NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE

Department of forest mensuration and forest management

"CONFIRMED"
Director of the Education and Research Institute of Forestry and Landscape-Park Management
_____ R. Vasylyshyn
"19" 05 2023 p.

"APPROVED"
at the meeting of the department of forest mensuration and forest management
Protocol No 11 dated May 10, 2023
Acting head of Department
_____ V. Myroniuk

"REVIEWED"
Program Coordinator _____ O. Bala

PROGRAM OF THE COURSE

Forest Inventory and Mapping

Specialization 205 – Forestry

Educational program Forestry

Education and Research Institute of Forestry and Landscape-Park Management

Developers: Professor, Doctor of Agricultural Sciences Viktor Myroniuk
(position, academic degree, academic title)

Kyiv – 2023

1. Description of the course

Forest Inventory and Mapping

(title)

Field of knowledge, specialization, educational program, educational degree		
Educational degree	*Master*	
Specialization	*205 – Forestry*	
Educational program	*Forestry*	
Characteristics of the course		
Type	Elective	
Total number of hours	180	
Number of ECTS credits	6.0	
Number of content modules	2	
Course project (work) (if applicable)	*Exam*	
Indicators of the course for full-time and part-time forms of study		
	Full-time form of study	Part-time form of study
Course (year of study)	*1*	*1*
Semester	*2*	*2*
Lecture classes	*30 hr.*	*8 hr.*
Practical, seminar classes	*30 hr.*	*8 hr.*
Laboratory classes	–	–
Self-study	*120 hr.*	*164 hr.*
Individual assignments	–	
Number of weekly classroom hours for the full-time form of study	*4 hr.*	

2. Purpose, objectives, and competencies of the course

The study course is aimed at methodological foundations of forest resource assessment using sample-based forest inventory. The course discovers applied aspects of the sampling approach used to obtain accurate and timely information on forests to support effective forest management. The specific focus of the course is a remote sensing-based forest cover mapping that integrates field observations collected on sample plots and satellite imagery.

Objectives of the course are as follows:

– overviewing methods of national forest inventories used in various countries;

– studying the theory and practical applications of sample-based methods in forest resource assessment;

– getting skills in field surveys using sampling methods;

– gaining knowledge in forest attribute assessment using sample data;

– practicing in interpretation of remote sensing data using both visual and automated approaches.

Acquisition of competencies::

integrated competency (IC):

– the ability to resolve complex tasks in forestry or during the study process that require investigations or innovations;

general competencies (GC):

– the ability to search, process and analyze information from various sources;
– the ability to use information and communication technologies;
– the ability to work in an international context;

professional (special) competencies (SC):

– the ability to integrate knowledge and solve complex forestry problems in broad or multidisciplinary contexts.

Program learning outcomes (PLO):

– fluent oral communication and writing skills in Ukrainian and foreign languages during professional discussion, research, and innovations in forestry;
– searching for the necessary data in scientific literature, databases, and other sources, experience in analysis and evaluation of obtained data;
– assessing the state of forest stands, forest resources in specific forest vegetation conditions, forecasting their potential usage;
– developing and improving technological and production processes, implementing modern digital technologies;
– applying modern experimental and mathematical methods, digital technologies, and specialized software to solve complex issues in forestry and game management.

3. Program and structure of the course

MODULE 1.
METHODOLOGY OF SAMPLE-BASED FOREST INVENTORY

Topic 1.
National forest inventory: historical background and current challenges

The use of forest inventory data in forest management. Prospects for harmonization of forest resource assessment regarding national features of forest inventories. The history of sample-based forest inventory. Overview of sampling designs and estimation procedures in selected countries of Northern and Western Europe, the US, and Canada. Comparisons of national forest inventories (sampling design, plot layouts, etc.).

Topic 2.
Sampling design in forest inventories

Sampling methods used in forest inventory. Simple random and systematic sampling. Stratified and cluster sampling. Multiphase sampling in forest inventories. Sample size for estimation of continuous forest variables and ratios (i.e., forest cover). Review of cluster layouts. Adjusting sampling intensities regarding spatial variability of forest cover.

