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Forest watershed management	
Field (if relevant)	E08210101 Forestry
Specializations	FORS603 Forest watershed management
Form of delivery	Classroom and online
Core/Elective	Elective
Course prerequisites (if relevant)	Dendrology, Silviculture, GIS technologies in forestry
Semester of the course	Year 2, Semester 3
Credit value	4 ECTS
Pass level/grading	Passed (A, B, C, D, E) / Failed (F)
Course language	English

Course Developers	Kazakh National Agrarian Research University, National University of Mongolia

Course summary
Key terms and notions
Forest hydrology; watershed; water resources; soil erosion; protection measures; fluvial process
Course aim
The aim of the course is to provide students with knowledge, experience, and skills necessary to evaluate and predict hydrological processes in the forest watersheds. However, this course is objected to teach students also how to make an optimal solution based on existing situation and data within the watershed boundary.
Competencies

General competencies	- Gain theoretical and practical knowledge on watershed materials using research work published in English - Work both independently and in collaboration with others - Understand the role of forests in a sustainability of watersheds and society (in a wide context) - Analyze the multiple overlapping stressors that create the need for watershed management.

Professional competencies	- Suggest potential methods/ways to prevent soil erosion and flood risks - Appraise forested watersheds and develop management plans to meet the objectives of stakeholders. - Construct scenarios of possible futures and consider their importance in current management - Take responsibility for self-managed learning and professional development - Use acquired knowledge and experience in problem solving
Learning outcomes	
By the end of this course, students will be able to	
LO1	List the basic concepts of forest watershed management, in English
LO2	Analyze and synthesize different effects of forestry practices and watershed management actions from a silvicultural, engineering, economic and management perspective.
LO3	Evaluate the role of watersheds and water resources in ensuring environmental sustainability
LO4	Access and interpret primary and secondary sources of information, in English
LO5	Apply subject knowledge and understanding to address familiar and unfamiliar problems
LO6	Construct reasoned arguments in English to support a position on the implications and the potential impacts of scientific advances
LO7	Develop management plan dealing with the protection and restoration of forest watersheds

Content, learning objectives, learning outcomes in modules/units						
Topic/Content	**Asynchronous**	**Synchronous**	**Individual work**	**Asynchronous theoretical component**	**Synchronous Practical component**	**Module Learning Outcomes**
Unit/Module 1 [BASICS OF FOREST HYDROLOGY]						
1. Introduction to forest hydrology	4	2	4	Basic understanding of forest hydrology	Basic understanding of forest hydrology; role of forest ecosystems in water conservation and	Define the relationship between hydrology forest ecosystem functions

					storage; forms of water, seasonal and permafrost; water resource and functions	
2. Global warming and water resource	4	2	4	Water resource problems and their consequences	Water resource problems and their consequences; factors affecting water resource and quality; scourge of permafrost and glaciers; deforestation and loss of soil moisture	Describe the main negative factors affecting water resources
3. Forest hydrological studies in different regions	4	2	4	Literature review on water resource and conservation	Analyses of researches on forest hydrological issues; scientific approaches for soil water conservation	Compare global hydrological problems and research findings
4. Forest and precipitation	4	2	4	Relationships between forest and rainfall	Effect of forest ecosystem on water resources; Interaction between forest coverage and precipitation; stable microclimate and water storage in the forest; forest soils and water storage	Explain the interaction between forest and water resources
5. Forests and streamflow quantity and quality	4	2	4	Issues regarding streamflow quantity and quality in the forest watersheds	Runoff generation and watershed discharges; soil erosion control measures, afforestation and reforestation; sources of water pollution and pollutants	Recognize the ways to conserve streamflow quantity and quality
6. Water cycling in different ecosystems	4	2	4	Features of the water cycling in different ecosystem types of the world	Distinctive features of water cycles in forest ecosystems; role of forest ecosystem in global water cycling and water storage, permafrost and seasonal permafrost soils	Correlate water cycles and their properties with different ecosystems
Total hours for Unit/module 1	Topics: 6 Asynchronous: 24 Synchronous: 12 Independent work: 24					
Unit/Module 2 [WATERSHED MANAGEMENT PLANNING AND IMPLEMENTATION]						
7. Watershed inventory and socio-economic assessment	4	2	4	Forest watershed level inventory and data collection	Socio-economic assessments in the watershed area, items of information; participatory inventory with stakeholders, institutions and user groups; problem analyses and prioritization by importance	Interpret existing environmental and socio-economic conditions in the watershed area
8. Disturbances in the forest watersheds	4	2	4	Potential types of disturbances in the forest watersheds	Human-induced negative factors and their consequence on water quality and resource; natural disturbances and prevention strategies; forestry and biological measures and techniques to improve the adaptation	Illustrate potential risks that might negatively affect forest watershed
9. Risk analysis at watershed at level	4	2	4	Importance of risk assessments and analyses	A literature review of watershed risk assessment methods; determination of facing issues in the	Identify existing risks and issues in the forest watershed area

					watershed; prevention and protection measures for mitigating the potential risks	
10. Conservation of forest watersheds	4	2	4	Silvicultural treatments to conserve the watersheds	Forest landscape restoration; biological and mechanical constructions; capacity building and ecological education	Design the appropriate silvicultural and protection measures to conserve the watershed
11. Watershed management plan and strategies	4	2	4	Key concepts of forest watershed plan	Mission and prioritization of the watershed management plan; participatory development of watershed management plan; strategy of the successful implementation of action plan and monitoring	Develop the management plan of the forest watershed area based on existing data and environmental specifics
12. Best practices of watershed management	4	2	4	Best practices and lessons learned from watershed management	Complexity of forest watershed management plan; common practices in successful watershed management action in global context	Prioritize the management activities based on facing issues in the watershed area
Total for Module/Unit 2	Topics: 6 Asynchronous: 24 Synchronous: 12 Independent work: 24					
Total for the course	**Modules: 2** **Topics: 12** **Asynchronous: 48 hours** **Synchronous: 24 hours** **Independent work: 48 hours**					

	Course learning outcomes	Learning types and teaching methods	Assessment methods
LO1	Explain the basic concepts of forest watershed management	Video lecture, recommended readings, seminar, group discussion and presentation	Examination test
LO2	Analyze and synthesize different effects of forestry practices and watershed management actions from a silvicultural, engineering, economic and management perspective.	Video lecture, recommended readings, seminar, literature review, individual work, group discussion and interpretation	Interpretation of individual work
LO3	Evaluate the role of watersheds and water resources in ensuring environmental sustainability	Video lecture, recommended readings, seminar, group discussion, questions and answers	Interview

