3.1. Tabular presentation on the study program Forestry 180 ECTS - III study cycle

No	Code	Subject	Semester	Status (M/E)	Tehaching	Independent research work	Others	ECTS
1st year								
1.		Methodology and techniques of scientific research	I	Mandatory	7	0	0	**6**
2.		Elective subject 1 from a scientific field	I	Elective	6	0	0	**8**
3.		Elective subject 2 from a scientific field	I	Elective	6	0	0	**8**
4.		Elective subject 3 from a scientific field	I	Elective	6	0	0	**8**
5.		Study research work (general report of the achivements in the field of research)	II	Mandatory	0	5	0	**8**
6.		Laboratory, field and experimental work - statistical modeling 1	II	Mandatory	0	10	0	**8**
7.		Preparation of the doctoral dissertation project	II	Mandatory	0	2	3	**6**
8.		Doctoral dissertation project	II	Mandatory	0	6	0	**8**
Total hours of active teaching and credits per year					**32**	**18**	**3**	**60**

2nd year								
9.		Defending the doctoral dissertation project proposal	III	Mandatory	0	0	2	**8**
10.		Laboratory, field and experimental work - statistical modeling 2	III	Mandatory	0	10	0	**8**
11.		Doctoral theis project proposal submision	III	Mandatory	0	10	0	**8**
12.		Research process information	III	Mandatory	0	0	2	**6**

13.		Laboratory, field and experimental work - statistical modeling 3	IV	Mandatory	0	15	0	**8**
14.		Publication of a scientific paper in a journal on SCI list or according to the Study Rules for the 3rd study cycle*	IV	Mandatory	0	0	1	**22**
Total hours of active teaching and credits per year					**0**	**35**	**5**	**60**

3rd year								
17.		Elective option: participation in the organization of teaching at the undergraduate studies or participation in a segment of an project	V	Mandatory	0	5	2	**8**
18.		Laboratory, field and experimental work - statistical modeling 4	V	Mandatory	0	10	2	**8**
20.		Work on the dissertation	V	Mandatory	0	10	4	**14**
21.		Preparation for definding and defense of a doctoral dissertation	VI	Mandatory	0	20	4	**30**
Total hours of active teaching and credits per year					**0**	**45**	**12**	**60**

TOTAL OF ACTIVE TEACHING HOURS AND CREDITS IN THE STUDY PROGRAM	**25**	**94**	**24**	**180**

	UNUVERSITY OF BANJA LUKA **FACULTY OF FORESTRY** **3rd study cyclus** **F O R E S T R Y**			
Subject	**Metodology and tecniques of scientific research**			
Professor/professors	PhD Vojislav Dukić, Associate professor PhD Branislav Cvjetković, assistant professor			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Mandat.	I	7	6

Условљеност

No conditioning

Aim

Scientific research should be understood as a systematic, critical, controlled and repeatable process of acquiring new knowledge, necessary for identifying, determining and solving scientific (theoretical and empirical) problems. From the aforementioned point of view, the main goal of the module is to present the basic theoretical assumptions of general and special methodology and thereby contribute to the formation of students' ideas about the methodology and methods of scientific research and writing scientific work.
In the field of NIR techniques, the goal is to acquire detailed theoretical and practical knowledge related to the techniques of scientific and research work, as well as mastering different procedures for accessing scientific and research work, through familiarization with the techniques of research design, collection, processing and presentation of data, as well as and writing scientific publications.

Outcome

A student should be trained in the field of forestry sciences to think critically about ways of thinking, to understand objective reality, to identify and define scientific questions, to design and implement research, to draw correct evidence and conclusions and to write a scientific paper - a doctoral thesis.
Training students for independent scientific and research work, through the selection of a research topic, research planning, selection and application of adequate techniques and correct interpretation of results. Students will be able to apply the acquired knowledge in research and development projects

Subject content

Basic principles of scientific research work: subject (task) of science, classification of sciences and scientific methods; planning scientific research: choosing a topic for scientific work, independent and team scientific work; Research methodology: data collection techniques, formation of a working hypothesis, research methods and techniques (experimental and theoretical research); Design of experiments: method of sampling and execution of experiments. Data collection and statistical processing. Presentation of research results; composition and structure of scientific reports and scientific papers.

Teaching methods

Lectures, seminar work

Препоручена литература

1. Hadživuković S. (1991): Statistički metodi, Univerzitet u Novom Sadu, Poljoprivredni fakultet.
2. Sakan M. (2005): Hipoteze u nauci. Prometej Novi Sad. ISBN 86-7639-926-3.
3. Graudal, L. O. V. (1993). Introduction to principles in design and evaluation of tree improvement Experiments. Danida Forest Seed Centre. Lecture Note D-6
4. Scherer-Lorenzen M. et al. (2005) The Design of Experimental Tree Plantations for Functional Biodiversity Research. In: Scherer-Lorenzen M., Körner C., Schulze ED. (eds) Forest Diversity and Function. Ecological Studies (Analysis and Synthesis), vol 176. Springer, Berlin, Heidelberg
5. Todorović, Z., Todorović, I. (2015). Metodologija naučnog istraživanja u ekonomiji. Ekonomski fakultet Univerziteta u Banjoj Luci.
6. Koprivica, M. (2015): Šumarska statistika. Univerzitet u Banjoj Luci, Šumarski fakultet.

Forms of knowledge testing and evaluation

Activites during studies	10	Test 1	20	Завршни испит	50
		Test 2	20		
Special indication for the subject					
Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.					
Name and surname of the teacher who prepared the data				PhD Vojislav Dukić, associate prof. PhD Branislav Cvjetković, assis. prof.	

	University of Banja Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**	

Subject	**Biotechnology in forestry**			
Professor/professors	**PhD Vanja Daničić , Assistant Professor** **PhD Jelena Aleksić, Associate Research Professor**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	6	8

Conditionality

No conditioning

Aim

The aim is to acquire knowledge about modern concepts, methods and techniques of genetic engineering and biotechnology applied in the field of forestry. Students get acquainted with the application and previous results in biotechnology in forestry in our country and in the world.

Outcome

Students will be trained for further scientific and professional training in the field of biotechnology. Students acquire knowledge of sophisticated technologies and possibilities of use in order to improve production in forestry.

Subject content

1. The concept, significance and potentials of biotechnology; 2. Statistical indicators of biotechnology application in our country and in the world; 3. Traditional biotechnology; 4. Genetic engineering; 5. Cloning (micropropagation); 6. Tissue engineering; 7. PCR application in biotechnology; 8. Detection and identification of gene function (genome research); 9. Molecular markers; 10. Proteomics research; 11. Biotechnology in the function of establishing bioenergy plantations; 12. Biotechnology in the creation of plants tolerant to diseases, pests, drought, etc .; 13. Genetically modified trees; 14. Danger of using biotechnology in forestry; 15. The future of biotechnology in our country and in the world.

Teaching methods

Lectures with the use of multimedia tools, active learning techniques and discussion; preparation and presentation of seminar papers

Recommended references

1. Burdon R., Liby W., (2006): Genetically Modified Forests – From Stone Age to Modern Biotechnogy. Printed in USA.
2. Jan. M., Gupta, P., (2005): Protocol for Somatic Embryogenesis in Woody Plants. Springer.
3. Kumar, S., M. Fladung, M. (2004): Molecular Genetics and Breeding of Forest Trees Published by Food Products Press.
4. FAO (2009): Forest Biotechnology and its Responsible Use, FAO
5. FAO (2004): Preliminary review of biotechnology in forestry. Summary available online at:http://www.fao.org/docrep/008/ae574e/AE574E03.htm.
6. Harry, D., Strauss, S., (2009): Biotechnology and Genetic Engineering in Forest Trees. Department of Forest Ecosystems and Society. Oregon State University.
7. Ballian D. (2005): Primjena molekularnih istraživanja u šumarstvu. In: Uvod u genetičko inženjerstvo i biotehnologiju, (Ed.) Bajrović, K.; Jevrić-Čaušević, A.; Hadžiselimović, R., INGEB, Sarajevo. 215-231. (str.320)

Forms of knowledge testing and evaluation

Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject

Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.	
Name and surname of the teacher who prepared the data	PhD Vanja Daničić , assis. prof PhD Jelena Aleksić, assoc. prof

	University of Banja Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**	

Subject	**Plant breeding in forestry**			
Professor/professors	**Ph.D Vanja Daničić, Assistant Proffesor** **Dr Saša Orlović, Full Proffesor**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	6	8

Conditionality

-

Aim

Students are introduced to the goals of breeding, the required genetic variability and breeding development. Students acquire knowledge about breeding programs in order to create new cultural forms of trees and shrubs as well as in the inventory and maintenance of forest genetic resources. The student should be able to develop critical thinking, set up experiments, interpret the obtained results and present them to the scientific and professional public.

Outcome

The student can apply different methods as well as applied research in a given discipline, and is able to decide which approach and method to use to solve a particular problem and is aware of the extent to which the chosen approach is appropriate to solve such a problem. The student can apply a detailed knowledge and critical understanding of the principles related to breeding. By using different breeding methods, the student can adequately achieve the goals (increase yield, quality, resilience, etc.) and at the same time maximally maintain diversity within forest ecosystems.

Subject content

1. Introduction to the principles, specifics and importance of breeding trees and shrubs; 2. Sources of genetic variability and genetic basis of breeding; 3. Selection of starting material; 4. Breeding methods; 5. Defining breeding goals; 6. Breeding of selected properties; 7. Testing of plant material and planning of experiments; 8. Planning of comparative tests; organization and technology of inspection; 9. Experiment analysis; statistical methods of processing the obtained data; analysis and interpretation of the obtained statistical parameters

Teaching methods

Lectures in combination with interactive teaching, preparation and preparation of a seminar paper

Recommended references

1. Tucović, A., (1979): Genetika sa oplemenjivanjem biljaka, Univerzitet u Beogradu.
2. Ballian, D., Kajba, D., (2011): Oplemenjivanje šumskog drveća i očuvanje njegove genetske raznolikosti. Univerzitet u Sarajevu i Zagrebu.
3. Borojević, Slavko (1992): Principi i metode oplemenjivanja biljaka – Naučna knjiga, Beograd. p. 1-378.
4. Eriksson, Gosta, Ekberg, Inger (2001): An Introduction to Forest Genetics – Swedish University of Agricultural Sciences, Genetic Centre, Departmant of Forest Genetics, Upsala, Sweden. p. 99-124

Forms of knowledge testing and evaluation

Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject

Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.

