. Post Advanced remote sensing training participants understanding levels in %.

Overall, the assessment results demonstrate that the Advanced Remote Sensing refresher training successfully strengthened participants' understanding of remote sensing principles and their practical applications for Integrated Land Use Planning. The predominance of Moderate, Good, and Excellent ratings across the assessment topics indicates improved technical competency and increased confidence in applying remote sensing techniques. However, the comparatively higher proportions of Moderate and Low Understanding responses for some topics suggest the need for additional hands-on training in advanced image processing, image analysis, spatial modelling, and the integration of remote sensing products into geospatial decision-making. Strengthening these practical components in future refresher and advanced training programs will further enhance participants' technical proficiency and their ability to address complex land use planning and natural resource management challenges.

Generally, the post-training assessment results indicate that the refresher training successfully achieved its primary objective of reinforcing and expanding the knowledge and practical skills acquired during the original Geospatial-based Integrated Land Use Planning training. The combination of experience-sharing discussions, project-based practical exercises, and competency-based evaluation demonstrated that participants not only retained substantial knowledge from the previous training but also strengthened their technical capacity through application-oriented learning.

The findings further suggest that the project-based approach adopted during the refresher training was highly effective in bridging the gap between theoretical knowledge and practical implementation. By completing an integrated flood susceptibility mapping exercise from data preparation through final cartographic presentation, participants gained valuable experience in applying GIS and remote sensing technologies to real-world planning challenges.

Nevertheless, the assessment also highlighted the need for continued technical support, particularly in advanced spatial modelling, hydrological analysis, weighted overlay techniques, and complex GIS workflows. Addressing these areas through future advanced training programs will further strengthen institutional capacity for implementing evidence-based Integrated Land Use Planning across Ethiopia.

9. Challenges Affecting Implementation

Despite the positive impacts of the previous training and the improved application of GIS and Remote Sensing across the participating regions, participants identified several institutional, technical, and policy-related constraints that continue to limit the effective implementation of Geospatial-based Integrated Land Use Planning (GILUP).

9.1 Technical and Infrastructure Challenges

Participants identified inadequate ICT infrastructure as one of the major barriers to implementing GILUP. Limited availability of computers, unreliable internet connectivity, insufficient access to licensed GIS and Remote Sensing software, and software compatibility issues—particularly between QGIS and proprietary software used during the training—restrict the routine application of geospatial technologies. Participants also reported inadequate access to high-resolution satellite imagery, standardized spatial datasets, and supporting datasets such as demographic information, which limits the quality and effectiveness of spatial analyses.

9.2 Financial and Human Resource Constraints

Limited financial resources were identified as a significant obstacle to implementing Integrated Land Use Planning activities, including the acquisition of software, hardware, and geospatial datasets. Participants also emphasized the shortage of skilled GIS and Remote Sensing professionals, particularly at zonal, woreda, and kebele levels. Although technical capacity has improved through the training, continuous professional development and expanded capacity-building programs are required to address human resource gaps and sustain implementation at decentralized administrative levels.

9.3 Institutional Coordination and Policy Support

Participants highlighted weak institutional coordination among organizations responsible for land administration, planning, agriculture, forestry, natural resources, and environmental management. Limited collaboration, inadequate data sharing, and the absence of standardized national spatial datasets continue to hinder integrated planning and often result in duplication of effort and

inconsistent planning outputs. Participants further noted the lack of comprehensive national policies and institutional frameworks for spatial data sharing, standardization, and Integrated Land Use Planning, together with limited institutional attention and commitment to mainstream GILUP into planning and decision-making processes.

9.4 Planning and Implementation Challenges

Participants also identified challenges associated with integrating urban and rural planning systems, which complicate the implementation of comprehensive land use plans across administrative boundaries. In addition, although many trained experts have begun applying their skills, limited institutional support and implementation mechanisms continue to constrain the wider adoption and scaling-up of GIS-enabled Integrated Land Use Planning.

Overall, these technical, financial, institutional, and policy constraints continue to limit the broader institutionalization of Geospatial-based Integrated Land Use Planning despite the substantial improvements in the technical capacity of trained personnel. Addressing these challenges will require sustained investment in ICT infrastructure, stronger institutional collaboration, improved access to geospatial data, enhanced policy support, and continued capacity-building initiatives.

10. Lessons Learned, Conclusions and Recommendations

10.1 Lessons Learned

The refresher training demonstrated that continuous capacity development is essential for strengthening technical competencies and sustaining the implementation of Geospatial-based Integrated Land Use Planning (GILUP). Participants who regularly applied GIS and remote sensing in their work showed stronger knowledge retention and greater confidence in using geospatial tools for land use planning, forest management, environmental monitoring, and Green Legacy initiatives.