LO4	Access and interpret primary and secondary sources of information	Video lecture, recommended readings, seminar, group discussion, presentation	Examination test
LO5	Apply subject knowledge and understanding to address familiar and unfamiliar problems	Video lecture, recommended readings, individual work, interpretation, questions and answers	Examination test
LO6	Construct reasoned arguments to support a position on the implications and the potential impacts of scientific advances	Video lecture, recommended readings, case study report, team work, group presentation	Presentation by each team
LO7	Develop management plan dealing with the protection and restoration of forest watersheds	Video lecture, recommended readings, individual work, oral presentation	Interpretation of individual work

Assessment scale			
Assessment scale	Mark on the scale of the higher education institution		
	90 – 100	A	passed
	80 – 89	B	
	70 – 79	C	
	60 – 69	D	
	50 – 59	E	
	0-49	F	failed

Equipment, digital tools, and educational technologies for the course	
Books and resources recommended for this course	
Essential Reading	Kevin Drake and Michael Hogan 2013. Watershed management guidebook: a guide to outcome-based watershed management, 300 p. https://tahoercd.org/wp-content/uploads/2013/03/TIP-WEB-version-FINAL.pdf FAO. 1990. Watershed management field manual: Watershed survey and planning. By Sheng T.C. Rome. 148 p. https://static1.squarespace.com/static/5eb18d627d53aa0e85b60c65/t/5f01fcbd362f28571107727f/1593965768083/water-shed-managment.pdf FAO, IUFRO and USDA. 2021. A guide to forest-water management. FAO Forestry Paper No. 185. Rome. https://doi.org/10.4060/cb6473en

Recommended Reading	https://www.fao.org/sustainable-forest-management/toolbox/modules/watershed-management/basic-knowledge/en/?type=111 https://www.routledge.com/Forest-Hydrology-An-Introduction-to-Water-and-Forests-Third-Edition/Chang/p/book/9781439879948 Forestry Best Management Practices in Watersheds, https://cfpub.epa.gov/watertrain/moduleFrame.cfm?parent_object_id=1517 Wang Lixian, Theory and Practice of Watershed Management in China. 2th ISCO Conference, Beijing 2002. https://www.tucson.ars.ag.gov/isco/isco12/VolumeIV/TheoryandPractice.pdf
Internet resources	https://www.youtube.com/watch?v=uaZPO7dgEnk https://www.youtube.com/watch?v=b98kdNGYZt0 https://www.youtube.com/watch?v=RDCFbfcRcUE https://www.youtube.com/watch?v=9uOyhhL12fc https://www.youtube.com/watch?v=9NqaaJ3HJ1g https://www.youtube.com/watch?v=QdjMvZVRvVs
Course quality monitoring	

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Planning of urban forestry	
Field (if relevant)	7M083Forestry
Specializations	7M08302 Forest resources and forestry
Form of delivery	Blendet: online and face to face
Core/Elective	Elective course
Course prerequisites (if relevant)	Silviculture, Organization of forestry, Forest economy, Inventory
Semester of the course	Year 2, Semester 3
Credit value	4 ECTS
Pass level/grading	Passed (A, B, C, D, E) / Failed (F)
Course language	English

Course Developers	Kazakh National Agrarian Research University

Course summary

The course deals with the features of strategic management in forestry, the introduction of modern methods of intensive forest management and reforestation and the information system of the forest complex. It will provide acquisition of theoretical knowledge and practical skills in forest inventory, strategies for the development of the forest complex, in the economic, environmental and social spheres, and in organizing the implementation and control of work on landscaping and landscaping.

The course has been developed within the *Iinternational Project Erasmus+ Internationalizing Master Programmes in Agriculture via English Medium Instruction (IMPROvE_AGRO) № 609563-EPP-1-2019-1-DE-EPPKA2-CBHE-JP*

Key terms and notions

Key terms and notions:
Forest complex; reforestation; forest inventory; forest management; urban forestry; organic architecture; improvement of populated areas

Course aim

The purpose of the course is to provide strategic management insights, within a modern concept of enterprise management. This is achieved by the provisions of system analysis, which allow explaining competitive advantages, identifying the causes of failures, identifying unused reserves, calculating losses and budget shortfalls, and substantiating a development strategy for the future and long term. The course will allow the students to co-op with the organizational, technological and production processes, in the forestry and urban sectors as a whole.

Competencies	
General competencies	- Possess the theory and modern methodological concept of strategic management in forestry and urban forestry - Gain theoretical and practical understanding using material published in English - Work both independently and in collaboration with others - Take responsibility for self-managed learning and professional development - Use acquired knowledge and experience in problem solving
Professional competencies	- analyze the current state and development trends of the forest complex in the world - effective forest management and implement in the state system - implement digital transformation in the forest industry - organize work on the improvement of cities and towns
Learning outcomes	
Upon successful completion of the module the students will be able to:	
LO1	Demonstrate historical review of the global forestry, in English
LO2	Improve forest management standards based on socio-economic needs
LO3	Select tree and shrub species for urban landscaping and determine proper methods of soil preparation and maintenance
LO4	Evaluate tree health condition and conduct an inventory in urban forests
LO5	Create a design for greening and landscape architecture
LO6	Design landscape architecture using professional software
LO7	Conduct tree morphological measurement and data collection for further planning

Content, learning objectives, learning outcomes in modules/units						
Topic/Content	**asynchronous**	**synchronous**	**independent work**	**Asynchronous theoretical component**	**Synchronous Practical component**	**Module/Unit Learning Outcomes**
Module/Unit 1: Strategic management in forestry						
1. Forestry development and historical overview in global context	4	2	6	Introduction to World Forestry	Analysis of changes in forest management standards that meet increased international, social, environmental and economic requirements. Natural disturbances in forested areas and their implications related to the biodiversity loss	Create a chronology of the historical development of the global forest sector
2. National forest management plans of different countries	4	2	6	Consider foreign experience of state regulation	Discuss the strategies for the development of the forest complex	Analyze changes in forest management standards in national policies according to the national plans and international regulations
3. Introduction to digitalization in forestry	6	4	6	Presentation of the use of computer programs and modern equipment in forestry	Presentation of the information system of the forest complex that will allow receiving, processing, storing and using information about the state of forests, about their quantitative and qualitative characteristics	Create an electronic map of the site with taxation descriptions of trees
4. State recording of forests and forest inventory	6	4	6	Presentation of a set of works on the description, mapping and determination of quantitative and qualitative indicators of individual sections of the forest fund	Analysis of the data of the state forest management and control of the state of forest plantations	Determine the state of forest plantations and manage them, planning forestry activities state forest accounting and forest inventory. Explain how to preserve urban soil with ecological characteristics

