

AFRICAN CENTRE FOR STATISTICS (ACS)
BACK TO OFFICE REPORT

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Section: ACS/DCIGK (Data Capacity and Integrated Geospatial Knowledge)	
Visit: Ministry of Lands, Water and the Environment	
<u>Mission Dates:</u> (2nd to the 27th of February 2026, Asmara, Eritrea)	<u>Travel itinerary:</u> Addis Ababa – Asmara – Ankara-Turkey-Addis Ababa
Title of Mission: <u>Second Capacity Developing Workshop on Spatial Insights: Empowering Decision-Making and Transforming Knowledge into Action with Geospatial Intelligence.</u>	
<u>Purpose/significance of mission:</u> The purpose of the mission was to conduct a comprehensive four-week capacity building program for technical staff at the Ministry of Lands, Water and the Environment (MLWE), specifically targeting critical knowledge and skill gaps in Geographic Information Systems (GIS) and Remote Sensing (RS) aimed at fostering the integration of statistical and geospatial information. These technical gaps had been identified by the Ministry as significant obstacles to the effective performance in land administration, water resource management, and environmental monitoring. The training was designed to strengthen staff understanding and practical abilities in using GIS and RS technologies to address these issues through intensive hands-on practice and real-world applications. The mission aimed to enable staff to apply these tools more effectively in their daily work, support assessment studies and research, enhance the implementation of various programs and projects, and improve the Ministry's overall Geospatial Information Management Systems (GIIMS). This workshop represented the second phase of a multi-year capacity development partnership designed to establish sustainable geospatial technical expertise within national institutions in Eritrea. The workshop was structured as an intensive four-week program comprising 25 full training days organized into thematic weekly modules, providing approximately 8 hours of contact time per day. A distinctive feature was the dual-platform approach providing parallel instruction in both ArcGIS Pro (industry-standard commercial platform) and QGIS (open-source platform), ensuring participants could apply learned concepts regardless of institutional software availability and licensing constraints. The ECA capacity building program was supported by RPTC Funds that's sponsored the workshop logistics and facilities. The workshop aligned with continental frameworks including the African Action Plan on Global Geospatial Information Management (2016–2030) and UN-GGIM Africa priorities such as the integration of Statistical and Geospatial Information among others.	
<u>Procedure</u>	
A. Meeting with His Excellency Mr Tesfai Ghebreselassie Sebhata, Minister of Land, Water and Environment of Eritrea.	
1. During the meeting with Minister Tesfai Ghebreselassie, the key technical issues discussed included the identification of GIS and Remote Sensing skill gaps among Ministry staff, challenges in integrating these technologies into daily operations, and the need for improved geospatial data collection and management. The discussion also covered ongoing and future capacity building initiatives, the application of GIS and RS in environmental monitoring and resource management, and the development of centralized geospatial information systems with consideration on linking statistics and geospatial information. 2. Additional topics included addressing technical infrastructure limitations, fostering collaborations with external partners, and reviewing relevant policy and regulatory frameworks to support effective implementation of geospatial technologies within the Ministry. His Excellency was also present during the teams' project presentations and handed over certificates to trainers at the end of the workshop. In the meeting with the staffs of the Ministry of Land, Water, and Environment of Eritrea, discussions focused on several key issues: addressing critical knowledge and skill gaps in Geographic Information Systems (GIS) and Remote Sensing (RS),	

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enhancing capacity for integrated water resources management, and improving the Ministry's ability to respond to climate change challenges. The staffs highlighted the importance of strengthening geospatial data collection and management, fostering policy coherence with national development and climate strategies, and advancing the use of GIS and RS in environmental monitoring, land management, and programme implementation. There was also emphasis on the need for continued capacity building, better coordination among stakeholders, and the development of knowledge management systems to support sustainable resource management and informed decision-making.

B. Meetings with technical staff of the Ministry of Lands, Water and the Environment

1. In the meetings with technical staff of the MLWE, discussions focused on several key issues: addressing critical knowledge and skill gaps in Geographic Information Systems (GIS) and Remote Sensing (RS), enhancing capacity for integrated water resources management, and improving the Ministry's ability to respond to climate change challenges. The staff highlighted the importance of strengthen in geospatial data collection and management, fostering policy coherence with national development and climate strategies, and advancing the use of GIS and RS in environmental monitoring, land management, and programme implementation.
2. There was also emphasis on the need for continued capacity building, better coordination among stakeholders, and the development of knowledge management systems to support sustainable resource management and informed decision-making. Approximately 27 participants from various MLWE departments participated, representing diverse educational backgrounds ranging from diplomates to master's degree levels, with varying levels of prior GIS exposure from novice to intermediate users.
3. The completion of the questionnaire on the Domestication of the Integrated Geospatial Information Framework (IGIF) for ministry was discussed and it was agreed that the elaborate questionnaire should be completed as soon as possible for the report to be produced by ECA.