Name and surname of the teacher who prepared the data	PhD Vanja Daničić , Ass. Prof PhD Saša Orlović, Full Prof

	University of Banja Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**			
Subject	**Population Genetics**			
Professor/professors	Vanja Daničić, Assistant Professor Saša Bogdan, Full Professor			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	6	8

Conditionality

Knowledge of the basics of genetics.

Aim

Understanding the characterization and monitoring of population genetic constitution and genetic structure in forest tree species (concepts and definitions, process of genetic characterization of populations, genetic constitution, Hardy-Weinberg equilibrium and effective population size, inbreeding, evolution-adaptation factors, racial differentiation).
Application of quantitative genetics methods (genetic test design and analysis) and molecular genetics (DNA marker analysis).

Outcome

To explain the importance of genetic characterization of forest tree populations, methods of determination and the influence of evolution-adaptation factors (selection, allele migrations, genetic drift, mutations) on the genetic diversity of populations; To calculate various parameters that describe: the amount of genetic diversity of a population, the level of genetic differentiation of populations and the effective size of a population; To discuss a state of genetic diversity of a population based on the calculated parameters.
To discuss usefulness and procedures of using different types of DNA markers for genetic characterization of a population; To calculate relevant parameters and discuss genetic status of a population.
To design genetic test for analysis of quantitative phenotypic traits, to explain process of collecting data from a genetic test; to analyse a genetic test (statistical data processing, to calculate basic quantitative genetic parameters).

Subject content

Lectures:Introduction to population genetics; Genetic constitution and population structure; Hardy-Weinberg's law of equilibrium in populations; Inbreeding; Evolutionary-adaptive factors (selection, gene migrations, mutations, genetic drift); Effective population size; Use of DNA markers; Genetic diversity of forest trees; Introduction to quantitative genetics (definitions, settings); Genetic testing (provenance trials, progeny trials, clone trials); Determination of quantitative genetic parameters; Genotype by environment interaction.
Exercises (practicum):Determining the genetic constitution of a population; Calculation of inbreeding and inbreeding depression coefficient; Calculation of the effects of evolutionary-adaptative factors on genetic composition of a population; Calculation of the effective population size; Calculation of genetic diversity parameters; Genetic trial design; Statistical analysis of genetic trial data; Calculation of quantitative genetic parameters; Determination of racial differentiation by genetic testing;

Teaching methods

Lectures, exercises, seminar, online classes

Recommended references

1. White, T. L., W. T. Adams, D. B. Neale, 2007: Forest Genetics. Wallingford, UK, Cambridge, CAB International. p682 (selecetd chapters).

<table>
<tr><td colspan="6">2. Adams, W.T., S.H. Strauss, D.L. Copes, A.R. Griffin, 1992; Population Genetics of Forest Trees. Springer Verlag Netherlands. 436 p.
3. Fins. L, S.T. Friedman, J.V. Brotschol, 2010: Handbook of Quantitative Forest Genetics. Springer. p.406. ISBN: 9789048141128.</td></tr>
<tr><td colspan="6">Forms of knowledge testing and evaluation</td></tr>
<tr><td rowspan="2">Activites during studies</td><td rowspan="2">10</td><td>Test 1</td><td>20</td><td rowspan="2">The final exam</td><td rowspan="2">50</td></tr>
<tr><td>Test 2</td><td>20</td></tr>
<tr><td colspan="6">Special indication for the subject</td></tr>
<tr><td colspan="6">Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.</td></tr>
<tr><td colspan="4">Name and surname of the teacher who prepared the data</td><td colspan="2">Vanja Daničić, Ass Prof
Saša Bogdan, Full Prof</td></tr>
</table>

University of Banja Luka
Faculty of Forestry
PhD studies

F O R E S T R Y

Subject	**Genetic diversity of forest trees and its conservation**			
Professor/professors	PhD Milan Mataruga, full prof. PhD Vanja Daničić, assis. prof			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective		*6*	*8r*

Условљеност

No conditioning

Aim

It is a generally accepted rule that the basis of evolutionary processes, as a source of adaptation in all species, is genetic diversity as the basic unit of biodiversity. As a response and finding a solution to the new changes in natural ecosystems, the solution is sought precisely in the preservation/conservation of genetic diversity. For these, as well as a number of other reasons, there is an obligation to study in more detail, and to acquaint the students of forestry faculties with the possibilities and obligations in the work of conservation and directed use of forest genetic resources.

Outcome

The study, monitoring and use of genetic resources are necessary and daily activities of almost every forester. Through each activity in forestry (production of seeds and planting material, artificial or natural regeneration of forests, thinning, remittances, etc.), the student acquires an idea of the importance and necessary activities in the direction of preserving genetic diversity.

Subject content

1. The concept of forest genetic diversity and the importance of its preservation; 2. State of forests and genetic resources here and in the surrounding area; 3. Forest genetic resources in the international context; 4. Forestry policies and a participatory approach in creating a strategy for the conservation of genetic resources; 5. Threats to forest genetic resources here and in the world; 6. Population genetics; 7. In situ preservation of genetic resources in natural forests; 8. Protected areas and genetic diversity; 9. Establishment and management of ex situ plantations; 10. Ex situ conservation through storage of genetic material; 11. Molecular markers in the function of measuring genetic diversity; 12. Population size in the conservation of genetic resources; 13. The role of genetic resources in sustainable forest management; 14. Establishment of new forests and plantations from the aspect of genetic diversity; 15. Breeding and genetic diversity.

Teaching methods

Lectures, seminar work and field/lab work

Recommended references

1. Šijačić-Nikolić, M., Milovanović, J. (2010): Očuvanje i usmjereno korišćenje šumskih genetičkih resursa
2. Geburek, Thomas; Turok, Josef (eds.) (2004): Conservation and Management of Forest Genetic Resources in Europe; Arbora Publishers, Zvolen. p. 1-669.
3. FAO, FLD, IPGRI (2004): Forest genetic resources conservation and management. Vol. 1: Overview, concepts and some systematic approaches. International Plant Genetic Resources Institute, Rome, Italy.
4. FAO, DFSC, IPGRI (2001): Forest genetic resources conservation and management. Vol. 2: In managed natural forests and protected areas (*in situ*). International Plant Genetic Resources Institute, Rome, Italy.
5. FAO, FLD, IPGRI (2004b). Forest genetic resources conservation and management. Vol. 3: In plantations and genebanks *(ex situ)*. International Plant Genetic Resources

Forms of knowledge testing and evaluation

Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject	
Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.	
Name and surname of the teacher who prepared the data	PhD Milan Mataruga, full prof. PhD Vanja Daničić, assis. prof

University of Banja Luka
Faculty of Forestry
PhD studies

F O R E S T R Y

Subject	**Forests genetics**			
Professor/professors	**Ph.D Vanja Daničić, Assistant Proffesor** **Ph.D Dalibor Ballian, Full Proffesor**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	6	8

Conditionality

No conditionality

Aim

The course is designed to follow the latest developments in forest production based on domestic and foreign experiences in order to upgrade and gain new knowledge in the field of genetics. The student should acquire a broad knowledge and understanding of the principles in genetics and breeding, while taking into account the sustainable use of genetic resources while respecting biodiversity. The student should acquire the basics for studying the genetic structure, diversity and differentiation of populations or genotypes of forest trees.

Outcome

Ability to apply knowledge, understanding and mastering skills in the field of theoretical and molecular genetics, which are the basis for timely breeding and conservation of forest genetic resources. The student acquires the ability to solve problems in various situations that arise during the work related to this area.

Subject content

1. Introductory lecture 2. Principles and molecular basis of genetic information flow. 3. DNA level of organization 4. Gene expression 5. Molecular markers history of development and types of molecular markers 6. Sampling for analysis 7. Methods of DNA isolation from various organs and tissues. 8. Determination of quality and quantification of DNA isolates 9. Recombinant DNA techniques 10. Basic principles of electrophoresis, PCR - polymerase chain reaction 11. Introduction to Internet sources and databases on markers and nucleotide sequences. 12. Selection of qualitative and quantitative properties using markers. 13. Application of molecular markers in modern forestry

Teaching methods

Lectures, seminar work and online classes.

Recommended references

1. Hoelzel A.R: (editor) (1998):Molecular Genetic Analysis of Populations, A Practical Approach, Oxford University Press, reprinted 2002, New York
2. Isajev, V., Šijačić-Nikolić, M. (2003): Praktikum iz genetike sa oplemenjivanjem biljaka, Šumarski fakultet Univerziteta u Beogradu i Banjaluci
3. Bošković, J., Isajev, V.(2007): Genetika,Megatrend Univerzitet u Beogradu4. Kajba, D., Ballian, D, (2007): Šumarska genetika. Univerzitet u Zagrebu i Sarajevu.
5. Erikson, G., Ekberg, I. (2001) : An introduction of forest genetics, Genetic center, Upsala, Sweden
6. Klug, W.S., Cummings, M.R. (2003) : Concepts of Genetics, Seveth edition, Prentice Hall, New Jersey
7. White, T., Adams, W., Neale, D, (2007): Forest Genetics. CABI Publishing

Forms of knowledge testing and evaluation

Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject

Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.	
Name and surname of the teacher who prepared the data	**Ph.D Vanja Daničić, Ass. Prof** **Ph.D Dalibor Ballian, Full Prof**

	University of Banja Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**	

Subject	**Ecophysiology of forest reproductive material**			
Professor/professors	**PhD Milan Mataruga, full professor** **PhD Branislav Cvjetkovic, assistant professor**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	6	8

Conditionality

No conditionality

Aim

For the successful establishment of new forests, it is necessary to provide adequate quality of seeds and planting material. Degraded habitats where seedlings are planted and present or predicted climate changes require the acquisition of knowledge about the ecophysiology of forest reproductive material (seeds or seedlings). The student should become familiar with basic and specific physiological reactions in seeds, as well as generatively and vegetatively produced planting material and the reaction of seedlings in more or less unfavorable conditions.