Topic 3.
Overview of sampling units

Configuration of sampling units. Sampling trees with probabilities proportional to stand density and sizes of trees. Calculation of inclusion zone for plots of different configurations. Calculation of areal means for fixed-area and variable-area sample plots. Standard techniques for correcting boundary plots and plots located on slopes. Combining sample plots in clusters. Selecting cluster layout regarding forest landscapes homogeneity.

Topic 4.
Measuring live and dead components on forest plots

Overview of the Field-Map GIS for field data collecting. Mapping positions of tally trees on sample plots. Segmentation of sample plots. Measuring diameters of tally trees growing on slopes, trees that have a lean or folks. Measuring sample tree heights. Evaluation of dead wood on sample plot.

Topic 5.
Inventory of standing trees using sampling with varying probability

Angle-counting approach for tree sampling. Tools used in forest inventory for sampling trees with probabilities proportional to tree sizes. Basal areas factor (BAF) of angle gauge. Choosing a suitable gauge constant. Proper use of gauge and wedge prism. Boundary trees in angle-counting. Calculation of mean values per hectare of basal area, tree volume, and tree number.

Topic 6.
Estimation of areal means and variances of forest attributes

Accuracy and precision in forest inventory. Key sources of errors in sample-based first inventory. Assessing forest attributes using design-based inference. Using covariation to increase the efficiency of sampling techniques.

MODULE 2
FROM SAMPLE PLOT DATA TO FOREST MAPS

Topic 7.
Remote sensing sensors and platforms in forest inventory

Optical satellite data used in mapping forests. Advanced remote sensing technologies and their use in forest inventories. Framework for continuous forest monitoring. Change detection using time series of Earth observations. Temporal segmentation approaches. Mapping forest areas consistent with national and international reporting requirements.

Topic 8.
Reference data for image classification

Use of sample-based forest inventory data in image classification. Collecting of reference data through visual photointerpretation of very high resolution images. The use of forest management and planning data in forest cover mapping. Environmental and climatic data used in mapping forests. Integration of forest attributes with explanatory variables to map forest characteristics.

Topic 9.
Mapping discrete and continuous forest attributes

Machine learning techniques for image classification. A general workflow for mapping forest cover using satellite imagery. Mapping species using forest inventory information. Spatial modeling of continuous forest attributes. Role of the nearest neighbor imputation technique in forest inventory and mapping.

Topic 10.
Map accuracy assessment

Thematic accuracy of forest maps. Non-site-specific and site-specific accuracy. Overall, user’s, and producer’s accuracies. Estimating Cohen’s kappa statistics using an error matrix. Correction of map errors using errors matrix. Application of R-squared values for assessing an accuracy of predicted distributions of continuous forest variables.

Names of content modules and topics	Number of hours												
	Full-time form							Part-time form					
	weeks	total	including					total	including				
			l	p	lab	ind	self		l	p	lab	ind	self
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Module 1. Methodology of sample-based forest inventory													
Topic 1. National forest inventory: historical background and current challenges	1	10	2	2			6	10					10
Topic 2. Sampling design in forest inventories	2	14	2	2			10	14	2				12
Topic 3. Overview of sampling units	3	16	2	2			12	16			2		14
Topic 4. Measuring live and dead components on forest plots	4–5	20	4	4			12	20			2		18
Topic 5. Inventory of standing trees using sampling with varying probability	6-7	20	4	4			12	20	2				18
Topic 6. Estimation of areal means and variances of forest attributes	8	10	2	2			6	10					10
Total for module 1		**90**	**16**	**16**			**58**	**90**	**4**		**4**		**82**
Module 2. From sample plot data to forest maps													
Topic 7. Remote sensing sensors and platforms in forest inventory	9–10	24	4	4			16	24			2		22
Topic 8. Reference data for image classification	11–12	24	4	4			16	24	2				22
Topic 9. Mapping discrete and continuous forest attributes	13–14	24	4	4			16	24			2		22
Topic 10. Map accuracy assessment	15	18	2	2			14	18	2				16
Total for module 2	**–**	**90**	**14**	**14**			**62**	**90**	**4**		**4**		**82**
Total hours	**–**	**180**	**30**	**30**			**120**	**180**	**8**		**8**		**164**

4. Practical class topics

№	Topic title	Number of hours
1	Sampling frame design	2
2	Exporting existing surveys in Open Foris Collect	2
3	Preparing custom code lists for interpretation	4
4	Creating land cover interpretation schema	4
5	Interpretation of sample units	4
6	Analyzing interpreted data with Saiku Server	2
7	Extracting training data for classification	2
8	Land cover classification	4
9	Map accuracy assessment	2
10	Change detection	4
	Разом	30