Total for Unit/module 1	Topics: 4 Asynchronous: 20 Synchronous: 12 Independent work: 24					
Module/Unit 2: Strategic management in urban forestry						
5. Landscape organization of a territory	4	2	6	Presentation of the creation of a complex of landscape-planning and agrotechnical measures to improve the environment; collection, storage of forest seeds, cultivation of decorative planting material	Analysis of the complex of urban planning, landscape planning, engineering, aesthetic and discussion on the agrotechnical measures for the development and creation of effective systems of green areas	Organize a set of measures to improve the environment, the destruction of pests and diseases of green spaces
6. Picturesque gardening	4	2	6	The concept of interior design techniques with ornamental plants, landscaping of cities and towns, features of the architectonics of woody plants, methods for creating decorative crowns and arrangement principles.	Development of a project for landscape gardening construction for various purposes	Design a small garden according to the features and the main directions of modern phyto-design.
7. Biotechnical complex	6	3	6	Application of modern innovative methods and techniques in the field of biotechnology to obtain valuable fruit and ornamental plants on the example of a biotechnological complex. Presentation of the need to study the biology of ornamental plants at the tissue, cellular, subcellular and molecular levels.	Presentation of the use the genotypic and physiological differences of the studied ornamental plants; Demonstration of micropropagation of ornamental plants, plant regeneration under in vitro conditions; Presentation of the methods of mathematical planning and analysis of the experiment Application of the transgenosis method - plant forms with genetic resistance to viruses Presentation of the theoretical foundations of the regulation of wildlife in urban environments	Cultivate of new plant cells under special conditions, for various kinds of research, acceleration of breeding processes, breeding of new plant varieties and clones.

8. Organic architecture	4	2	6	Analysis of the importance of maximum integration into the surrounding landscape	presentation of the main direction of organic architecture; study of modern building technologies; a new trend in modern architecture "Green Walls", etc.	Create a modern building, preserving naturalness in everything: in form, materials, interiors and exteriors.
9. Soil in an urban environment	4	3	6	The study of the ecological state of the soil cover of the urban environment and the characteristics of soil-forming processes, the identification of the main sources of pollution and the preservation of a more natural state of the soil.	Presentation of the anthropogenic sources of soil pollution	Explain how to preserve urban soil with ecological characteristics
Total for hours for Unit/module 2	Topics: 5 Asynchronous: 22 Synchronous: 12 Independent work: 30					
Total for the Course	**Modules: 2** **Topics: 9** **Asynchronous: 42** **Synchronous: 24** **Independent work: 54**					

	Course learning outcomes	Learning types and teaching methods	Assessment methods
LO1	Demonstrate historical review of the global forestry in English	Lecture, video records, individual presentation	Report and presentation on the development of forestry in different countries
LO2	Improve forest management standards based on socio-economic needs	Lecture, group discussion and interpretation	Interpretation of individual work
LO3	Select tree and shrub species for urban landscaping and determine proper methods of soil preparation and maintenance.	Seminar, field practice, presentation	Interview, report and presentation on the urban biogeocenosis

LO4	Evaluate tree health condition and conduct inventory in urban forests	Lecture, video records, field practice, group discussion, presentation	Examination test
LO5	Create a design for greening and landscape architecture	Lecture, video records, individual work and presentation	Examination test
LO6	Design landscape architecture using professional software	Seminar, field practice, individual work and presentation	Report and presentation
LO7	Conduct tree morphological measurement and data collection for further planning	Seminar, field practice, individual work and presentation	Interpretation of individual work

Assessment scale			
Assessment scale	Mark on the scale of the higher education institution		
	90 – 100	A	passed
	80 – 89	B	
	70 – 79	C	
	60 – 69	D	
	50 – 59	E	
	0-49	F	failed

Equipment, digital tools, and educational technologies for the course	
Books and resources recommended for this course	
Essential Reading	Cecil Konijnendijk, Syaka Sadio, Thomas Barfoed Randrup, Jasper Schipperijn Urban and peri-urban forestry in a development context - Strategy and implementation Pam Hazelton, Brian W Murph, Understanding Soils in Urban Environments 2nd Edition, ISBN : 978-1-78924-993-4, 192 pages, 2021 WHO. Release of genetically modified organisms in the environment: is it a health hazard? In: WHO/EURO-ANPA Seminar Report. (7th - 8th September, 2000, Rome Italy) WHO European Centre for Environment and Health, Rome Division, 2000. p. 17. Richard J. Dietrich. Biological and Ecological Factors in Urban Built Environment: Recent Research and Practice in West Germany, Journal of the Royal Statistical Society. Series D (The Statistician) Vol. 39, No. 2, Special Issue: Health of Inner Cities and Urban Areas (1990), pp. 185-190 (6 pages)
Recommended Reading	Rowe, J.S. 1992. The ecosystem approach to forestland management. For. Chron. 68: 222-224. Hunter, M.L. 1990. Wildlife, forest and forestry. Principles for managing forest for biodiversity. Prenctice Hall. Canadian Council of Forest Ministers, 2002. National forest database program. http://nfdp.ccfm.org/cp95/data_e/ (viewed 16 May, 2002). Strategic participatory forest management system for sustainable forestry development. *Madera bosques* [online]. 2021, vol.27, n.1, e2712260. J.L. Morel, C. Schwartz, L. Florentin, C. de Kimpe, URBAN SOILS, in Encyclopedia of Soils in the Environment, 2005 Richard V. Pouyat, Tara L.E. Global Change and Forest Soils Trammell, in Developments in Soil Science, 2019 Jean Louis Morel, Geoffroy Séré, Viacheslav Vasenev, Thomas Nehl. Ecosystem services provided by soils in highly anthropized areas (SUITMAs), Reference Module in Earth Systems and Environmental Sciences, 2023
Internet resources	https://www.youtube.com/watch?v=BWx8f1Nrmr8 https://www.youtube.com/watch?v=M2uDFSt7Atg
Course quality monitoring	

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Multi-purpose Forest Inventory	
Field (if relevant)	E08210101Forestry
Specializations	FORS612 Forest resources and forestry
Form of delivery	Classroom and online
Core/Elective	Professional elective course
Course prerequisites (if relevant)	Dendrology, Forest mensuration, Forest management
Semester of the course	Year 2, Semester 1
Credit value	4 ECTS
Pass level/grading	Passed (A, B, C, D, E) / Failed (F)
Course language	English

Course Developers	Kazakh National Agrarian Research University, National University of Mongolia

Course summary

The course provides students with understanding of forest inventory that aims to the development of multipurpose management of forest resources, at national and local levels, using internationally adopted forest inventory methods, which are based on remote sensing and ground -based sampling and measurement technologies. Students will be skilled with designing and conducting the field data collection in the forested areas and carry out data processing, using GIS technology for the determination of forest resources and their spatial analyses and management planning for multiple purposes. The course, taught in English, employs methodology intended for integrated learning of both content and language. The course has been developed within the international Erasmus+ project "Internationalizing Master Programs in Agriculture via English Medium Instruction (IMPROvE _AGRO)", No 609563-EPP-1-2019-1-DE-EPPKA2-CBHE-JP (15.01.2020 – 15.01.2023).