Outcome

By observing the ecophysiological characteristics during the seeds fomation, as well as the growth and development of seedlings, student can adequately explain the phenomena and reactions thereof. Based on this, the student acquires knowledge about the methods and time of seed collection, its storage and further use. By getting to know the physiological processes and parameters in the juvenile growth phase of woody plants, the student can more easily understand and explain the need to use different types of hormonal preparations, fertilizers, pesticides, as well as other new technologies in the production of quality planting material. "Physiological" quality planting material ensures success in establishing forests in different ecological conditions.

Subject content

1. Introduction to the concept of ecophysiology of forest reproductive material; 2. Physiology of seed formation; 3. Physiology of seed germination; 4. Ecophysiological basis of seed dormancy; 5. Physiological activities during seed storage; 6. Ecology of seed dispersal; 7. Ecophysiology of seed germination; 8. Mineral nutrition and water regime in the production of planting material; 9. Physiology of stress; 10. Adaptation of seedlings to different environmental conditions; 11. Physiological and morphological concept of seed and planting material production; 12. Production concept for a previously known habitat; 13. Genetic variability of physiological parameters; 14. Reaction of seedlings to growing treatments; 15. Physiological parameters of seed and planting material quality.

Teaching methods

Lectures, exercises and field research

Recommended references

1. Krstić, B., Oljača, R., Stanković, D. (2011): Fiziologija drvenastih biljaka. Univerzitet u Banjoj Luci i Novom Sadu.
2. Oljača, R., Srdić, M., (2005): Fiziologija biljaka – praktikum. Univerzitet u Banjoj Luci.
3. Farmer R., (1997): Seed Ecophysiology of Temperate and Boreal Zone Forest Trees.
4. Grossnickle, S. (2000): Ecophysiology of Norther Spruce species – The performance of planted seedlings.
5. Fenner, M. (1992): Seeds – The Ecology of Regeneration in Plant Communities. CAB International

Scientific papers

Forms of knowledge testing and evaluation

Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject	
Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.	
Name and surname of the teacher who prepared the data	PhD Milan Mataruga, full prof. PhD Branislav Cvjetkovic, assis prof.

University of Banja Luka
Faculty of Forestry
PhD studies

F O R E S T R Y

Subject	**Forest reproductive material and climate changes**			
Professor/professors	**PhD Milan Mataruga, full professor** **PhD Branislav Cvjetković, assistant professor**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	I	6	8

Conditionality

No conditioning

Aim

The goal of the course is to improve knowledge about the potential and possibilities of using and transferring forest reproductive material in the light of climate change. Through this course, the student should study the ways and methods of producing seeds and planting material of the most important species of this region.

Outcome

Knowing the importance of breeding, on the one hand, and preserving genetic resources on the other, the student acquires knowledge about the targeted use of the gene pool of woody species and shrubs through activities on monitoring, collecting, manipulating and using the seeds of forest species. High-quality seeds in the production of planting material provide prerequisites for adequate transfer of the same to the areas intended for afforestation.

Subject content

1. Categories of forest reproductive material. 2. Forest seed objects and plantations (genetic-ecological aspects); 3. Genetic improvement of seed objects 4. Regions of provenance (seed zones); 5. Climate change - current and scenarios; 6. International experiences in the transfer of forest reproductive material; 7. Current guidelines and recommendations in the transfer of forest reproductive material; 8. Sorting, storage and transport of forest reproductive material; 9. Organizational structure of forest seed manipulation; 10. Scientific basis in the transfer of forest reproductive material

Teaching methods

Lectures, seminar work and field teaching

Препоручена литература

1. Konnert, M., Fady, B., Gömöry, D., A'Hara, S., Wolter, F., Ducci, F., Koskela, J., Bozzano, M., Maaten, T. and Kowalczyk, J. 2015. Use and transfer of forest reproductive material in Europe in the context of climate change. European Forest Genetic Resources Programme (EUFORGEN), Bioversity International, Rome, Italy. xvi and 75 p
2. Матаруга, М., Исајев, В., Лазарев, В., Балотић, П., Даничић, В. (2005): Регистар шумских сјеменских објеката РС – основа унапређења сјеменске производње. Бања Лука
3. Copeland L., McDonald, M (2001) Principles of Seed Science and Technology – Fourth Edition.Kluwer Academic Publishers
4. Радови (оригинални научни, прегледни, стручни и остала литература)

Forms of knowledge testing and evaluation

Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject

Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.

Name and surname of the teacher who prepared the data	PhD Milan Mataruga, full prof. PhD Branislav Cvjetković, assis. prof

	University of Banja Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**	

Subject	**Forest plantations**			
Professor/professors	**PhD Branislav Cvjetković, assistant professor** **PhD Saša Orlović, full professor**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1/2	*It will be assigned later*	8

Conditionality

None.

Aim

The aim of the course is to acquaint students with specific aspects of plantation establishment and plantation cultivation of forest species for different needs.

Outcome

Through the course, students get acquainted with all aspects of work in plantation forestry. Students get acquainted with plantations and their different purposes, the choice of starting material, the selection and preparation of habitats for the establishment of plantations as well as works on plantation silviculture. Getting acquainted with a wide range of plantations of different types and purposes following modern world trends in intensive wood production for different purposes is one of the learning outcomes of the subject.

Subject content

1. Overview of the condition and importance of forest plantations in the world and in our country; 2. Habitats suitable for plantation establishment; 3. Defining the purpose of plantations 4. Preparing the terrain for plantations establishmnt; 5. Selection of taxa and planting material for plantations; 6. Methods and techniques of plantation establishment; 7. Scheme and density of planting plants; 8. Time of establishment; 9. Control of competitive vegetation; 10. Silviculuture 11. Thinnings.

Teaching methods

Lectureres, seminars

Recommended references

Evans, J (2009). Planted forests. Uses, impact and sustainability. FAO
West, PW (2014) Growing plantation forests. Springer
Scientifica andother papers related to plantation forestry

Forms of knowledge testing and evaluation

Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject

Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.

Name and surname of the teacher who prepared the data	**PhD Branislav Cvjetković, assis. prof** **PhD Saša Orlović, full professor**

	University of Banja Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**	

Subject	**Agroforestry**			
Professor/professors	**Ph.D Miljan Cvjetković, associate professor** **Ph.D Branislav Cvjetković, assistant professor**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1/2	*It will be assigned later*	8

Conditionality

No.

Aim

The aim of the course is to acquaint students with agroforestry; all aspects of combining forest and agricultural species in the same habitat.

Outcome

Students are introduced to the possibilities of combining different agricultural and forest species in the same habitat, with the maximum use of resources in the aboveground and the pedosphere. Knowledge is acquired about a wide range of possibilities of combining species, traditional and modern agroforestry, possibilities of using the potential of several different species in one habitat in economic, ecological and social terms.

Subject content

1. Silvoarable agroforestry; 2. Forest farming; 3. Riperian buffer zones; 4. Improved fallow; 5. Silvipasture

Teaching methods

Lectures, seminar paper

Recommended references

1. Jannaki, RR, Alavalapati, D., Mercer E. (2004). Valuing agroforestry systems. Methods and application. Advances in agroforestry, Kluwer academice publishers
2. Den Herder et al. (2015) Current extent and trends of agroforestry in the EU27. Report Project AGFORWARD
3. Batish DR, Kholi, RK, Jose, S, Singh, HP (2008). Ecological base of agroforestry. CRC Press Taylor & Francis Group
Scientific and other papers relevant for the agroforestry.

Forms of knowledge testing and evaluation

Activites during studies	10	Test 1 Test 2	20 20	The final exam	50

Special indication for the subject

Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.

Name and surname of the teacher who prepared the data	Ph.D Miljan Cvjetković, assoc. prof Ph.D Branislav Cvjetković, assist. prof

	University of Banja Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**			
Subject	**Planted forests**			
Professor/professors	**PhD Branislav Cvjetković, assis. professor** **PhD Milan Mataruga, full professor**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1/2	*It will be assigned later*	8

Conditionality

None

Aim

The aim of the course is to acquaint students with the achievements on the issue of establishing new forests for different purposes in different habitat conditions.

Outcome

Through knowledge and analysis of habitat conditions, students gain knowledge about the choice of planting material, tree species, defining the purpose, and the establishment of new forests and plantations. In addition to establishing forests in the function of wood (timber and lumber) production, students acquire knowledge in afforestation/reforestation of specific habitat conditions (degraded habitats), intensive plantations (plantations for biomass production), phytoremediation, etc.

Subject content

1. Overview of the condition and importance of planted forests in the world and in our country; 2. Habitats suitable for the establishment of new forests; 3. Technique of work in the preparation of the terrain for afforestation/reforestation; 4. Selection of species for afforestation; 5. Manner of establishing forests (sowing or planting); 6. Reclamation of degraded habitats; 7. Planting density; 8. Time of sowing or planting; 9. Control of competitive vegetation; 10. Nursing measures (hoeing, fertilizing, cleaning, pruning of branches, etc.); 11. Thinning in forest crops; 12. Types of planting material for the establishment of new forests; 13. Phytoremediation; 14. Special purpose plantations; 15. Bioenergy plantations.