C. The training was structured into four thematic weekly modules:

4. Week 1: GIS and Remote Sensing Fundamentals (February 2–6, 2026)
 - a. The opening week established foundational knowledge in GIS and Meetings with technical staff of the Ministry of Lands, Water and the Environment
 - b. Four-week intensive training program (February 2–27, 2026), remote sensing technologies. Topics included GIS basics and mapping, coordinate systems and map projections, cartographic principles, data sources and management, spatial data formats, digitization and editing, topology concepts, remote sensing fundamentals (electromagnetic spectrum, spectral signatures, resolution concepts), satellite platforms (Landsat, Sentinel-2, MODIS), and land use/landcover (LULC) visual interpretation techniques.
5. Week 2: Land and Water Applications (February 9–13, 2026)
 - a. Building upon foundational skills, the second week advanced participants into applied geospatial analysis. Topics included automated LULC classification (supervised and unsupervised methods), accuracy assessment, multi-temporal analysis and change detection, Digital Elevation Models (DEMs) and terrain analysis, watershed delineation and hydrological modelling, Dams detection and development, calculating the cost and environmental impact on dams using LULC and other techniques and spectral indices for environmental monitoring (NDVI for vegetation, NDWI for water bodies).
6. Week 3: Cadastral GIS and Integration (February 16–20, 2026)
 - a. The third week shifted focus toward land administration and cadastral applications. Topics included land administration fundamentals and cadastral concepts, Land Administration Domain Model (LADM), cadastral data models and parcel-based geodatabase design, topology rules for cadastral datasets, field data collection technologies (GNSS, mobile GIS), cadastral analysis and reporting, and cross-domain integration connecting cadastral data with LULC, water, and environmental datasets.
7. Week 4: GIIMS, Web GIS, Governance, and Capstone (February 23–27, 2026)
 - a. The final week elevated focus to enterprise-level considerations. Topics included Institutional Information Management Systems (IIMS) architecture, enterprise geodatabase

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design principles, web-based geospatial platforms and dashboards, data governance frameworks and Standard Operating Procedures (SOPs), metadata standards (ISO 19115), and culminated in capstone project presentations demonstrating comprehensive skill integration.

D. Hands-on exercises and practical applications

8. In addition to theoretical sessions, the workshop emphasized hands-on exercises to build practical competencies in managing geospatial databases, processing remote sensing data, and conducting spatial analysis relevant to environmental monitoring and resource management. Participants gained experience in digitizing, geo-referencing, and populating geodatabases, as well as using advanced platforms such as Google Earth Engine and AI tools for big data compilation.
9. Comprehensive training materials were provided to all participants including PowerPoint presentation decks, detailed hands-on training manuals for both ArcGIS Pro and QGIS (60 manuals), sample datasets representing Eritrean geographic contexts (administrative boundaries, satellite imagery, elevation data, sample cadastral parcels), reference documents on best practices and frameworks, and exercise templates and worksheets.

E. Capstone project presentations (February 27, 2026)

10. The workshop concluded with capstone project presentations where participant groups showcased integrated geospatial solutions addressing real MLWE operational challenges. Three exemplary projects were presented:
11. Project 1: LULC Classification and Change Detection of Prosopis Juliflora in Lower Barka River Strip
 - a. A comprehensive multi-temporal analysis using supervised classification of Landsat imagery from 2015 and 2025 to map and quantify the spread of an invasive species threatening agricultural productivity. The project identified 756 hectares of net expansion with detailed transition matrices quantifying impacts on productive lands.
12. Project 2: Gergera Dam Site Selection Alternative Analysis
 - a. A sophisticated hydrological modeling project comparing two dam site options using DEM processing, watershed delineation, storage capacity calculation, and multi-criteria LULC impact assessment. The analysis demonstrated that the alternative site analysis using the techniques acquired during the training offers three times the storage capacity with shorter dam axis and reduced impact on high-value agricultural lands.
13. Project 3: The Role of GIS in Modern Cadastral Systems
 - a. A pilot cadastral GIS system implementation for Mai Chihot area, demonstrating transformation from paper-based record-keeping to digital geodatabase management. The project produced professional property maps and attribute tables, with strategic recommendations for institutional transformation.

Brief Summary of work accomplished:

A. Foundational capacity establishment

14. During the four-week capacity building workshop held in Asmara from February 2 to 27, 2026, staff from the Ministry of Lands, Water and the Environment participated in an intensive program focused on Geographic Information Systems (GIS) and Remote Sensing (RS). The workshop began with an introduction to the principles of GIS, including geospatial data models, geodetic reference systems, and the organization and management of GIS data. Participants were introduced to the practical applications of GIS in areas such as water productivity, crop monitoring, irrigation, and land use mapping, laying a strong foundation for understanding how these technologies can be leveraged in their daily work.

