Hawassa University
Wnodo Genet College of Forestry and Natural resource /Department of Geographic Information Science
2024/2025 Academic Year, Semester II
GIS and RS for Forest Resource Assessment **(**GISc 4124**)**

Course outline/plan

Instructor: Kedyalew Sahle (Lecturer), Office Nr 59, kefyalewsahle.k@gmail.com, 0916835940
ECTS: 5 (better to mention the number of hrs for lecture, Practical, tutorial)
Course description- This course provides the basic skills on the major application of geospatial technology for forest resources assessment, and uses this information for decision support in forest management and inventory. It further enhances the skill in forest information extraction from various types of satellite imagery. RS and GIS for forest/tree biophysical parameter mapping and the support for defining, mapping and managing of forest resources will be the core point of the course. The course also deals on different techniques of change detection and fire monitoring using multi-temporal and spectral satellite image. It further address the use of Radar, Drone, and Lidar technology for forestry application, and the basics of landscape model for carbon flux estimation in forestry. Geospatial based forest management information system building and forest base map development is the main topics to be covered in this course.

Course objective: Students completing this subject should:

- ✓ Understand the use and importance of different remote sensing products in forest application
- ✓ Identify the major activities and required information for forest resources management
- ✓ Explain the role of GIS and RS in forestry and tree resources management and monitoring
- ✓ Use RS & GIS to define, mapping and managing forest resources
- ✓ Understand the use of RS and GIS for forest/tree biophysical parameter mapping
- ✓ Use RS & GIS to identify forest species type, composition, diversity, stocking and volume
- ✓ Design and implement forest information system and forest base map at different scale
- ✓ Use GIS and RS for monitoring deforestation and forest fire detection
- ✓ Write the major objectives of the course
- ✓ You can also start with a phrase "Students completing this course should"
- ✓ You can/should find this information on the curriculum

Schedule (5ECTS course: a course with 2 hrs theory and 3 hours practical**)**
Prerequisite NA

Week	Topics to be covered	Major teaching-learning activities & Assessment of learning
1	***Unit 1. Introduction*** ✓ Overview of Optical, Microwave, RADAR LiDAR, and thermal remote sensing for forest resources assessment ✓ Use and importance of RS & GIS in forest identification and measurement ✓ 1.3 General application of RS and GIS in forestry	2 hrs lecture
	Major activities: ✓ Demonstrate RS imageries with different resolution ✓ Demonstrate selected applications of RS and GIS in forestry ***UNIT 1: Exercise:*** Review of remote sensing data (optical, microwave and active remote sensing) with emphasis to forestry in planning, monitoring and management- use WWW	3 hrs: Reading assignment (lab session)

Week	Topics to be covered	Major teaching-learning activities & Assessment of learning
2	***Unit 2. Information requirements for forest resources management*** ✓ 2.1. Forest boundary ✓ 2.2 Forest compartment ✓ 2.3 Forest types / stratification ✓ 2.4 Forest site characteristics (physical) ✓ 2.4 Forest owners ✓ 2.5. Forest inventory summary ✓ 2.6 Forest cover change ✓ 2.7 Forest biomass ✓ 2.8 Forest damage	2 hrs lecture
	Demonstration: ✓ Forest branch ✓ Forest site ✓ Forest block ✓ Forest comertement ✓ Sub-compartment ***UNIT 2: Exercise:*** Review of forest related information requirements / activities (e.g. spatial information for forest management, forest monitoring, forest inventory, forest fire, etc.) using case studies and reports.	Reading assignment on forest information requirements 3 hours assess the forest information requirements
3 , 4 and 5	***Unit 3. GIS & RS application in forestry management*** ✓ 3.1 Forest boundary delineation ✓ 3.2 Forest compartment mapping ✓ 3.3 Use of RS and GIS for Forest inventory • 3.3.1 Compilation units mapping • 3.3.2 Stratification of the mapping units • 3.3.3 Sampling (plot distribution) • 3.3.4 Locating sample plots ✓ 3.4 Relating inventory summary with forest compartment spatial data ✓ 3.5 Forest zoning ✓ 3.6 Forest road network mapping ✓ 3.7 Trees outside forest mapping ✓ 3.8 Thematic maps preparation using inventory summary ✓ 3.9.Synthetic Aperture Radar (SAR)sensing to support forest resource monitoring & management ✓ 3.10. Automated Individual Tree-Crown Delineation and Treetop Detection with Very-High-Resolution Aerial Imagery ✓ 3.11. LiDAR and Drone/UAV remote sensing for forest application	6 hrs lecture