Teaching methods

Lecturers, seminars

Recommended references

1. Stilinović, S., (1991). Pošumljavanje, Univerzitet u Beogradu.
2. Đorović M.,Isajev V., Kadović R., (2003): Sistemi antieroziong pošumljavanja i zatravljivanja. Šumarski fakultet. Banja Luka.Siyag, P.R. (1998): The Afforestation Manual : Technology and Management. Vedams eBooks (P) Ltd. New Delhi, India.
3. Stanturf, J. A., Madsen P. (2004): Restoration Of Boreal And Temperate Forests. CRC Pr I Llc.
4. Nambiar, S.; Ferguson, I. (2005): New Forests Wood Production and Environmental Services. CSIRO PUBLISHING. 256 pages
5. Mansourion S., Vallauri, D., Dudly, N., (2005): Forest Restoration in Landscapes – Beyond Planting Trees. Springer.
6. Shepherd, K., (1986): Plantation silviculture. Forestry Sciences.
7. Savill, P., Evans, J., Auclair, D., Falck, J. (1997): Plantation Silviculture in Europe. Oxford-New York-Tokyo
8. Scinetific papars and other refereces related to afforestation/reforestation

Form of knowledge assessment and grading

Exam, seminar

Forms of knowledge testing and evaluation

Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		
Special indication for the subject					
Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.					
Name and surname of the teacher who prepared the data				PhD Branislav Cvjetković, assis. prof PhD Milan Mataruga, full prof.	

University of Banja Luka
Faculty of Forestry
PhD studies

F O R E S T R Y

Subject	**Growth dynamics of trees and forest stands**			
Professor/professors	Prof. Vojislav Dukić, Ph. D. and Prof. Branko Stajić, Ph. D.			
Subject code	**Status**	**Subject code**	**Status**	**Subject code**
It will be assigned later	Elective	*It will be assigned later*	Elective	*It will be assigned later*

Conditionality

No conditionality

Aim

Acquiring in-depth and additional knowledge about the laws of trees and forest stand growth. The focus is on understanding or quantitative and qualitative study of ecological and anthropogenic impact on forest growth, their stability and level of production and acquiring the necessary knowledge to understand and predict how forest grow and respond to anthropogenic impact and natural disturbances.

Outcome

Ability to analyze growth dynamics of trees and forest stands and create optimal solutions in order to achieve the optimal level of forest ecosystems production and stability.

Subject content

Introduction, Planning experiments for research of forests growth and yield, Description and analysis of simple structure of stands, Description and analysis of spatial structure of stands, Quantification of stand development, Characteristics of growth by tree species in even-aged and uneven-aged stands, Characteristics of growth by species in natural and planted forests, Influence of mixture on tree and stands growth, Optimal stand condition and potential production, Study of changes in stand structure, including stand behavior during and after growth disturbances, Structure and dynamics of virgin forests.

Teaching methods

Mentoring work with students and term papers.

Recommended references

1. Maunaga, Z., Dukić, V. (2019): Prirast šuma, Univerzitzet u Banja Luci – Šumarski Fakultet, Banja Luka.
2. Pretzsch, H. (2009): Forest Dynamics, Growth and Yield. Springer-Verlag. Berlin Heidelberg.
3. Oliver, D. Ch., Larson, C. B. (1996): Forest stand dynamics, John Wiley & Sons, Inc. New York, Chichester, Brisbane, Toronto, Singapore.

Forms of knowledge testing and evaluation

Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject

Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.

Name and surname of the teacher who prepared the data	PhD Vanja Daničić , assis. prof PhD Jelena Aleksić, assoc. prof

University of Banja Luka
Faculty of Forestry
PhD studies

F O R E S T R Y

Subject	**Forest inventory**			
Professor/professors	**Prof. Vojislav Dukić, Ph. D.**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	6	8

Conditionality

No conditionality

Aim

Teaching in the subject of forest inventory gives to doctoral students the necessary knowledge of the theory and application of dendrometric methods in scientific research and practical work.
The forest inventory provides the necessary information for silviculture, forest protection, forest harvesting, organization and economics in forestry and especially for forest management planning.

Outcome

Students should master theoretical and practically knowledge about different methods of forest inventory. In addition to knowledge about forest inventory methods, knowledge is also gained about the inventory of other forest resources.

Subject content

Introduction to modern methods of forest inventory, Representative method in forest inventory-sample method, Methods of stand inventory based on total or partial survey, Relascopy method in forest inventory, Sample planning in forest inventory, Methods for estimating taxonomic elements of stands and forests. Methods for estimating biomass and carbon stocks of stands and forests, Methods for estimating the quality, vitality and assortment structure of stands, Methods of national forest inventories, Remote sensing methods, Application of LIDAR technology in forest inventory.

Teaching methods

Mentoring work with students and term papers.

Recommended references

- Kangas, A., Maltamo, M. (2006): Forest Inventory (Methodology and Applications), Springer, Netherlands.
- Vidal, C., Alberdi, I., Hernández, L., Redmond, J. J. (2016): National forest inventories. Springer. 845 p.
- Peterson, B., Dubayah, R., Hyde, P., Hofton, M., Blair, J. B., Fites-Kaufman, J. (2007): Use of LIDAR for forest inventory and forest management application. Proceedings of the seventh annual forest inventory and analysis symposium; October 3-6, 2005; Portland: 193-202. (Vol. 77).

Forms of knowledge testing and evaluation

Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject

Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.

Name and surname of the teacher who prepared the data	**PhD Vojislav Dukić, assoc. prof.**

University of Banja Luka
Faculty of Forestry
PhD studies

F O R E S T R Y

Subject	**Sustainable forest management**			
Professor/professors	PhD Zoran Maunaga, Full prof. and PhD Vojislav Dukić, assoc. prof			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	*1*	6	*8*

Conditionality

No conditionality

Aim

Introduction to the forest as a historical natural creation and economic object, ie. establishing the lasting relationship between human and forest.

Outcome

Ability to actively participate in the adoption of strategic documents in forestry, project task development for top-level research and development of laws and bylaws.

Subject content

Historical development of forest in the world and in our country; Concepts of forests and forest management; Forest management planning, goals and principles, forest functions; Forest management types; Specifics of forests and forest production; Principle of forest sustainability and sustainable management (balance of production and consumption); Management control mechanisms (law, regulations, supervision).

Teaching methods

Mentoring work with students and term papers.

Recommended references

1. Maunaga, Z. (2016): „Šuma u prošlosti“, skripta.
2. Maunaga, Z, Koprivica, M., Dukić, V. (2012): Unapređenje planiranja gazdovanja šumama u svojini Republike Srpske. Završni uzvještaj projekta. Magaprojekt, d.o.o. Banja Luka.
3. Von Gadow, K., Pukkala, T., Tomé, M. (Eds.). (2001): Sustainable forest management (Vol. 1). Springer Science & Business Media.

Forms of knowledge testing and evaluation

Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject

Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.

Name and surname of the teacher who prepared the data	PhD Zoran Maunaga, full prof. and PhD Vojislav Dukić, assoc. prof

University of Banja Luka
Faculty of Forestry
PhD studies

F O R E S T R Y

Subject	**Statistics in Forestry**			
Professor/professors	PhD Zoran Maunaga, Full professor			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	6	8

Conditionality

No conditionality

Aim

Acquiring in-depth and additional knowledge in the field of statistics. Teaching in the subject of Statistic in forestry gives doctoral students the necessary knowledge of the theory and application of statistical methods in scientific research. According to the content, purpose and goal of the study material, is part of the experimental scientific work. Knowledge of statistical methods enables students to properly use statistics in the study of mass phenomena in forestry, or to collect the necessary data, their processing and interpretation. Only a good knowledge of statistical methods and their proper application can lead to objective conclusions in scientific research.

Outcome

Students should master statistical methods about empirical and theoretical distributions, methods of regression and correlation analysis, representative method, testing of statistically hypotheses, analysis of time series and especially planning and analysis of field experiment in forestry.

Subject content

Introduction of statistical methods with application in forestry; Probability of complex events; Random variable and theoretical distribution; Multiple linear and curvilinear regression and correlation; Analysis of time series; Estimation of set parameters with combined samples; Testing statistical hypothesis and inference; Variance and covariance analysis – simple and multiple; Planning and analysis of field experiments in forestry; Application and use of statistical software packages (SPSS and Statistica)

Teaching methods

Mentoring work with students and term papers.

Recommended references

1. Koprivica, M. (2015): Šumarska statistika, Šumarski fakultet, Banja Luka.
2. Hadživuković, S. (1991): Statistički metodi, Poljoprivredni fakultet, Novi Sad.
3. Jayaraman, K. (1999): A Statistical Manual For Forestry Research, FAO regional office for Asia and the Pacific, Bangkok.

Forms of knowledge testing and evaluation

Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject

Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.

Name and surname of the teacher who prepared the data	PhD Zoran Maunaga, full prof.

	University of Banja Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**	

Subject	**Bioindication of forest vitality - dendrochonology**			
Professor/professors	PhD Branko Stajić, Full Professor and PhD Vojislav Dukić, Assoc. prof.			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	*6*	8

Conditionality

No conditionality

Aim

The main goal is to improve and expand knowledge about bioindication of forest vitality and health based on the characteristic of trees and stand growth increment, acquired t previous levels of study, but and innovate knowledge in the field of dendrochronology and relevant sub-disciplines (primarily dendroecology and dendroclimatology). The knowledge gained from monitoring of growth increment is the basis without which optimal frameworks for the use and conservation of forests cannot be determined, which can significantly contribute to their sustainable and climate-oriented management.

Outcome

Students are trained for research work in the extremely current field of analysis and quantification of the impact of various stimulating and especially limiting factors on the growth and increment of forest ecosystems. Through the acquired knowledge, students are able to validly conclude about complex nature of the relationship between growth increment and process off devitalization forest trees and stands, especially in the field of timely detection of devitalization process of forests and their health disturbance, their development of future trends, estimation of possible future revitalization, as well as quantitative and qualitative assessment of forest growth loss.