5. Self work topics

№	Topic title	Number of hours
1	Data management in Quantum GIS	20
2	Setting up Open Foris environment	20
3	Importing and editing Collect Earth survey design	20
4	Tracking changes in land cover using Google Earth imagery	20
5	Processing raster layers in Quantum GIS	20
6	Working with SCP for Quantum GIS	20
	Total	120

6. Samples of control questions, tests for assessing the level of knowledge acquisition by students

1. Objectives of a national forest inventory.
2. The issues of harmonizing methods of forest inventory at global scale.
3. Specifics of forest inventory of large countries.
4. Provide examples of forest inventory cycle durations in European countries.
5. Forest inventory in Scandinavian countries.
6. The role of multiphase sampling to increase forest inventory efficiency.
7. Configurations of sample plots used in forest inventories.
8. Cluster sampling in forest inventory. What form of clusters used in forest inventories?
9. The effect of forest cover distribution on spatial arrangements of sampling units.
10. Circular and nested plots.
11. Angle-count and truncated angle plots.
12. Optimizing efficiency of field work using nested and truncated angle plots.
13. Basal area factor.
14. Sampling with probabilities proportional to tree sizes and stand density.
15. Calculating tree factors for fixed- and variable-area plots.
16. Plots located on stand edges or slopes.
17. Ratio and model-based estimates in forest inventory.
18. Constructing confidence intervals for continuous variables (forest cover).
19. Field work on sample plots of a national forest inventory. Field crew equipment.
20. Rules of tree diameter and height measurements.
21. Tally and sample trees.

22. Sample plots segmentation.
23. Satellite sensors used in forest inventory.
24. Spatial, temporal, and spectral resolution of optical remote sensing data.
25. Role of time series in mapping forest cover.
26. Temporal segmentation algorithms for satellite time series processing.
27. Advances remote sensing technologies in forest inventory.
28. Sources of reference data for image classification.
29. Visual photointerpretation of very high-resolution images.
30. Use of national forest inventory data for mapping forest attributes.
31. Algorithm for automatic image classification.
32. Machine learning in image classifications.
33. Mapping discrete and continuous forest variables.
34. Nearest neighbor imputation technique.
35. Accuracy of thematic maps.

7. Teaching methods

All tasks and assignments are completed in a computer lab using relevant software and algorithms. The instructions for completing tasks are provided on Elearn online platform.

8. Forms of assessment

Lab assignments (10), self-work assignments (6), midterm tests (20), final exam.

9. Distribution of grades received by students

Evaluation of student knowledge is carried out on a 100-point scale and is converted to national grades according to Table 1 "Regulations and Examinations and Credits at NULES of Ukraine" (order of implementation dated April 26, 2023, protocol No 10).

Student rating, points	National grade based on exam results	
	Exams	Credits
90-100	Excellent	Passed
74-89	Good	
60-73	Satisfactory	
0-59	Unsatisfactory	Not passed

In order to determine the rating of a student (listener) in the discipline R_{dis} (up to 100 points), the rating from the exam R_{ex} (up to 30 points) is added to the rating of a student's academic work R_{aw} (up to 70 points): $R_{dis} = R_{aw} + R_{ex}$.

9. Educational and methodological support

Elearn online study course at https://elearn.nubip.edu.ua/course/view.php?id=872.

10. Recommended sources of information

1. Congalton, R. G., & Green, K. (2008). *Assessing the Accuracy of Remotely Sensed Data: Principles and Practices, Second Edition*.

2. Kangas, A., & Maltamo, M. (Eds.). (2006). *Forest inventory: Methodology and applications*. Springer.

3. Kershaw, J. A., Ducey, M. J., Beers, T., & Hush, B. (2016). *Forest Mensuration*, 5th ed.

4. Tomppo, E., Gschwantner, T., Lawrence, M., & McRoberts, R. E. (Eds.). (2010). *National forest inventories: Pathways for common reporting*. Springer.

5. Tutorials – Open Foris. (n.d.). Retrieved May 15, 2023, from https://openforis.org/tools/collect-earth/tutorials/