The project-based flood susceptibility mapping exercise proved during this refresher training highly effective in enhancing participants' practical skills in spatial analysis, data integration, and decision-support mapping. However, differences in participants' technical backgrounds

highlighted the need for differentiated training approaches and additional support for those with limited practical experience.

The training also emphasized that successful GILUP implementation depends not only on technical skills but also on institutional commitment, inter-sectoral collaboration, reliable geospatial data, adequate ICT infrastructure, and supportive policies. While participants' GIS and remote sensing competencies improved significantly, advanced applications such as hydrological modelling, watershed analysis, and spatial modelling require continued practice and technical support.

10.2 Conclusions

The Geospatial-based Integrated Land Use Planning (GILUP) refresher training successfully achieved its primary objective of reinforcing the knowledge and practical skills acquired during the previous regional capacity-building program under the Forest, Land Use and Restoration (FOLUR) Project. By combining structured experience-sharing discussions, project-based practical exercises, and competency-based post-training assessments, the program provided a comprehensive platform for evaluating knowledge retention, strengthening technical capacity, and promoting institutional learning. The practical focus on flood susceptibility mapping using Geographic Information Systems, Remote Sensing, and Multi-Criteria Decision Analysis demonstrated the value of integrating geospatial technologies into real-world planning applications.

The experience-sharing sessions confirmed that many participants have successfully transferred the knowledge gained from the original training into their professional activities. GIS and remote sensing technologies are increasingly supporting land use planning, forest management, cadastral registration, Green Legacy initiatives, FOLUR implementation, and other sectoral planning processes across the participating regional states. Several regions have also strengthened institutional collaboration, established geospatial coordination mechanisms, and expanded the use of spatial information for evidence-based decision-making.

The post-training assessment results further demonstrated that participants achieved improved understanding of both Geographic Information Systems and Advanced Remote Sensing concepts.

Most participants reported moderate to good levels of understanding across the assessed competencies, indicating that the refresher training effectively strengthened both theoretical knowledge and practical skills. Nevertheless, the assessment also identified advanced analytical topics—including hydrological analysis, watershed delineation, weighted overlay analysis, and spatial modelling—that would benefit from continued practical training and technical mentoring.

Despite these positive achievements, participants identified several challenges that continue to affect the implementation of Geospatial-based Integrated Land Use Planning. These include inadequate ICT infrastructure, limited access to licensed software, shortages of skilled professionals at decentralized administrative levels, weak institutional collaboration, and insufficient opportunities for trained personnel to consistently apply their skills. Addressing these constraints will require sustained investment in technical infrastructure, continuous capacity development, stronger institutional coordination, and supportive policy frameworks.

Overall, the refresher training demonstrated that continuous capacity-building is essential for sustaining institutional competence in geospatial technologies and supporting evidence-based land use planning. The combination of refresher training, practical application, institutional collaboration, and regular follow-up provides a robust model for strengthening the implementation of Integrated Land Use Planning in Ethiopia. Continued commitment by the Ethiopian Space Science and Geospatial Institute, the Ministry of Planning and Development, regional governments, and development partners will be critical for translating the technical capacities developed through the FOLUR Project into sustainable land management practices and improved planning outcomes.

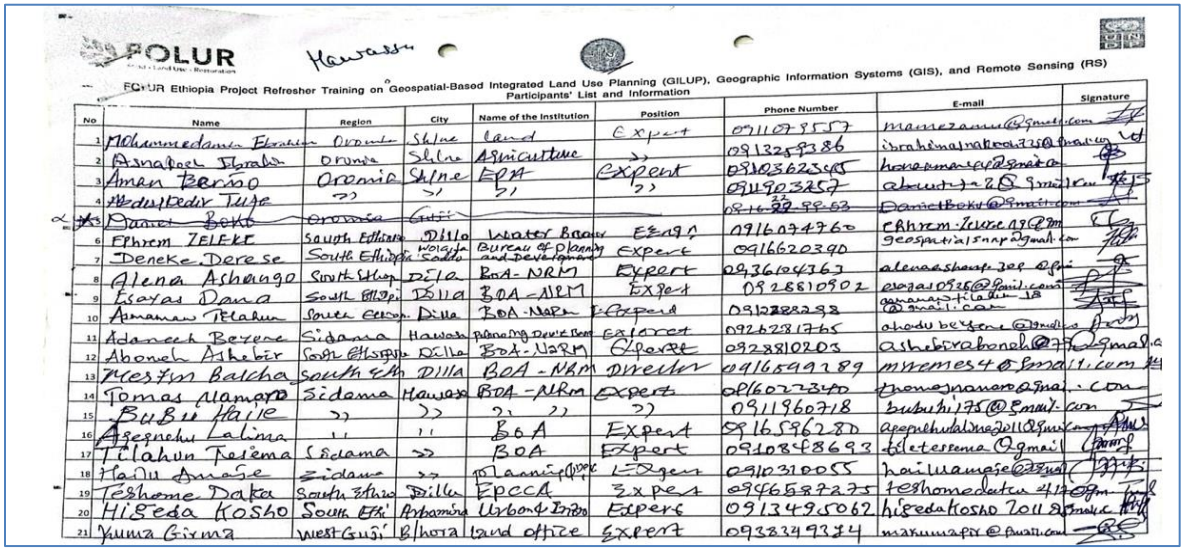
10.3 Recommendations

To strengthen future GILUP implementation and capacity-building efforts, the following actions are recommended:

- Institutionalize continuous capacity building through regular refresher training, advanced courses, mentoring, and technical support.
- Expand training to zonal, woreda, and kebele levels to strengthen decentralized, evidence-based land use planning.