Subject content

Theoretical classes: Methodological procedures of data collecting, preparation, analysis and processing in the function of defining a sample of trees with “normal” growth flows and the required strength of climate signal; Procedures for synchronization and detrending of growth increment; Objective and timely assessment of the beginning process of devitalization process (before the appearance of visible devitalization symptoms); Detection of the cause of devitalization and assessment of possibilities for revitalization and minimization of possible damages; Practical classes: Includes field work and research and laboratory work.

Teaching methods

Mentoring work with students and term papers.

Forms of knowledge testing and evaluation

Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject

Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.

Name and surname of the teacher who prepared the data	PhD Branko Stajić, Full Prof . PhD Vojislav Dukić, Assoc. Prof.

	University of Banja Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**	

Subject	**Planning of hunting grounds management**			
Professor/professors	**PhD Dragan Gačić, Full Professor**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	*6*	8

Conditionality

BSc and MSc studies finished

Aim

Acquisition of general and expert knowledge in planning and organization of hunting grounds and game populations.

Outcome

Abbility for integral management and sustainable use of hunting potential in deteriorating environmental conditions and various types of hunting grounds.

Subject content

Theoretical part: General characteristics and specifics of natural resource management. Ecological basis of integral management of natural resources. Similarities and differences of planning in forestry, agriculture and hunting (classical and modern settings and solutions). Professional and scientific bases of planning in hunting with the protection of hunting fauna. State of hunting and planning of hunting grounds management in highly developed European countries (eg Austria, Hungary, Czech Republic, Slovenia). Biological-ecological bases of planning the cultivation, protection and sustainable use of hunting fauna. Technical-technological, economic and legal-regulatory bases of planning in hunting. Use of forest and hunting potential in protected areas (special nature reserves and national parks). General and special objectives of hunting management and measures and means for their realization. Types of plans and programs with regard to maturity, object of planning and purpose of the planning document. Arrangement of hunting grounds (spatial and functional, types of hunting facilities and their construction). Monitoring of game populations and their habitats. Planned and extraordinary audits, as w

Teaching methods

Teaching is conducted in the form of audio-visual presentations, consultations, interactive work, research-laboratory work and seminars.

Recommended references

1. Stanković S. i grupa autora (1991): Velika ilustrovana enciklopedija lovstva, knjiga 1 i 2, Građevinska knjiga-Beograd, Dnevnik-Novi Sad.
2. Apollonio M., Andersen R., Putman R. (Eds.) (2010): European ungulates and their management in the 21st century, Cambridge University Press, Cambridge, UK.
3. Putman R., Apollonio M., Andersen R. (Eds.) (2011): Ungulate management in Europe : problems and practices, Cambridge University Press, Cambridge, UK.
4. Gačić D. (Ur.) (2020): Jelenska divljač u Srbiji : savremeni pristup i metodologija za izradu programa reintrodukcije, Univerzitet u Beogradu - Šumarski fakultet, Beograd, Planetaprint, str. 1-336.
5. Hafner M. (2014): Varovanje in urejanje življenjskega okolja divjadi, Lovska zveza Slovenije, Ljubljana.

6. Massei G., Kindberg J., Licoppe A., Gačić D., Šprem N., Kamler J., Baubet E., Hohmann U., Monaco A., Ozoliņš J., Cellina S., Podgórski T., Fonseca C., Markov N., Pokorny B., Rosell C., Náhlik A. (2015): Wild boar populations up, number of hunters down? A review of trends and implications for Europe, Pest Management Science 71 (4): 492-500.
7. Gačić D., Puzović S., Zubić G. (2009): Veliki tetreb (Tetrao urogallus) u Srbiji - osnovne pretnje i mere zaštite, Šumarstvo 1-2, Beograd, str. 155-166.
8. Gačić D., Mladenović S., Simić A., Ostojić M. (2018): Sadašnje stanje divljih papkara u Srbiji sa naglaskom na običnog jelena (Cervus elaphus L.), Zbornik radova 8. naučnog skupa o lovstvu i lovnom turizmu „Lovstvo i održivi razvoj kroz prizmu konflikta ekonomskog, ekološkog i etičkog“, 21. april 2018., Žagubica, str. 81-94.
9. Žarković M., Stojnić V., Jevtić N., Gačić D., Milovanović B., Ćirović P. (2018): Primena GIS tehnologije u cilju unapređenja planiranja gazdovanja lovištima u Srbiji, Zbornik radova 8. naučnog skupa o lovstvu i lovnom turizmu „Lovstvo i održivi razvoj kroz prizmu konflikta ekonomskog, ekološkog i etičkog“, 21. april 2018., Žagubica, str. 222-238.

Forms of knowledge testing and evaluation					
Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject
Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.

Name and surname of the teacher who prepared the data	PhD Vanja Daničić , assis. prof PhD Jelena Aleksić, assoc. prof

	University of Banja Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**	

Subject	**Game ecology**			
Professor/professors	**PhD Dragan Gačić Full Profesor**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	*6*	8

Conditionality

BSc and MSc studies finished

Aim

The goal is to acquire basic knowledge about the importance of game populations and the laws that govern them and their habitats.

Outcome

Training for the execution of tasks arising from complex planning of management of wild game populations in the wild (so-called open hunting grounds) and fenced hunting grounds, or fenced parts of hunting grounds.

Subject content

Theoretical part: The role, importance and protection of game in biocenoses. Basic biotic systems and their functional characteristics. Living conditions and the concept of environmental factors. The influence of ecological factors on the distribution (spatial distribution) and survival of the species. Characteristics and suitability of certain biotopes for certain game species. Structural elements of the population and its dynamics. Basic principles of managing game populations (lowland, mountain, mountain and water ecosystems). Ecological foundations of modern hunting management. Causes of endangerment and protection measures of important game species (red deer, roe deer, wild boar, fallow deer, mouflon, chamois, field partridge, hare, grouse, large animals, birds of prey). Principles of managing game populations in special conditions (fenced hunting grounds, game farms, game farms) and protected areas (national parks, nature reserves). Active protection of rare and strictly (permanently) protected game species. Forecasting and directing the structure and dynamics of the population of important game species. Planning the degree of use of populations of farmed game species. The use of GIS and ecological modeling in the analysis of the relationship between game populations and the environment.

Teaching methods

Teaching is conducted in the form of audio-visual presentations, consultations, interactive work, research-laboratory work and seminars.

Recommended references

1. Papović R., Šapkarev J. (1990): Animalna ekologija, Naučna knjiga, Beograd.
2. Kolar B. (1999): Ekologija živali in varstvo okolja divjadi, Lovska zveza Slovenije, Ljubljana.
3. Tome D. (2006): Ekologija : organizmi v prostoru in času, Tehniška založba Slovenije, Ljubljana.
4. Đukić N., Maletin S. (1998): Poljoprivredna zoologija sa ekologijom II – Zooekologija, Poljoprivredni fakultet, Novi Sad.
5. Danell K., Bergström R., Duncan P., Pastor J. (2006): Large herbivory ecology, ecosystem dynamics and conservation, Cambridge University Press, Cambridge, UK.

6. Gossow H. (1976): Wildökologie, Sonderauflage für den Deutschen Forstverein e.V. - reprint der originalausgabe.
7. Gačić D., Danilović M., Gačić J., Stojnić D. (2015): Effects of roads and railways on large game in the Belgrade area: A case-study of nine municipalities, Fresenius Environmental Bulletin 24 (4): 1310-1317.
8. Gačić D., Danilović M., Đorđev Lj. (2013): Lined irrigation canals in field hunting grounds of Vojvodina and their influence on wildlife. *Forest review* 44: 11-15.

Gačić, D.P. (2016): Monitoring populacija divljači i njihovih staništa u Srbiji, Zlatorogov zbornik, 4 (4): 46-56.

Forms of knowledge testing and evaluation					
Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject
Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.

Name and surname of the teacher who prepared the data	**PhD Dragan Gačić Full Profesor**

	University of Banja Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**	

Subject	**Game managament**			
Professor/professors	**PhD Dragan Gačić, Full Professor**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	*6*	8

Conditionality

BSc and MSc finished

Aim

Acquiring general and professional knowledge in breeding and protection of game.

Outcome

Gaining scientific knowledge for the implementation, control and organization of work in the field of production and breeding of game using the most modern knowledge and technologies.

Subject content

Theoretical part: The need, importance and goals of production and breeding of game in modern hunting management. Basics of hunting zoology. Professional and scientific basis of modern game production and farming. Biological-ecological characteristics of the most important game species and their influence on the choice of production and breeding methods. Genetic basics (selection methods and their application in game breeding). Basics of game nutrition. Production and storage of game feed. Cultivation and protection of game in the wild (so-called open hunting grounds). Breeding and protection of game in fenced areas (fenced hunting grounds and fenced parts of hunting grounds). Indoor game production (breeding farms, game farms and game parks). The problem of growing game in special purpose forests (protected areas of nature). Catching and transporting live game as an integral part of modern game production and breeding technology. Economic aspects of game production and breeding.

Teaching methods

Teaching is conducted in the form of audio-visual presentations, consultations, interactive work, research-laboratory work and seminars.