B. Remote sensing and advanced analysis techniques

15. The training then progressed to cover the fundamentals of remote sensing, including basic concepts, types of sensors, and the use of spatial data for water resources management. Sessions explored image interpretation, multispectral imagery, and the use of digital elevation models for topographic and hydrological analysis. Participants learned about the interpretation of satellite imagery, time series analysis, and the practical use of Earth observation data platforms like Google Earth Engine,

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as well as the integration of AI agents for geospatial big data compilation. Overviews of the Sentinel-1 and Sentinel-2 satellite missions provided insights into the irrelevance for land, marine, emergency response, and climate change applications.

C. Practical competency development and applied skills

16. Hands-on exercises formed a core part of the workshop, enabling staff to apply their learning directly using software such as ArcGISPro and QGIS. Practical sessions included displaying and querying data, managing spatial data formats, working with geodatabases, digitizing and geo-referencing data, and conducting spatial analysis. Participants also learned how to process remote sensing data for applications such as vegetation monitoring, water quality assessment, open water and flood mapping, and land cover classification all of which are directly relevant to the Ministry's mandate.

D. Enterprise systems and capstone achievements

17. The workshop concluded with advanced topics such as the use of high-resolution satellite imagery for population and housing censuses, building footprint extraction, and the creation of enumeration area maps. Enterprise GIS concepts including Institutional Geospatial Information Management Systems (GIIMS) architecture, geodatabase design, web GIS platforms, and data governance frameworks were introduced. The program closed with capstone project presentations demonstrating participants' ability to integrate multiple competencies to address real-world MLWE challenges. Overall, the workshop significantly enhanced the technical capacity of Ministry staff, equipping them with practical skills and knowledge to support evidence-based decision-making and improve the management of Eritrea's land, water, and environmental resources.

E. Quantitative assessment results

18. A comprehensive pre-training and post-training evaluation was conducted with 18 participants using a standardized 5-point competency assessment scale. The evaluation covered 49 distinct competency areas across five major sections, yielding 881 individual pre/post competency ratings. Overall training effectiveness showed: Pre-training average competency score of 2.28/5.0 (Basic Awareness Level); Post-training average competency score of 3.56/5.0 (Moderate-Good Skills Level); Overall improvement of 1.28 points (56.0% increase). Outstanding performance was recorded in Week 3 Cadastral GIS (82.0% improvement) and Week 2 Land & Water with Practical competency development and applied skills as well as Enterprise systems and capstone achievements.

19. Quantitative assessment results

Applications (70.7% improvement). Approximately 80% of participants achieved greater than 1.0-point improvement across assessed competencies, demonstrating highly effective capacity development outcomes.

Implications for ECA

A. Institutionalize regular training and establish communities of practice

20. To maximize return on the capacity development investment, ECA should support the establishment of a formal GIS/RS User Group bringing together workshop participants monthly to share experiences, troubleshoot challenges, showcase applications, and continue peer learning. MLWE leadership should be encouraged to assign concrete operational projects where trained staff can immediately apply acquired skills, including continuation of the capstone projects that provide blueprints for implementing integrated geospatial solutions addressing priority MLWE operational challenges. Periodic (quarterly) remote or in-person consultations with UNECA experts should be arranged to provide technical guidance on specific challenges.

B. Support technical infrastructure and data access

21. Critical infrastructure limitations were identified during the workshop, including limited and intermittent internet connectivity, varied computer hardware capacity affecting resource-intensive operations, and need for high-resolution satellite imagery and reliable GPS equipment. ECA should advocate with development partners to ensure trained staff have continued access to necessary software through licensing or open-source alternatives, relevant datasets (satellite imagery, DEMs, administrative boundaries), and improved technical infrastructure. Systematic documentation of successful applications of geospatial analysis to MLWE operational challenges should be encouraged, creating an institutional knowledgebase and demonstrating value to leadership.

C. Advance specialized capacity development

22. Building upon this foundational training, ECA should plan targeted follow-up training on specialized topics such as Python scripting for geospatial automation, advanced machine learning for

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classification, LiDAR data processing, or drone imagery analysis based on institutional priorities. A Training of Trainers program should be developed to identify and further develop a core group of "super-users" who can provide internal training to additional MLWE staff and other government agencies, creating sustainable capacity multiplication effects. Extended practicum workshops focusing exclusively on applying skills to ongoing MLWE projects, with minimal new content presentation, could complement initial training by providing sustained practice opportunities.