Key terms and notions

forest inventory; sampling design; data collection; mensuration; carbon stock; biodiversity; remote sensing; spatial analyses; information system; productivity

Course aim

The aim of the course is to provide students with the knowledge, experience, and skills necessary to determine information needs for forest inventory, develop sampling design and methods for field data collection, and processing, and use of forest inventory. This will result in developing multipurpose planning of forest resources, using innovative methods of remote sensing and ground-based field measurements.

Competencies	
General competencies	– Gain theoretical and practical knowledge forest hydrology and watershed ecosystems using materials published in English – Learning and reviewing lecture material prepared in English – Carrying individual work using online lecture and other recommended sources – Use of research findings in solving the problems – Conducting data processing and interpretation
Professional competencies	– Designing forest inventory at different levels in accordance with information needs – Skilled with field measurements and data collection – Able to use remote sensing and GIS technologies in forest inventory and spatial analyses of forest resources – Apply forest inventory results in solving the forest management issues
Learning outcomes	
By the end of this course, students will be able to	
LO1	Explain the importance of monitoring forest resources.
LO2	Analyze how forest resources can be reliably monitored over time to achieve a range of objectives.
LO3	Apply sampling systems commonly used in forest inventories.
LO4	Evaluate the quantitative and qualitative characteristics of forests based on inventory data.
LO5	Recognize the forest management issues
LO6	Choose the most efficient silvicultural ways to manage forests for multiple purposes.

Content, learning objectives, learning outcomes in modules/units						
Topic/Content	**Asynchronous**	**Synchronous**	**Individual work**	**Asynchronous theoretical component**	**Synchronous Practical component**	**Module Learning Outcomes**
Unit/Module 1 [FOREST INVENTORY AND SAMPLING DESIGN]						
1. Forest inventory in the global context	4	2	4	Global warming and modern trend of forest inventory	Forest resources and carbon pools; greenhouse; gas emission and sequestration, country report to the international organizations	Recognize the trend of international forest inventory and practice
2. Importance of multipurpose forest inventory and forest ecosystem monitoring	4	2	4	Understanding of multipurpose inventory and forest ecosystem monitoring	Monitoring of forest ecosystem; updating the forest inventory data; multiple use of forest resources;	Explain the importance of multipurpose forest inventory
3. Forest inventory in different countries	4	2	4	World forest inventory review	Historical overview and experiences of forest inventory; mission, goals and objectives of multipurpose forest inventory	Compare the forest inventory goals and objectives and goals in global context
4. Levels of forest inventory and information needs	4	2	4	Different levels of forest inventory and their specifics	Information needs in relation to forest inventory levels; ideas of multipurpose inventory and principles; contribution of forest inventory in forest management planning	Interpret the differences between inventory levels and information needs
5. Sampling design and plot configuration	4	2	4	Sampling methods, their advantages and disadvantages	Statistical and random sampling; sampling unit, clustering, fixed radius	Describe the optimum sampling design depending on information needs
6. Planning multi-purpose forest inventory actions	4	2	4	Preparation and roadmap development for the field data collection	Inventory team organization; capacity building; legal framework of forest inventory; participatory forest inventory	Define the appropriate ways to carry out preparation for field data collection
Total for Unit/module 1	Topics: 6 Asynchronous: 24 Synchronous: 12 Independent work: 24					
Unit/Module 2 [DATA MANAGEMENT OF FOREST INVENTORY AND PLANNING]						
7. Forest inventory and requirements	4	2	4	Field data collection and measurement accuracy	Use of remote sensing and GIS technologies in forest inventory; introduction of advanced technologies and measurement tools in field measurements	Identify the field work organization

8. Forest inventory information system	4	2	4	Components of forest information system	Basic components of forest information system; GIS based technologies and analyses; software and applications used for data processing; accuracy of forest inventory data	Describe the forest information system and components
9. Forest inventory data management systems and regulation	4	2	4	Forest inventory data management	Forest inventory data management; spatial and temporal data analyses in forest inventory; determination of forest resources and monitoring; estimation of carbon emission and sequestration	Compare and analyze the data management systems and regulations in international level
10. Quantitative and qualitive characteristics of the forests	4	2	4	Key quantitative and qualitive characteristics for forest inventory	Key quantitative and qualitive variables of forest inventory; monitoring of forest resources and stand characteristics; basic requirements and advances in evaluation of forest ecosystem services; identification addressing forestry issues based on inventory data analyses	Illustrate the main variables and terms of forest inventory
11. Principles and components of a forest management plan	4	2	4	Understanding of a sustainable forest management plan	Criteria and indicators of sustainable forest management; Designing long- and short-term action plans for solving forest management issues; Quality control and monitoring	Design action plans in accordance with the principles of sustainable forest management
12. Development of forest management plan for multiple purposes	4	2	4	Forest resources and their multiple use	Role of forest ecosystem services in mitigation global warming; participatory inventory and management; non-timber forest products and services in forest management planning	Develop the forest management plan for multiple purposes based on forest inventory data
Total for Unit/module 2	Topics: 6 Asynchronous: 24 Synchronous: 12 Independent work: 24					
Total for the course	**Modules: 2** **Topics: 12** **Asynchronous: 48** **Synchronous: 24** **Independent work: 48**					