Recommended references

1. Stanković S. i grupa autora (1991): Velika ilustrovana enciklopedija lovstva, knjiga 1 i 2, Građevinska knjiga-Beograd, Dnevnik-Novi Sad.
2. Leskovic B., Pičulin I. (Eds.) (2012): Divjad in lovstvo, Lovska zveza Slovenije, Ljubljana.
3. Gačić D. (Ur.) (2020): Jelenska divljač u Srbiji : savremeni pristup i metodologija za izradu programa reintrodukcije, Univerzitet u Beogradu - Šumarski fakultet, Beograd, Planetaprint, str. 1-336.
4. Ristić Z. (2011): Gajenje i zaštita divljači, PMF, Novi Sad.
5. Novaković V. (1996): Divlji papkari - tehnologija gajenja i korišćenja, JP „Srbijašume“, Beograd.
6. Đukić N. i grupa autora (2018): Poljoprivredna zoologija, Poljoprivredni fakultet, Novi Sad.
7. Gačić D. (2006): Rast parogova srndaća u poljskim lovištima Vojvodine - uticaj starosti na vrednost trofeja, Glasnik Šumarskog fakulteta 94, Beograd, 109-122.
8. Gačić D., Prentović R., Pilipović V., Ostojić M. (2015): Hunting tourism and safety

aspects of hunting fauna use in Serbia, Bulletin of the Faculty of Forestry, Special issue on the occasion of the international symposium “Forest engineering of Southeast Europe - state and challenges“, Belgrade, 45-54.
9. Gačić D., Stamenković S., Vilotić D., Borota D., Ostojić M. (2020): Program naseljavanja jelenske divljači (Cervus elaphus L.) u lovištu „Vršačke planine“, Univerzitet u Beogradu, Šumarski fakultet, Beograd, str. 1-81.

Forms of knowledge testing and evaluation					
Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject
Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.

Name and surname of the teacher who prepared the data	**PhD Dragan Gačić, Full Prof.**

University of Banja Luka
Faculty of Forestry
PhD studies

F O R E S T R Y

Subject	**Dynamics of forest stands**			
Professor/professors	**PhD Zoran Govedar, Full Professor, ASARS**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	6	8

Conditionality

No conditioning

Aim

The goal of the subject is for doctoral students to learn about the interaction relationships between forest stands and the limiting factors of their development, the architecture and structure of the development phases in the forest, and quantitative indicators of the dynamics of the development of forest stands.

Outcome

The learning outcome is the provision of students' knowledge and ability to determine the interaction of ecological factors in the development of stands, defining the threatening factors of forest regeneration, monitoring the dynamics of changes in the elements of stands and determining the structural forms of stands for the purposes of quantifying the elements of the dynamics of crop development. The student is trained to plan and implement breeding measures that ensure the achievement of forest management goals and forest functions, based on knowledge of the dynamics of forest development.

Subject content

Introduction, Forest plant interactions and growth and development constraints; Architecture and structure of stands; Disturbances in forest development and regeneration; Overview and characteristics of the development stages of natural forests (commercial forests and rainforests); Temporal and spatial dynamics of development phases; Development of groups of trees; Interaction between trees and between groups of trees; Restoration and development of forests in specific microhabitats; Quantification of the dynamics of stand development; Characteristics of old forests and forests of large areas.

Teaching methods

Lectures and exercises, consultations, literature study, writing scientific papers, passed pre-examination requirements

Recommended references

1. Oliver, Ch., D., Larson, B.C. (1996): Forest stand dynamics. Update edition, John Wiley & Sons, Inc.
2. Shugart, H. H. (2003): A Theory of Forest Dynamics: The Ecological Implications of Forest Succession Models. Blackburn Press

Burschel, P., Huss, J. (1987): Grundriß des Waldbaus – Ein leitfaden für stadium und praxis. Verlag Paul Parey, Hamburg und Berlin

Forms of knowledge testing and evaluation

Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject	
Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.	
Name and surname of the teacher who prepared the data	**PhD Zoran Govedar, Full Professor, ASARS**

	University of Banja Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**	

Subject	**Silviculture of basic forest types**			
Professor/professors	**PhD Zoran Govedar, Full Professor, ASARS**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	6	8

Conditionality

No conditioning

Aim

The aim of the course is to familiarize with the application of certain methods of natural restoration and forest care of the most important and most represented types of forests and to train students for scientific research work with the aim of modernizing the methods of natural restoration according to the types of pure and mixed forests.

Outcome

Based on the acquired knowledge, the student can develop forestry on a typological basis on scientific and modern bases. The student acquired knowledge that in relation to the basic theoretical and practical knowledge in the field of forestry, especially in the part related to the functional definition, bioecological characteristics of forest ecosystems as a basis for planning, the integrity of plans (especially cultivation and protection components) provides multiple aspects of durability and sustainable development of the most important (main) forest types.

Subject content

Introduction, goals, ways and tasks of cultivating basic types of forests; Ecological, structural and production characteristics of basic types of forests - the starting point for forestry and an integral silvicultural plan; The internal structure of forest ecosystems - an element of integral planning; Simulating the development of the forest fund and cultivation works in accordance with the found state of the forests and management goals; Factors for choosing the method of natural forest regeneration (cultivation factors, technical - technological aspects, secondary factors), assessment of success; Planning of breeding measures in the function of remediation of the drying state of forests; Silviculture of basic types of pure forests; Silviculture of basic types of mixed forests; Modern forest management planning (content, modern solutions and research tasks); Evaluation of the success of natural forest regeneration; Criteria for choosing the type and method of thinning as a stand care measure;

Teaching methods

Lectures and exercises, consultations, literature study, writing scientific papers, passed pre-examination requirements

Recommended references

1. Stojanović, Lj, Krstić, M. (2000) Gajenje šuma III, Udžbenik, Finegraf, Beograd.
2. Dakov, M., Vlasev, V. (1979): Obšo lesovodstvo. Zemizdat, Sofija.
3. Mlinšek, D. (1968): Slobodna tehnika gejenja šuma na osnovu nege. Dokumentacija za tehniku i tehnologiju u šumarstvu, br. 63, Beograd.
4. Šafar, J. (1963) Uzgajanje šuma. Zagreb.

<table>
<tr><td colspan="6">5. Vyskot, M. a kolektiv (1978): Pesteni lesu, Praha</td></tr>
<tr><td colspan="6">Forms of knowledge testing and evaluation</td></tr>
<tr><td rowspan="2">Activites during studies</td><td rowspan="2">10</td><td>Test 1</td><td>20</td><td rowspan="2">The final exam</td><td rowspan="2">50</td></tr>
<tr><td>Test 2</td><td>20</td></tr>
<tr><td colspan="6">Special indication for the subject</td></tr>
<tr><td colspan="6">Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.</td></tr>
<tr><td colspan="4">Name and surname of the teacher who prepared the data</td><td colspan="2">PhD Zoran Govedar, Full Professor, ASARS</td></tr>
</table>

University of Banja Luka
Faculty of Forestry
PhD studies

F O R E S T R Y

Subject	**Forest management systems**			
Professor/professors	**PhD Zoran Govedar, Full Professor, ASARS**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	6	8

Conditionality

No conditioning

Aim

The goal of the course is to familiarize students with theoretical and practical knowledge of forest management systems. During the study of the subject, cultivation, equipment, ecological, economic and use components by forest types are mastered.

Outcome

The student is able to scientifically improve forest management systems depending on the type of forest, its purpose, and to observe the shortcomings and advantages of each of them and to improve them on scientific grounds for the needs of practice. The student is trained to use and improve scientific methods and achievements in forest management.

Subject content

Introduction, issues and importance of the forest management system; Historical development of the forest management system; Forest functions and forest management systems; The relationship between management and forest management systems; Management systems as instruments for achieving goals; Scientific and practical foundations of the forest management system; Cultivation component of forest management system; Group management; The system of management with fertile cuttings of a long undergrowth period; The system of managing selective fellings (classical and group - selective system); Spatial arrangement of departments when applying different forest management systems; Noise conversion systems; Management systems based on the principles of forest care; Additive and substitutive methods of reforestation; Elaboration of management system on scientific basis.

Teaching methods

Lectures and exercises, consultations, literature study, writing scientific papers, passed pre-examination requirements

Recommended references

1. Matthews, J. D. (2006): Silvicultural systems. Clarendon press, Oxford
2. Reininger, H. (2000): Das plenterprinzip. Leopold Stocker Verlag, Graz – Stuttgart
3. Diaci, J. (2006): Gojenje gozdov. Učbenik, Biotehniška fakulteta v Ljubljani, Ljubljana
4. Шютц, Ж.Ф. (1999): Лесовьдство. Земиздат, София
5. Drinić, P. (1979): Sistemi gazdovanja šumama (teorijske osnove i praktična primjena). Šumarski fakultet, Sarajevo
6. Milin, Ž. (1988): Grupimično gazdovanje (teorijske osnove osobine i primjena). Posebno izdanje Glasnika Šumarskog fakulteta Univerziteta u Beogradu, Beograd

Forms of knowledge testing and evaluation

	10	Test 1	20	The final exam	50

Activites during studies		Test 2	20		
Special indication for the subject					
Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.					
Name and surname of the teacher who prepared the data				**PhD Zoran Govedar, Full Professor, ASARS**	

	University of Banja Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**			
Subject	**Close to Nature Silviculture**			
Professor/professors	**PhD Zoran Govedar, Full Professor, ASARS**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	6	8

Conditionality

No conditioning

Aim

The goal of the course is to deepen the scientific and practical knowledge of students in the development of methods of cultivating indigenous forests in accordance with natural potentials.

Outcome

The student is able to scientifically improve the methods of growing forests in accordance with the natural processes that take place in naturally preserved forest ecosystems. The student has sufficient knowledge for scientific research and the application of knowledge about the dynamics of natural forests in order to increase the self-regulation of the process in the application of cultivation measures. On the basis of scientific and research work, the student can master the differentiated breeding methods that through the bioregulation of the process can achieve optimal production in integration with the ecological and social functions of forests. The student is trained to use and improve scientific methods and achievements in forest management.