D. Foster interdepartmental and inter-agency collaboration

23. The workshop successfully fostered enhanced collaboration among MLWE departments by bringing together staff from land administration, water resources, environmental monitoring, and planning units. Cross-departmental interactions during group exercises highlighted opportunities for data sharing, joint analytical projects, and integrated information systems serving multiple organizational functions. ECA should facilitate expansion of this collaborative approach to other Eritrean government ministries and agencies, promoting cross-sectoral geospatial data integration. Regional engagement should be encouraged through active participation in UN-GGIM Africa, African Geodetic Reference Frame (AfREF) initiatives, and bilateral exchanges with neighboring countries for knowledge sharing.

E. Support digital infrastructure and enterprise systems

24. The capstone project on cadastral GIS transformation highlighted the urgent need for MLWE to establish a dedicated Geospatial Information Management unit within its organizational structure with clear mandate, adequate staffing, and resource allocation. ECA should provide technical assistance in designing and implementing enterprise-level Institutional Geospatial Information Management Systems with Advance specialized capacity development as well as foster interdepartmental and inter-agency collaboration
25. Support digital infrastructure and enterprise systems
- a. (GIIMS) connecting geospatial data, statistical data, administrative records, and field observations within unified institutional platforms. Architecture components should include central geodatabase servers, data warehouses, metadata catalogs, web services (WMS, WFS), and client applications (desktop GIS, web viewers, mobile apps). Implementation considerations include infrastructure requirements, data migration strategies, user access management, and change management processes.

F. Strengthen policy and data governance frameworks

26. Week 4 training addressed critical institutional considerations including data governance frameworks, Standard Operating Procedures (SOPs), metadata standards, and data quality assurance protocols. However, participants noted that formal governance structures defining data ownership, update responsibilities, quality standards, access policies, and archiving procedures remain under developed. ECA should support MLWE and Eritrean national authorities in developing a comprehensive national geospatial information strategy aligned with IGIF priorities, addressing data infrastructure, standards, institutional arrangements, capacity development, and governance frameworks. Metadata standards aligned with ISO 19115 and national/regional frameworks should be formalized. Academic partnerships should be forged with Eritrean higher education institutions to integrate geospatial curricula, support student training, and create talent pipeline for government geospatial positions.

Conclusion

Outcome Level Accomplishment

Overall Capstone Evaluation – Concrete Outcomes

1. The three capstone projects generated concrete geospatial solutions for:
 - Monitoring invasive *Prosopis juliflora* expansion and associated land-use changes in the Lower Barka River strip using supervised classification and change detection.
 - Comparing alternative dam sites for the Gergera catchment through DEM-based watershed modeling, storage capacity estimation, and LULC impact analysis to support evidence-based water infrastructure planning.
 - Piloting a GIS-based cadastral system for Mai Chihot by establishing a parcel geodatabase, digitizing parcels from high-resolution imagery, and producing integrated map and tabular outputs for land administration.
2. Participants demonstrated integrated technical competence by combining:

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- Remote sensing image processing, classification, and multi-temporal change detection.
 - DEM analysis, watershed delineation, and hydrological modeling for reservoir and watershed studies.
 - Spatial database and geodatabase design, cadastral data modeling, and parcel mapping with topology rules.
 - Multi-criteria analysis and decision-support workflows tailored to MLWE land, water, and cadastral use cases.
3. The capstone outputs were operationally relevant for MLWE because:
- Each project directly addressed a real institutional priority: invasive species control, dam site selection, and cadastral modernization.
 - Proposed methods and workflows are feasible within existing or realistically attainable MLWE capacity and resources.
 - Recommendations can immediately inform planning, policy dialogue, and follow-up technical projects within the Ministry.
4. The projects met professional standards through:
- Structured presentations articulating clear problem statements, objectives, methodologies, results, and recommendations.
 - Cartographic products with appropriate symbology, scales, legends, titles, and essential map elements.
 - Quantitative indicators (e.g., hectares of *Prosopis* expansion, reservoir volumes, affected land-use classes) underpinning evidence-based conclusions and acknowledging methodological limitations.
5. The capstone process reinforced collaborative learning by:
- Enabling mixed-experience teams to work through the full project cycle from problem definition to analysis and presentation.
 - Integrating diverse skill sets (remote sensing, GIS analysis, database design, domain knowledge) within each team.
 - Promoting peer learning and feedback through shared presentations and plenary discussion.
6. Collectively, the capstone projects provide concrete evidence that participants achieved the workshop's learning objectives and are now capable of independently designing, implementing, and communicating geospatial solutions to real-world land, water, and environmental management challenges facing MLWE.

Conclusion

This capacity building exercise has been appreciated by the Government of Eritrea as the mass media has covered the positive outcomes of the event through National Television News, news paper articles and social media outlets etc.

CC: Attachments

A Comprehensive report on the Second Capacity Developing Workshop on Spatial Insights: Empowering Decision-Making and Transforming Knowledge into Action with Geospatial Intelligence.