	Course learning outcomes	Learning types and teaching methods	Assessment methods
LO1	Explain the importance of monitoring forest resources.	Video lecture and suggested readings, seminar, individual work, group discussion	Examination test
LO2	Analyze how forest resources can be reliably monitored over time to achieve a range of objectives.	Video lecture and suggested readings, seminar, individual work, oral presentation	Interview
LO3	Apply sampling systems commonly used in forest inventories.	Video lecture and suggested readings, inter-group discussion, seminar	Interpretation of individual work
LO4	Evaluate the quantitative and qualitative characteristics of forests based on inventory data.	Video lecture and suggested readings, practice working on computer software, interpretation of individual work	Examination test
LO5	Recognize the forest management issues	Video lecture and suggested readings, group discussion, seminar,	Presentation by each team
LO6	Choose the most efficient silvicultural ways to manage forests for multiple purposes.	Video lecture and suggested readings, teamwork, discussion, presentation by each team	Interpretation of individual work

Assessment scale			
Assessment scale	Mark on the scale of the higher education institution		
	90 – 100	A	passed
	80 – 89	B	
	70 – 79	C	
	60 – 69	D	
	50 – 59	E	
	0-49	F	failed

Equipment, digital tools, and educational technologies for the course

Books and resources recommended for this course	
Essential Reading	Henttonen, H.M., Kangas, A. (2015). Optimal plot design in a multipurpose forest inventory. *For. Ecosyst.* **2,** 31 https://doi.org/10.1186/s40663-015-0055-2 Tewari V.P. (2016) Forest inventory, assessment, monitoring, and long-term forest observational studies, with special reference to India, Forest Science and Technology, 12:1, 24-32, DOI: 10.1080/21580103.2015.1018962 Alberdi, I. Forest Resources Assessments: Mensuration, Inventory and Planning. Forests 2021, 12, 296. https://doi.org/10.3390/f12030296 Cris Brack, LlChris McElhinny, Robert Waterworth, Zand Simon Roberts L. (2011) Multi-scale Forest Inventory and Modelling for Multi-purpose Management. *J. For. Plann.* 16: 133-139. United States Department of Agriculture. Forestry Inventory Methods (2018) Forestry Technical Note. https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=42554.wba
Recommended Reading	Henttonen, H.M., Kangas, A. Optimal plot design in a multipurpose forest inventory. *For. Ecosyst.* **2**, 31 (2015). https://forestecosyst.springeropen.com/articles/10.1186/s40663-015-0055-2 Swiss National Forest Inventory: Methods and Models of the Second Assessment, 2001. Edited by Peter Brassel and Heike Lischke, https://www.lfi.ch/publikationen/publ/anleitungen/LFI2_Methoden.pdf Dan Altrell (2019) Multipurpose National Forest Inventory in Mongolia, 2014-2017 -A tool to support sustainable forest management. Geography, Environment, Sustainability, Vol.12, No 3, p. 167-183 DOI-10.24057/2071-9388-2019-36 The **3rd** WG meeting was dedicated to the topic **"Design of a Multipurpose National Forest Inventory,** Cayenne, French Guiana, on April 28th and 29th. https://reddguianashield.wordpress.com/working-groups/working-group-3/ Gschwantner, T., Schadauer, K., Vidal, C., Lanz, A., Tomppo, E., di Cosmo, L., Robert, N., Englert Duursma, D. & Lawrence, M. 2009. Common tree definitions for national forest inventories in Europe. Silva Fennica 43(2): 303–321. http://www.metla.fi/silvafennica/full/sf43/sf432303.pdf

Internet resources	https://www.youtube.com/watch?v=92qtevghuW0 https://www.youtube.com/watch?v=NDfTpBhUUrM https://www.youtube.com/watch?v=ovvolB9Asyw https://www.youtube.com/watch?v=YOEAxoCNZdE
Course quality monitoring	

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Dendroecology	
Field (if relevant)	Forestry
Specializations	Dendroecology
Form of delivery	Blended: Online lectures, and face-to-face laboratory/seminars
Core/Elective	Elective
Course prerequisites (if relevant)	Dendrology, Forest Ecology, and Wood anatomy
Semester of the course	Year 2, semester 3
Credit value	4 ECTS
Pass level/grading	Passed (A, B, C, D, E) / Failed (F)
Course language	English

Course Developers	National University of Mongolia

Course Summary

This course provides an in-depth exploration of forest ecology through the lens of tree ring methods. Tree rings serve as valuable archives, offering insights into the environmental history, growth patterns, and responses of trees to various ecological factors. Participants will gain a comprehensive understanding of how tree ring analysis contributes to ecological research and ecosystem management.

The course, taught in English, employs the Content and Language Integrated Learning (CLIL) methodology intended for integrating content and language learning. The course has been developed within the international Erasmus+ project "Internationalizing Master Programmes in Agriculture via English Medium Instruction (IMPROvE _AGRO)", No 609563-EPP-1-2019-1-DE-EPPKA2-CBHE-JP (15.01.2020 – 15.01.2023).

Key terms and notions

Tree ring, tree growth, secondary growth, data collection, tree ring measurement, cores, disk, wood anatomy, xylem, phloem, tree ecology, tree ring width, fire scars, defoliation, insect outbreak, fires frequency

Course aim

This course employs a blended learning approach to provide students with a comprehensive understanding of forest ecology and its dynamics, including disturbances. There are many scientific methods to explore the ecological histories of forest ecosystems. In this course, we are emphasizing tree ring methods. By the end of the course, students should be able to understand the Fundamentals of forest ecology, analyze tree ring data, interpret ecological histories, and apply multidisciplinary knowledge and hands-on field and laboratory experiences. Moreover, students will get critical thinking and problem-solving skills, communication and presentation skills, and application of dendroecology in their research and management.

Competencies	
General competencies	- Theoretical and practical understanding using materials published in English - Learning and reviewing lecture materials prepared in English - Carrying out individual work using online lectures and other recommended sources - Use of research findings in solving the problems
Professional competencies	- Define the fundamental theory underpinning the field of forest ecology and dendrochronology. - Experienced in immersive lab and field-based experiential learning in tree-ring science microscopy and wood anatomy - Acquire data collection, data analysis and visualization, numeracy, and science literacy and communication
Learning outcomes	
By the end of this course, students will be able to	
LO1	Explain the fundamental theory of forest ecology, disturbances, and forest dynamics
LO2	Apply sampling method of tree ring for forest ecological studies
LO3	Perform cross-dating by skeleton plot and master chronology development for ecological studies
LO4	Distinguish wood anatomical features of ecological disturbances
LO5	Interpret tree ring data using graphics.