Subject content

Introduction, issues and importance of close to nature forest cultivation; Concept and development of the idea of close to nature forestry; Reasons and needs for application; State of forests in Republic of Srpska - cultivation aspect; Management characteristics of functional forest types depending on habitat and management goals; the laws of growth and renewal in close-to-nature forest cultivation; Principles and elements of close to nature forest cultivation (forest composition, cultivation forms, cultivation methods); Description and assessment of critical loads (Dauerwald), protection of wood stock (Voratspflege); Principles of small-scale farming; Production and alternative possibilities of forestry; Transformation of the cultivation form of forests; Transformation of the structural form of forests; Structure and development of natural forests; Implementation of close to nature forestry;

Teaching methods

Lectures and exercises, consultations, literature study, writing scientific papers, passed pre-examination requirements

Recommended references

1. Korpeľ, Š., Saniga, M (1995): Prírode blízke pestovanie lesa, ÚVVP Zvolen
2. Schütz, J.Ph. (1999): Close to nature silviculture – is this concept compatible with species diversity? Swiss Federal Institute of Technology, ETH Zurich, CH 8092, Switzerland
3. Hladík, M., Korpeľ, Š., Lukáč, T., Tesař, V. (1993): Hospodárenie v lesoch horských oblastí. VŠZ LF Praha, Matice lesanícka písek, Praha

<table>
<tr><td colspan="6">4. Korpeľ, Š., Saniga, M. (1993): Výberný hospodársky spôsob. VŠZ Praha, Matice lesnícka písek, Praha</td></tr>
<tr><td colspan="6">Forms of knowledge testing and evaluation</td></tr>
<tr><td rowspan="2">Activites during studies</td><td rowspan="2">10</td><td>Test 1</td><td>20</td><td rowspan="2">The final exam</td><td rowspan="2">50</td></tr>
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<tr><td colspan="3">Name and surname of the teacher who prepared the data</td><td colspan="3">PhD Zoran Govedar, Full Professor, ASARS</td></tr>
</table>

	University of Banja Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**			
Subject	**Soil and water degradation**			
Professor/professors	**PhD Marijana Kapović Solomun, Associate professor and PhD Ratko Ristić, Full Professor**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	6	8

Conditionality

No conditionality

Aim

Acquiring knowledge about the basic types of land and water degradation, as well as the basic factors that cause degradation.

Outcome

Students qualification and acquisition of skills for:
• understanding the positive and negative impacts of anthropogenic factors on natural resources, especially land and water
• understanding the mutual influence of soil quality and health on water resources

Subject content

• Global trends and land degradation; The most important factors of soil and water degradation
• Basic factors of soil erosion by water and wind
• Fires as a degradation factor
• Other factors of land degradation
• Analysis of basic natural characteristics of torrent basins.
• Socio-economic factors of erosion processes
• Negative and positive effects of demographic development on land and water resources
• Risks of living in endangered and potentially endangered areas and opportunities for sustainable management of land and water resources
• International conventions and agreements;
• Neutrality of soil degradation.

Teaching methods

Practical teaching
Use of audio-visual methods for processing content related to the concept, causes and types of degradation processes.
Preparation of a seminar paper in the field of land and water degradation.

Recommended references

1. Kostadinov, S. (1996): Bujični tokovi i erozija, Šumarski fakultet Univerziteta u Beogradu, Beograd.
2. Zlatic, M. (2002): Socio-Economic Aspects of Degradation and Soil Management for Sustainability in Mountainous Regions; Key note paper: International Year of Mountains Conference: “Natural and Socio-Economic Effects of Erosion Control in Mountainous Regons, Proceedings, pp 497-516, Belgrade/Vrujci Spa.
3. Ristić, R. **Kapović Solomun, M**. Malušević I. Ždrale, S. Radić, B. Polovina, S. Milćanović, S. 2021. Healthy soils - Healthy people, Reality of Balkan region, Chapter in book: The Soil-Human Health Nexus, edited by distinguished professor

<table>
<tr><td colspan="6">Rattan Lal, Taylor and Francis group, New York, USA.
DOI: 10.1201/9780367822736
4. J.L. Chotte, E. Aynekulu, A. Cowie, E. Campbell, P. Vlek, R. Lal, M. Kapović Solomun, G. von Maltitz, G. Kust, N. Barger, R. Vargas and S. Gastrow. 2019. Realising the Carbon Benefits of Sustainable Land Management Practices: Guidelines for Estimation of Soil Organic Carbon in the Context of Land Degradation Neutrality Planning and Monitoring. A report of the Science-Policy Interface. United Nations Convention to Combat Desertification (UNCCD), Bonn, Germany.</td></tr>
<tr><td colspan="6">Forms of knowledge testing and evaluation</td></tr>
<tr><td rowspan="2">Activites during studies</td><td rowspan="2">10</td><td>Test 1</td><td>20</td><td rowspan="2">The final exam</td><td rowspan="2">50</td></tr>
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<tr><td colspan="3">Name and surname of the teacher who prepared the data</td><td colspan="3">PhD Marijana Kapović Solomun, Assoc. prof
PhD Ratko Ristić, Full Prof.</td></tr>
</table>

	University of Banja Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**			
Subject	**Sustainable land management**			
Professor/professors	**PhD Marijana Kapović Solomun, Associate professor and PhD Ratko Ristić, Full Professor**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1/2	*It will be assigned later*	8

Conditionality

No conditionality

Aim

Introducing students to methods and ways of studying sustainable land management, with reference to problems, approaches and techniques.

Outcome

The ability of students to choose adequate ways of sustainable land management in the specific conditions of the research area.

Subject content

- Levels of interventions and activities in the multiple approach of participatory groups in sustainable land management;
- Management of natural resources in the local community;
- International legal and institutional frameworks for land;
- UNCCD Convention;
- The role of the political and legal framework in SLM;
- Modern techniques and approaches to sustainable land management (WOCAT methodology);
- Management procedures for sustainable land use;
- The role of education in sustainable land use;

Teaching methods

Lectures, auditory exercises, consultations.

Recommended references

1. Kapović Solomun, M. 2019.Afforestation of bare land in karst areas". International Sustainable Land Management Technique accepted and published in World database WOCAT (World Overview of Conservation Approaches and Technologies) entitled: Afforestation of bare land in Bosnia and Herzegovinahttps://qcat.wocat.net/en/wocat/technologies/view/technologies_4367/
2. Kapović Solomun, M., Barger, N., Keesstra, S., Cerda, A., Marković, M. 2018. Assessing land condition as a first step to achieving Land Degradation Neutrality: A case study of the Republic of Srpska, Environmental Science and Policy 90 (2018), 19-276-257-1
3. Editor: Zlatic, M. (2010): Global Change - Challenges for Soil Management, Advances in Geoecology, Volume 41, Catena Verlag, Reiskirchen.
4. Editors: Zlatić, M. and Kostadinov, S. (2014): „Challenges: Sustainable Land Management – Climate Change", ADVANCES IN GEOECOLOGY 43, A Cooperating Series of the International Union of Soil Science (IUSS), ISBN 978-3-923381-61-6, US-ISBN 1-59326-265-5, CATENA VERLAG GMBH, Reiskirchen.

5. **Kapović Solomun, M**., Ferreira, C., Barger, N., Tošić, R., Eremija, S. 2020. Understanding the role of policy framework on land degradation in stakeholders perception from a post conflict perspective of Bosnia and Herzegovina, Land Degradation and Development, pp. 1-10, https://doi.org/10.1002/ldr.3744

Forms of knowledge testing and evaluation

Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject

Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.

Name and surname of the teacher who prepared the data	**PhD Marijana Kapović Solomun, Assoc. prof** **PhD Ratko Ristić, Full Prof.**

	University of Banja Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**	

Subject	**Prevention and protection from torrential floods**			
Professor/professors	**PhD Ratko Ristić, Full Professor and PhD Marijana Kapović Solomun Associate Professor**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	6	8

Conditionality

No conditionality.

Aim

Introduction to methods, facilities and technologies for regulation of torrents and torrent basins and protection against torrential floods.

Outcome

Acquired knowledge about methods, facilities and technologies for regulating torrents and flood protection

Subject content

Theoretical classes

Principles for regulation of torrents and torrents. Systems for regulation of torrent flows and torrent basins. Biological, biotechnical and technical works. Methods and facilities for arranging torrent beds. Longitudinal and transverse objects. Static and hydraulic calculations for facilities for regulating torrents. Rehabilitation of ravines and landslide processes. Flood protection. Ecological bases for regulation of torrents.

Practical teaching

During the exercises and professional practice, students make a study in the form of a project for arranging the torrent with all the necessary calculations and drawings. Within the subject, field classes are held, according to the planned program.

Teaching methods

Lectures, exercises, seminar papers, fieldwork

Recommended references

1. Kostadinov, S. (2008): Bujični tokovi i erozija, III deo: Uređenje bujičnih tokova, Šumarski fakultet, Beograd
2. Đeković, V. (1997): Projektovanje u bujičarstvu. Šumarski fakultet, Beograd
3. Koboltschnig, G. et al. (2012): INTERPRAEVENT (International Research Society)-2012. Proceedings, Vol. 1&Vol. 2 (ISBN: 978-3-901164-19-4), Grenoble, France. Pg. 1-1126.

Forms of knowledge testing and evaluation

Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject

Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.

Name and surname of the teacher who prepared the data	**PhD Ratko Ristić, Full Prof.** **PhD Marijana Kapović Solomun Assoc. Prof.**

	University of Banja Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**			
Subject	**Risk zones reonization from natural disasters**			
Professor/professors	**PhD Ratko Ristić, Full Professor and PhD Marijana Kapović Solomun Associate Professor**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	6	8

Conditionality

No any.

Aim

Acquiring knowledge about the regionalization of the zone of potential risk of natural disasters (catastrophes): floods, torrential floods, landslides, landslides, forest fires and droughts.

Outcome

Acquired knowledge for making a map of erosion and erosion areas, determining flood zones in torrents, zoning of landslides, making a map of the risk of forest fires.

Subject content

Theoretical classes:
Erosion and flood risk-global aspect. Vulnerability to erosion and torrential floods - regional and local aspect. The catchment area as a starting element in the threat assessment. Natural risk factors (physical-geographical characteristics of the basin; climatic-meteorological characteristics of the area; pedological and geological characteristics; vegetation cover; development of erosion processes). Making a map of erosion and erosion areas. Determination of flood zones in torrential floods. Landslide risk zone zoning. Anthropogenic risk factors (land use; level of urbanization; layout of settlements, roads and other infrastructure facilities). Determining the risk of forest fires.
Practical teaching:
Preparation of a study that includes risk assessment and zoning of natural disasters: erosion, landslides, landslides, torrential floods, forest fires.