Week	Topics to be covered	Major teaching-learning activities & Assessment of learning
	UNIT 3 : Exercise: Review of application of remote sensing and GIS in forestry (type of application, required input data, general approaches, outputs, limitations). Mapping and performing time series forest areas monitoring using selected satellite products (MODIS, Sentinel-2, and Sentinel-1, ETRSS-1, and Landsat series). Driving canopy height , individual trees detection and crown delineation **Practical**: ✓ Mapping: forest boundary, forest site, forest compartment and sub compartment	9 hours Review of and practical on application of remote sensing and GIS in forestry
FIRST EXAMINATION (Test I)		
6	***Unit 4. Forestry cover mapping*** ✓ 4.1 Approaches for forest cover mapping ✓ 4.2 Manual digitizing of forest cover ✓ 4.3 Digital image classification • Single data image classification • Multi-data image classification ✓ 4.4 Sampling approaches for forest area estimation ✓ 4.5 Accuracy assessment ✓ 4.5.1 Accuracy assessment for manual digitation ✓ 4.5.2 Accuracy assessment for digital image classification ✓ 4.5.3 Accuracy assessment for sampling approaches	4 hrs lecture
	UNIT 4: Exercise: Forest cover mapping of selected area in Ethiopia with various land cover types using the three approaches: manual digitizing, supervised classification, point sampling approach, produce thematic maps, perform accuracy assessment, and evaluate the three approaches. Satellite products MODIS, Landsat series, Sentinel and ETRSS-1).	6 hours practical
7	***Unit 5. Forestry cover change analysis*** ✓ 51 Use of forest cover change analysis ✓ 5.2. IPCC Guidelines for National Greenhouse Gas Inventories with emphasis to forest cover change. ✓ 5.3 Approaches for forest cover change analysis • Wall to wall using single data and multi date approaches • Sampling approach ✓ 5.4. Accuracy assessment of forest cover change analysis ✓ 5.5. Reporting of forest cover changes ✓ 5.6. Monitoring forest cover change using vegetation indices.	2 hrs lecture

Week	Topics to be covered	Major teaching-learning activities & Assessment of learning
	UNIT 5: ***Exercise: 1)*** review the IPCC guidelines focusing on land cover change analysis; 2) Forest cover mapping analysis using a) single date images, b) multi-date images, c) sample point approaches; carry out accuracy assessment according to olofsson et. al. (2014) [Good practices for estimating area and assessing accuracy of land change). Forest cover change analysis based on FAO guidelines. Reading assignment on selected topics , the topics to be decided by the instructor(course manager)	5 hours practical
	FIRST EXAMINATION (Test 2)	
8	***Unit 6. Forest biomass estimation*** ✓ 6.1 Introduction to forest biomass ✓ 6.2 Forest biomass estimation approaches ✓ 6.3 Role of remote sensing in forest biomass estimation ✓ 6.4 Limitations of remote sensing in forest biomass estimation	2 hrs lecture
	UNIT 6: Exercise: 1) review existing approaches applied in Ethiopia. Volume estimation, Tree density and biomass estimation. Deriving forest biophysical parameters such as: tree height, indices, canopy closure, LAI and volume from high resolution optical, Lidar, and Drone imagery.	3 hours practical
9	***Unit 7.*** **Forest Fires monitoring** ✓ 7.1 Remote sensing types for active forest fire monitoring ✓ 7.2 Remote sensing types for monitoring areas damaged by forest fire ✓ Detecting Fires ✓ Mapping Burned Areas ✓ Monitoring burnt areas ✓ Indices for Danger Assessment	2 hrs lecture
	UNIT 7: Exercise: review the mapping approaches for forest damage area assessment and monitoring of forest damaged areas. Practical: Forest Fire hazard zone mapping	3 hours practical