Content, learning objectives, and learning outcomes in modules/units						
Topic/Content	**Asynchronous**	**Synchronous**	**Indepentent work**	**The asynchronous theoretical component**	**Synchronous Practical component**	**Module Learning Outcomes**
Unit/Module 1 [Principles of Dendroecology]						
1. Forest as ecosystems	4	2	4	The forest as an ecosystem Forest soil structure Shade-light tolerance	Detailed exploration of the abiotic factors affecting tree growth (e.g., soil, climate). Discussion of biotic interactions within the forest community.	- Describe how abiotic factors, such as soil and climate, influence tree growth and forest dynamics. - Classify and illustrate the role of biotic interactions within the forest community and their impact on dendroecological processes. - Apply their knowledge of the forest environment to real-world scenarios, demonstrating an ability to critically assess and discuss complex ecological interactions.
2. The development of forestry and forest ecology	4	2	4	Historical overview of the development of forestry. Evolution of forestry practices and their relationship with forest ecology. Key milestones and figures in the history of forestry.	Detailed exploration of the interaction between forestry practices and forest ecology. Examination of how historical decisions impact modern forest ecosystems.	- Demonstrate an understanding of the historical development of forestry, recognizing key events, figures, and shifts in forestry practices. - Analyze and articulate the ecological consequences of historical forestry practices and their implications for contemporary forest ecology. - Explore and discuss the integration of ecological principles in modern forestry, evaluating current practices and potential improvements.
3. Understanding the Forest environment	4	2	4	Overview of the components of the forest environment. Discussion of the abiotic and biotic factors influencing tree growth. Introduction to the role of microenvironments within the forest.	Detailed exploration of the abiotic factors affecting tree growth (e.g., soil, climate). Discussion of biotic interactions within the forest community.	- Demonstrate an understanding of how abiotic factors, such as soil and climate, influence tree growth and forest dynamics. - Articulate the role of biotic interactions within the forest community and their impact on dendroecological processes. - Apply their knowledge of the forest environment to real-world scenarios, demonstrating an ability to assess and discuss complex ecological interactions critically

4. Forest disturbance and succession	4	2	4	Overview of forest disturbance and succession. Definitions and key concepts related to disturbance regimes and successional processes. Introduction to common types of disturbances and successional patterns.	In-depth exploration of different disturbances (e.g., fire, insects, wind) and their ecological impacts. Discussion on successional stages and pathways in forest ecosystems.	- Distinguish different disturbances and their ecological impacts on forest ecosystems. - Define the various successional pathways in forest ecosystems, recognizing the factors influencing successional dynamics.
5. Ecological site classification	4	2	4	Overview of ecological site classification and its significance in dendroecology. Explanation of key concepts such as site types, ecological indicators, and classification criteria. Introduction to common ecological site classification systems.	In-depth exploration of different ecological site classification systems. Discussion on the integration of dendroecological principles into classification criteria.	- Demonstrate an understanding of different ecological site classification systems and their relevance to dendroecology. - Apply classification criteria to practical exercises, demonstrating their ability to classify ecological sites based on dendroecological principles. - analyze and discuss how dendroecological principles are integrated into ecological site classification, emphasizing the importance of considering tree-ring data in the classification process.
6. Seminar by students	4	2	4	Comparing and contrasting forest disturbance regimes in different continents.	Analyzing the ecological consequences of various disturbances on a global scale. Discussing international collaboration in mitigating and managing forest disturbances.	- explore the application of forest ecological principles across different ecosystems, cultures, and management contexts.
Total for Unit/Module 1	Topics: 6 Asynchronous: 24 Synchronous: 12 Independent work: 24					
Unit/Module 2 [Dendroecology and its applications]						
7. Introduction of dendrochronology	4	2	4	Basic principles and definitions in dendrochronology	Applications of dendrochronology. subfields of dendrochronology. objectives	- Describe the basic principles of dendrochronology. - Classify subfields of dendrochronology

8. Growth and structure of wood	4	4	4	Tree physiology: basic wood structure: cell features and types	Forms of wood structure; reaction wood; growth initiation and absent rings; ring anomaly	- Recall wood anatomical features. - Identify functions of the xylem, cambium, and phloem - Distinguish ring anomalies, including missing absent, and false rings
9. Seminar	4	4	4	Literature review of dendrochronological studies of different regions	Individual work on literature surveys on conducted dendrochronological studies in the regions	- Summarize dendrochronological studies in own regions. - Present a summary of the literature reviews
10. Field and laboratory methods of dendroecology	4	4	4	Principles behind site selection; field methods;	Gears for fieldwork; random verses and targeted sampling; plots and transects; coring a tree	- Apply different sampling methods - Practice establishing plots and transects. - Apply handling borers and coring a tree
11. Skeleton plotting	4	4	4	Analysis of cores and cross sections; crossdating, skeleton plotting, list method, memorization method	The goal of crossdating is to assign calendar dates to each annual ring, and one way to start is to mark a visual ring count of the decades on the wood	- Identify and record relative ring widths (narrow, wide, normal) on tree cores/ cross sections - Plot and synchronize ring sequences across multiple samples - Apply skeleton plotting for interprepting past disturbances (fire, insects; succession, herbivory)
12. Group/ Individual works	4	4	4	Interpretation of tree ring data	Teeline and subarctic studies; interactions of multiple disturbances	- Explore interactions of multiple disturbances in the upper, lower treeline, and alpine regions.
Total for Module/Unit 2	Topics: 6 Asynchronous: 24 Synchronous: 22 Independent work: 24					
Total for the course	**Modules: 2** **Topics: 12** **Asynchronous: 48 hours** **Synchronous: 24 hours** **Independent work: 48 hours**					

	Course learning outcomes	Learning types and teaching methods	Assessment methods
LO1	Define the fundamental theory of dendrochronology, its site-selecting principles	Lectures, video records, and suggested readings	Examination test on essential terms and descriptions
LO2	Sample trees for the study purpose and site selection	Field practice, video instructions, and sample collections	Core quality test for laboratory measurements
LO3	Perform cross-date by doing skeleton plotting and master chronology development	Laboratory practices and preparation of samples for measurement	Individual assessment of skeleton plots and master chronology

Assessment scale			
Assessment scale	Mark on the scale of the higher education institution		
	90 – 100	A	Passed
	80 – 89	B	
	70 – 79	C	
	60 – 69	D	
	50 – 59	E	
	0-49	F	Failed