- Establish a monitoring and follow-up system to assess knowledge application, provide coaching, and identify additional capacity needs.
- Improve ICT infrastructure by upgrading computing facilities, internet connectivity, geospatial software, and access to quality spatial datasets.
- Strengthen institutional collaboration through coordinated data sharing, interoperable geospatial databases, and cross-sectoral partnerships.
- Enhance policy and institutional support by integrating GILUP into national planning priorities with adequate financial and technical resources.
- Promote practical, project-based learning using real-world applications such as land suitability assessment, watershed management, drought monitoring, climate risk assessment, forest monitoring, and urban planning.
- Raise awareness among decision-makers to encourage investment in geospatial technologies and promote evidence-based planning across all administrative levels.

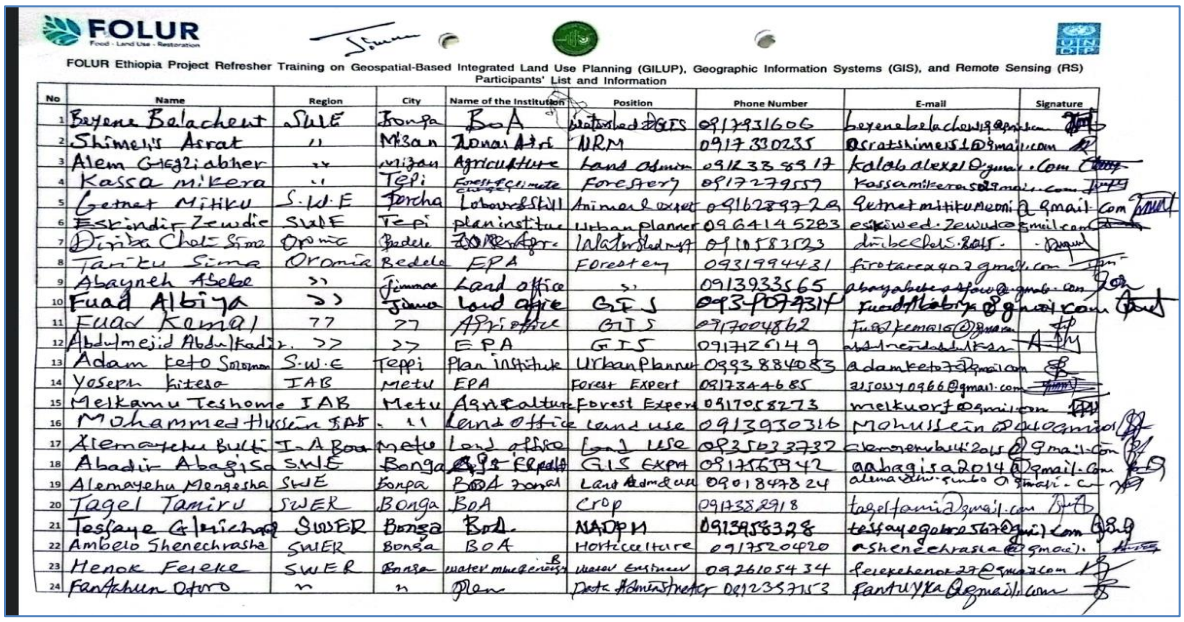
Annex I: Attendance Sheet (signed by participants)



FOLUR

FOLUR Ethiopia Project Refresher Training on Geospatial-Based Integrated Land Use Planning (GILUP), Geographic Information Systems (GIS), and Remote Sensing (RS)
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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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34	Tariku Asfaw	SWE	Tepi	FOLUR Fin.	Finance & Admin	0913892486		
35	Biruk Befikadu	"	"	FEPCC-SWE	Driver	0911954811		
36	Girmachew Habte	"	"	Plan institute	Driver	0991043644	Girmachewhabte	
37	Menesha Ebsa	Dawuro	A.A.	OEFCA	Driver	0911887699	-	
38	Benetet Bekele	SWE	A.A.	FEPCC	Driver	0917936011		

Annex II: Photos During the Refresher-Training Session




Tare
16 July 2026 9:35 am




Tare
16 July 2026 9:27 am

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.	☐	☐	☐	☐	☐