Week	Topics to be covered	Major teaching-learning activities & Assessment of learning
10	***Unit 8 National and global forest mapping initiatives*** ✓ 8.1. Remote sensing types for global and national level mapping ✓ 8.2 National level forest cover mapping activities (historical and current) ✓ 8.3 Global forest cover mapping and monitoring ✓ 8.5 Global forest monitoring services ✓ 8.6 Technical consideration of monitoring by satellites ✓ 8.7.Relevant existing standards and initiatives • Dublin Core • ISO 19115: Geographic information – metadata • INSPIRE • Open Geospatial Consortium • Content Standard for Digital Geospatial Metadata • Controlled vocabularies • Example: A European Forest Information System	2 hrs lecture
	UNIT 8: Exercise: Compile list of national and global mapping initiatives (online review) – group work. **Discussion on**: The existing infrastructures and tools available for Global Monitoring of Forest cover Change and the technical consideration of forest monitoring by satellites.	3 hours practical
11 and 12	***Unit 9. Forest Management Information Systems(FMIS)*** ✓ 9.1. Introduction to forest information systems (FIS) ✓ 9.2. Main component of FIS (Input, Analysis, Estimation and Prediction, Decision support, Presentation and visualization) ✓ 9.3 Tools for national forest management system (e.g. Google Earth Engine, earthmap, ✓ Collect earth ,Global Forest cover Watch) ✓ 9.4. Web services (web mapping: features, available systems) ✓ 9.5. Unified Modelling Language (UML) for forestry project application.	2 hours theory
	UNIT 9: Exercise: 1) Design and test sample geo-database for forestry application; 2) apply webservices (upload one of the data/mas generated in unit 4 or 5 to a web service; edit the metadata'. The instructor or the students select available webserver. If that is not possible, students upload their data to a common geo-database sever of the GIS lab); 3) Deriving forest information of Ethiopia from: Google Earth Engine, earthmap, Collect earth. Exercise on Project work on Forest resources map development (plantation and natural forest)	6 hours practical
Third EXAMINATION (Practical Exam)		
Fourth EXAMINATION (Final Exam)		

References:

1. Remote Sensing of Plant Biodiversity. Editors : Jeannine Cavender-Bares , John A. Gamon, Philip A. Townsend

2. The core of GISciences as system based approach. Published by: Faculty of Geo-Information Science and Earth Observation (ITC), University of Twente.
3. Remote Sensing and GIS Accuracy Assessment. Edited by Ross S. Lunetta and John G. Lyon
4. UAV Based Remote Sensing, Volume 2.Special Issue Editors ,Felipe Gonzalez Toro and Antonios Tsourdos
5. LiDAR Remote Sensing and Applications. Pinliang Dong and Qi Chen.
6. Radar remote sensing to support tropical forest management. J.J. van der Sanden
7. Remote Sensing of the Environment. An Earth Resource Perspective. John R. Jensen. Second Edition
8. Seeing the Forest for the Trees. A Manager's Guide to Applying Systems Thinking. By: Dennis Sherwood
9. Towards a European Forest Information System. European Forest Institute Research Report 2007, By Andreas Schuck, Tim Green, Gennady Andrienko, Natalia Andrienko, Alex Fedorec, Aljoscha Requardt, Tim Richards, Roger Mills, Eero Mikkola, Risto Päivinen, Michael Köhl ,Jesus San-Miguel-Ayanz.
10. REMOTE SENSING OF FOREST ENVIRONMENTS: Concepts and Case Studies. By Michael A. Wulder and Steven E. Franklin.
11. Understanding Forest Disturbance and Spatial Pattern. Remote Sensing and GIS Approaches. Edited by Michael A. Wulder Steven E. Franklin.
12. Forest Inventory, Methodology and Applications. Edited by: Annika Kangas and Matti Maltamo
13. Sampling Methods, Remote Sensing and GIS Multiresource Forest Inventory. By MICHAEL KÖHL , STEEN MAGNUSSEN , and MARCO MARCHETTI.
14. Remote Sensing for Sustainable Forest Management. By: Steven E. Franklin.
15. Decision Methods for Forest Resource Management. By Joseph Buongiorno, and J. Keith Gilless
16. Designing and Conducting a Forest Inventory - case: 9th National Forest Inventory of Finland. By Erkki Tomppo , Juha Heikkinen, Helena M. Henttonen , Antti Ihalainen, Matti Katila , Helena Mäkelä Tarja Tuomainen , Nina Vainikainen
17. R E M O T E S E N S I N G of Natural Resources. Edited By Guangxing Wang & Qihao Weng
18. Remote Sensing for Ecology and Conservation. A Handbook of Techniques. By Ned Horning, Julie A. Robinson, Eleanor J. Sterling, Woody Turner, and Sacha Spector
19. Hyperspectral Remote Sensing, Fundamentals and Practices. Ruiliang Pu
20. Remote Sensing of Landscapes with Spectral Images. A Physical Modeling Approach. By John B. Adams and Alan R. Gillespie
21 Advances in Land Remote Sensing. System, Modeling, Inversion and Application. By Shunlin Liang

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Methods of assessment

- tests/quiz = 20%
- practical activity and report/s =20%
- practical exam = 15%
- ***final examinations =45%.***