Equipment, digital tools, and educational technologies for the course	
Increment borer, wood glues, sandpapers, microtomes, microscopes, pencils, erasers, graph papers.	
Books and resources recommended for this course	
Essential Reading	Speer J. H. Fundamentals of tree-ring research. – University of Arizona Press, 2010. Stokes, M.A., and T. L. Smiley (1968). An Introduction to Tree-Ring Dating, University of Arizona Press, Tucson. (Reprinted 1995). Pages xi – xiii, xv – xvii, 3 – 20. Fritts H. C., Swetnam T. W. Dendroecology: a tool for evaluating variations in past and present forest environments //Advances in ecological research. – 1989. – T. 19. – C. 111-188. Amoroso M. M. et al. (ed.). Dendroecology: tree-ring analyses applied to ecological studies. – Springer, 2017. – T. 231. Cook, e. Kairiukstis, l. Methods of dendrochronology. Applications in the environmental sciences. Dordrecht, Kluwer academic publishers and the international institute for applied systems analysis, 1990. Schweingruber, f h. Tree rings and environment dendroecology. Berne: paul haupt publishers, 1996. 609 p. Isbn 3-258-05458-4. Schweingruber, f h. Trees and Wood in Dendrochronology: Morphological, Anatomical, and Tree-Ring. Analytical Characteristics. Berlin: Springer-Verlag, 1993. 402 p. ISBN 3-540-54915-3.
Recommended Reading	Rubino D. L., McCarthy B. C. Comparative analysis of dendroecological methods used to assess disturbance events //Dendrochronologia. – 2004. – T. 21. – №. 3. – C. 97-115. Splechtna B. E., Gratzer G., Black B. A. Disturbance history of a European old-growth mixed-species forest—A spatial dendro-ecological analysis //Journal of Vegetation Science. – 2005. – T. 16. – №. 5. – C. 511-522. Abrams M. D., Orwig D. A., Demeo T. E. Dendroecological analysis of successional dynamics for a presettlement-origin white-pine-mixed-oak forest in the southern Appalachians, USA //Journal of Ecology. – 1995. – C. 123-133.

	Paritsis J., Veblen T. T. Dendroecological analysis of defoliator outbreaks on *Nothofagus pumilio* and their relation to climate variability in the Patagonian Andes //Global Change Biology. – 2011. – Т. 17. – №. 1. – С. 239-253. Lavoie C., Rochefort L. The natural revegetation of a harvested peatland in southern Québec: a spatial and dendroecological analysis //Ecoscience. – 1996. – Т. 3. – №. 1. – С. 101-111. Girard F., Payette S., Gagnon R. Dendroecological analysis of black spruce in lichen—spruce woodlands of the closed-crown forest zone in eastern Canada //Ecoscience. – 2011. – Т. 18. – №. 3. – С. 279-294. Song K. et al. The spatiotemporal pattern of historical disturbances of an evergreen broadleaved forest in East China: a dendroecological analysis //Plant Ecology. – 2011. – Т. 212. – С. 1313-1325. Rasmussen K. K. Dendroecological analysis of a rare sub-canopy tree: Effects of climate, latitude, habitat conditions and forest history //Dendrochronologia. – 2007. – Т. 25. – №. 1. – С. 3-17.
Internet resources	List or overview of dendrochronological studies done in their country using www.dendrobox.org **Links for asynchronous laboratory methods and computer program tutorial methods** https://www.youtube.com/watch?v=bRUAIitg1xw https://www.youtube.com/watch?v=bU-TXV-N-hk https://www.youtube.com/watch?v=4llqKt3mH5o&t=822s https://www.youtube.com/watch?v=PQaqq1bm82A&t=109s https://www.youtube.com/watch?v=fE--EtqpKM4 https://www.youtube.com/watch?v=fHBE1i3MpvM

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Technology of tree planting in multiple regions	
Field (if relevant)	7M083Forestry
Specializations	7M08302 Forest resources and forestry
Formofdelivery	Blended: online and face-to-face
Core/Elective	Elective course
Courseprerequisites (if relevant)	Forest seed business, Forest nurseries, Forest crops
Semesterofthecourse	Year2, Semester4
Credit value	4 ECTS
Pass level/grading	Passed (A, B, C, D, E) / Failed (F)
Courselanguage	English

Course Developers	**Kazakh State Agrarian Research University**
Course summary	
This course introduces the master to social- scientific research, the study of the development of the theoretical foundations of forest seed business, the cultivation of forest planting material, the possession of undergraduates theoretically interested and practical skills upon arrival, refers to the forest and forest-growing regions on the territory of the republic, the classification of types of growth conditions and practical use it for a reasonable selection of the range of tree species and types of forest crops for growing artificial plantations. The course, taught in English, uses the CLIL methodology, designed for a comprehensive study of content and language. The course has been developed within the international Erasmus+ project "Internationalizing Master Programmes in Agriculture via English Medium Instruction (IMPROvE _AGRO)", No 609563-EPP-1-2019-1-DE-EPPKA2-CBHE-JP (15.01.2020 – 15.01.2023).	
Key terms and notions	
Key terms and notions: Nurseries, planting materials, seeds, seedlings, saplings, herbicides, cultivation agrotechnics, sowing, care, protection, zoning.	
Course aim	
The purpose of the study is to train undergraduates in theoretical positions and practical skills in matters related to forest plantation and forest culture zoning of the territory of the republic; studying the classifications of growth conditions cycles and its practical use; to teach undergraduates the correct and reasonable selection of the species composition of tree species and cycles of forest crops for growing artificial forest plantations.	
Competencies	
General competencies	By the end of the course, masters will have gained general competencies, such as: - acquire fundamental knowledge of forest cyclology, dendrological areas; - be familiar with types and categories of silvicultural areas; - get acquainted with the main directions of reforestation and afforestation; - know the ways and methods of forest growing.
Professional competencies	By the end of the course, students develop professional competencies, such as: - selection of the range of tree species and cycles of forest crops for different areas - soil preparation for the creation of forest plantations - technology for sowing and planting forests

	- maintain forests, using mechanization tools.
Learning outcomes	
By the end of this course, students will be able to:	
LO1	Analyze the chronology of forestry
LO2	Identify tree species for planting in different regions
LO3	Develop and implement activities to improve the quality and productivity of forests for multiple purposes
LO4	Use advanced technologies of forest management: growing planting material, creating forest and green plantations, carrying out care (agro-technical, forestry) work, wood-harvesting technologies
LO5	Assess the role of green spaces in various natural conditions
LO6	Analyze and summarize modern tree planting technologies from the point of view of forestry, economics and management
LO7	Carry out field work and collecting data for further planning

Content, learning objectives, learning outcomes in modules/units

Topic/Content	asynchronous	synchronous	independent work	Asynchronous theoretical component	Synchronous Practical component	Module Learning Outcomes
Module/Unit 1						
MODULE 1 Technology of tree planting in multiple regions						
1. Overview of various forest planting technologies	6	4	6	The concept of features of landing technologies in various natural conditions	Different countries have a different climate, so every corner of the Earth has its own, sometimes unique nature, flora and fauna. Depending on the climatic conditions of the region, it is necessary to choose the right technology for planting forest crops.	Determine the use of planting methods, depending on the region
2. Technology of planting trees in mountains and other hard-to-reach places	6	4	6	Applying of steep mountain slopes for planting trees	Use of drones, moisture storage trenches, slope terracing and hydropneumatic guns (seed capsules)	Use of planting methods in mountain regions
3. Tree planting technology in the desert	6	4	6	Moisture-retaining technologies for planting trees in arid regions	Environmental water-retaining integrated technology and “water box” technology for planting plants in dry, eroded, desert and rocky areas	Use of planting methods in arid regions
Total for Unit/module 1	Topics: 3 Asynchronous: 18 Synchronous: 12 Independent work:18					
Module/Unit 2						
Module 2 Modern technologies for growing forests						
4. Technology of planting trees with a "root-balled tree system" and the use of mycorrhizal fungi	6	4	8	Symbiosis of trees with mycorrhiza	Use of cassette technology and mycorrhizal fungi	Assess the survival rate of planting trees with the use of mycorrhizal fungi
5. Evaluation of the survival rate of created forest plantations and methods for their determination	6	4	8	Application of various methods, depending on the planting areas (model, diagonal, GIS technologies, etc.)	Application of visual, instrumental, computational and aerospace methods.	Evaluate the survival rate of forest plantations
6. Creation of intensive plantations of fast-growing tree species for the production of commercial timber and energy raw materials	6	4	8	Creation of energy plantations: fast-growing hybrid forms of tree species; commodity wood; decorative breeds; forest vacation and marketing	Application of visual, instrumental, computational methods for laying plantings of fast-growing tree species	Discuss the purpose of intensive plantations and fast growing tree species. Explain the value of commercial wood and energy raw materials. Definition and meaning of intensive plantings.

						Characteristics and advantages of fast-growing tree species.
7. Absorbable potential of forest ecosystems and methods for determining CO2 absorption	6	4	8	Forest absorption capacity and carbon balance.	To estimate carbon dioxide emissions from fuel combustion by visual, software	Evaluate the absorption capacity of forests and the carbon balance, be able to calculate carbon dioxide emissions from fuel combustion using software
Total for Module/Unit 1.2	Topics: 4 Asynchronous: 24 Synchronous: 16 Independent work: 32					
Total for the course	**Modules: 2** **Topics: 7** **Asynchronous: 42** **Synchronous: 28** **Independent work: 50**					

	Course learning outcomes	Learning types and teaching methods	Assessment methods
LO1	Analyze the chronology of forestry	Lecture, video records, individual presentation	Report and presentation on the development of forestry in different countries
LO2	Identify tree species for planting in different regions	Lecture, video records, individual work	Examination test on basic terms and descriptions
LO3	Develop and implement activities to improve the quality and productivity of forests for multiple purposes	Field practice, demonstration different techniques	Apply effective tree planting technology in nurseries in different regions
LO4	Use advanced technologies of forest management: growing planting material, creating forest and	Field practice, laboratory, individual presentation	Examination test

	green plantations, carrying out care (agrotechnical, forestry) work, wood-harvesting technologies		
LO5	Assess the role of green spaces in various natural conditions	Lecture Individual presentation	Learn the types of forest protection plantings
LO6	Analyze and summarize modern tree planting technologies from the point of view of forestry, economics and management	Lecture Individual presentation	Calculation and analysis of calculations in the effectiveness of various modern landing technologies
LO7	Carrying out field work and collecting data for further planning	Seminar, field practice, individual work and presentation	Interpretation of individual work

Assessment scale			
Assessment scale	Mark on the scale of thehigher educationinstitution		
	90 – 100	A	passed
	80 – 89	B	
	70 – 79	C	
	60 – 69	D	
	50 – 59	E	
	0-49	F	failed

Equipment, digital tools, and educational technologies for the course	
Books and resources recommended for this course	
Essential Reading	Carbon sequestration can be defined as the capture and secure storage of carbon that would otherwise be emitted to, or remain, in the atmosphere. Encyclopedia of Energy, 2004 Waring R.H., Running S.W. Forest Ecosystems. Academic Press. 2013 Genene A., Tefera M., Zerihun G., Solomon Z. Training manual on: Forest carbon pools and carbon stock assessment in the context of SFM and REDD+. Wondo Genet, Ethiopia. November, 2013
Recommended Reading	Binkley, C.S. 1997. Preserving nature through intensive plantation forestry: The case of forestland allocation with illustrations from British Columbia. For. Chron. 73: 553- 559. https://www.fao.org/3/y0900e/y0900e06.htm Leonel J.R. Nunes,Catarina I.R. Meireles,Carlos J. Pinto Gomes and Nuno M.C. Almeida Ribeiro. Forest Contribution to Climate Change Mitigation: Management Oriented to Carbon Capture and Storage. Climate 2020, 8(2), 21; https://doi.org/10.3390/cli8020021
Internetresources	https://youtu.be/9QrvPHuqH0I https://youtu.be/_7RmljVLzlM , https://youtu.be/WN0zKSEKZSM https://youtu.be/yHbwy2g5_1Q, https://youtu.be/HzTB4ZDwPaI?list=PL5MDcgMmY2CXV3x-v0KCjMd1ZhglmS3tW https://www.youtube.com/watch?v=nXophqU-rp4&pp=ygVUVGhlc2Ugc2VlZC1maXJpbmcgZHJvbmVzIHBsYW50IHRob3VzYW5kcyBvZiB0cmVlcyBlYWNoIGRheSB8IFBpb25lZXJzIGZvciBPdXIgUGxhbmV0 https://www.youtube.com/watch?v=ld_-lp0LTzM&pp=ygVRUGxhbnRpbmcgdGhlIGRlc2VydCB3aXRoIER1YmFpIE11bmljaXBhbGl0eSB1c2luZyBHcm9hc2lzIFRlY2hub2xvZ3kgdG8gY29tYmF0Li4u https://www.youtube.com/watch?v=29GA3H8GjCw https://youtu.be/KTpaJn22w4I https://www.youtube.com/watch?v=5ATQ7exWReI

Course quality monitoring