Teaching methods

Practical teaching.
Use of audio-visual methods for processing content related to the concept, causes and types of degradation processes.

Recommended references

1. Morgan, R.P.C. (1990): Soil Erosion and Conservation. Longman, Scientific&Technical, with John Wiley & Sons, New York.
2. Şen Z. (2018): Flood Modeling, Prediction and Mitigation, Springer International Publishing, ISBN 13:978-3-319-52356-9
3. Baldassarre D G. (2013): Floods in a Changing Climate: Inundation Modelling, International Hydrology Series, ISBN 10:1107018757
4. Goyal M R., Harmsen E W (2016): Flood Assessment : Modeling & Parameterization, Innovations in Agricultural & Biological Engineering, ISBN 13:978-1-77188-457-0
5. Boardman, J.; Poesen, J. (2006): Soil Erosion in Europe. John Wiley&Sons, England.
6. Harmon, S.R.; Doe, W.W. (2001): Landscape Erosion and Evolution Modelling. Kluwer Academic/Plenum Publishers, New York.

7. Bryant E. (2005): Natural hazards. Cambridge University Press, New York
8. Patrick L. Abbott (2008): Natural disasters. McGraw-Hill Higher education, sixth edition
9. Ristić, R.; Malošević, D. (2011): Hidrologija bujičnih tokova. Univerzitet u Beogradu Šumarski fakultet.
10. Roni P., Beechie T., (2012): Stream and Watershed Restoration: A Guide to Restoring Riverine Processes and Habitats, Wiley-Blackwell, ISBN: 978-1-405-19956-8

Forms of knowledge testing and evaluation

Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject

Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.

Name and surname of the teacher who prepared the data	**PhD Ratko Ristić, Full Prof** **PhD Marijana Kapović Solomun Assoc. Prof.**

	University of Banja Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**			
Subject	**Ecology of Forest Ecosystems**			
Professor/professors	Dr Jugoslav Brujić, associate prof., Dr Vladimir Stupar, associate prof.			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1/2	*It will be assigned later*	8

Conditionality

Aim

The aim of the subject is to acquaint students with the components of forest ecosystems, their relationships and dynamics.

Outcome

The student will be able to independently understand, analyze, evaluate and quantify the components of forest ecosystems, their relationships and dynamics, which is the basis for planning measures to achieve specific goals in forestry.

Subject content

Structure of forest ecosystems: climatic, edaphic and orographic factors, floristic composition, vegetation layers, functional types. **Functioning of forest ecosystems:** ecological niche, trophic networks, relations of action, coactions and reactions, circulation of matter and energy flow. **Dynamics of forest ecosystems:** origin and historical development, naturalness, successions, climax, stability of forest ecosystems, degradation and anthropogenic pressure on forest ecosystems, distribution of forest ecosystems. Influence of forest management on the condition, typological definition and conservation status of forest ecosystems.

Teaching methods

Lectures, seminar, consultations and methods of interactive teaching.

Recommended references

1. Vukelić, J., Rauš, D. (1998). Šumarska fitocenologija i šumske zajednice u Hrvatskoj. Šumarski fakultet Sveučilišta u Zagrebu.
2. Leuschner C., Ellenberg H. (2017). Ecology of Central European forests: Vegetation ecology of Central Europe, Volume I. Springer International Publishing: 972 pp. doi:10.1007/978-3-319-43042-3
3. Lakušić D., Šinžar-Sekulić J., Rakić T., Sabovljević M. (2015). Osnovi ekologije. Univerzitet u Beogradu, Biološki fakultet, Beograd: 317 pp.
4. Ellison A. M., Bank M. S. et al. (2005). Loss of foundation species: consequences for the structure and dynamics of forested ecosystems. Frontiers in Ecology and the Environment. 3 (9): 479–486.
5. Verhoef, Herman A. (2012). Community Ecology. Oxford Bibliographies.
6. Stevanović B. M., Janković M. M. (2001). Ekologija biljaka sa osnovama fiziološke ekologije biljaka. NNK International, Belgrade: 514 pp.
7. Barudanović S. Et al. (2015). Ekosistemi Bosne i Hercegovine u funkciji održivog razvoja. Univerzitet u Sarajevu, Prirodno-matematički fakultet, Sarajevo: 249 pp.

Form of knowledge assessment and grading

During the semester, each student will write a seminar paper consisting of an ecological analysis of a chosen area, consisting of several different ecosystems. In this paper, the student will apply various methods of ecological analysis of represented ecosystems. All written materials together with the written exam will be the basis for the oral final exam and the final grade.

Seminar: 50 Oral exam: 50

	University of Banja Luka Faculty of Forestry PhD studies F O R E S T R Y			
Subject	**Classification systems of forest ecosystems**			
Professor/professors	Dr Jugoslav Brujić, associate prof., Dr Vladimir Stupar, associate prof.			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1/2	*It will be assigned later*	8

Conditionality

Aim

The aim of the course is to acquaint students with different systems of classification of forest ecosystems and their practical use with emphasis on forestry and nature protection.

Outcome

The student will be able to understand and independently apply different classification systems of forest ecosystems, which is the basis for the management of forest ecosystems and protected areas.

Subject content

Principles of classification of forest ecosystems: physiognomic (by life forms), ecological (by ecofactors), physiognomic-ecological, horological, dynamic-genetic, floristic (Braun-Blanquet), typological (forest-typological classifications of BiH, neighboring and other countries). International Habitat Classifications: EUNIS, PHYSIS, NATURA 2000. National Habitat Classifications in Serbia and Croatia. Combined hierarchical systems (EuroVegSurvey, US NVC). Floristic-vegetation regions (Walter, Horvat et al., Bohn et al., Rivas-Martínez et al.). Code of Phytocoenological Nomenclature. Syntaxonomy of forest vegetation in BiH.

Teaching methods

Lectures, consultations and methods of interactive teaching.

Recommended references

1. Stefanović V. (1986). Fitocenologija. Svjetlost – Zavod za udžbenike i nastavna sredstva, Sarajevo.
2. Vukelić J. (2012). Šumska vegetacija Hrvatske. Šumarski fakultet, Sveučilište u Zagrebu, DZZP, Zagreb: 403 str.
3. Sarić M. R. (Ur.). (1997). Vegetacija Srbije II - Šumske zajednice 1. Srpska akademija nauka i umetnosti, Odeljenje prirodno-matematičkih nauka, Beograd: 474 str.
4. Škorić D. M. (Ur.). (2006). Vegetacija Srbije II - Šumske zajednice 2. Srpska akademija nauka i umetnosti, Odeljenje hemijskih i bioloških nauka, Beograd: 369 str.
5. Milanović Đ., Brujić J., Đug S., Muratović E., Lukić-Bilela L. (2015). Vodič kroz tipove staništa BiH prema Direktivi o staništima EU. Prospect C&S, Brussels: 186 str.
6. Chytrý, M., Tichý, L., Hennekens, S. M., Knollová, I., Janssen, J. A. M., Rodwell, J. S., Peterka, T., Marcenò, C., Landucci, F., Danihelka, J., Hájek, M., Dengler, J., Novák, P., Zukal, D., Jiménez-Alfaro, B., Mucina, L., Abdulhak, S., Aćić, S., Agrillo, E., … Schaminée, J. H. J. (2020). EUNIS Habitat Classification: Expert system, characteristic species combinations and distribution maps of European habitats. Applied Vegetation Science, 23(4), 648–675. https://doi.org/10.1111/avsc.12519
7. Whittaker R. H. (Ed), 1978: Classification of Plant Communities, (Handbook of Vegetation Science), Kluwer Academic Publishers

Form of knowledge assessment and grading

During the semester, each student will prepare a seminar paper with an analysis of an area, consisting of several ecosystems. In this paper, the student will apply all classification schemes to the selected case. All written materials will be the basis for the oral final exam and the final grade.

Seminar: 50 Oral exam: 50

	University of Banja Luka Faculty of Forestry PhD studies F O R E S T R Y			
Subject	**Methods of Data Analysis in Research of Forest Ecosystems**			
Professor/professors	Dr Jugoslav Brujić, associate prof., Dr Vladimir Stupar, associate prof.			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1/2	*It will be assigned later*	8

Conditionality

Aim

The aim of the subject is to acquaint students with modern statistical, numerical, geospatial methods and applications in the study of forest ecosystems.

Outcome

The student will be able to understand and independently use modern methods and applications in the research of forest ecosystems.

Subject content

Data collection methods in forest ecosystem research. Methods of multivariate statistical analysis of ecological data: classification and cluster analysis, ordination. Computer aided multivariate statistical analysis of environmental data in R and Python. Digitization and storage of phytocenological relevés in TURBOVEG. Manipulation of phytocenological relevés in the JUICE software package. Application of GIS and remote sensing in spatial analysis, mapping, monitoring and modeling of forest ecosystems. Spatial databases. Basics of using open source GIS desktop applications. Google Earth Engine platform and application of Python scripts.

Teaching methods

Lectures, practical project, consultations.

Recommended references

1. Mueller-Dombois, D., & Ellenberg, H. (1974). Aims and methods of vegetation ecology. John Wiley & Sons.
2. Karadžić, B. & Marinković, S. 2009. Kvantitativna ekologija. IBISS, Beograd
3. Hennekens, S. M., & Schaminée, J. H. J. (2001). TURBOVEG, a comprehensive data base management system for vegetation data. Journal of Vegetation Science, 12(4), 589–591.
4. Tichý, L. (2002). JUICE, software for vegetation classification. Journal of Vegetation Science, 13(3), 451–453.
5. Borcard, D., Gillet, P., Legendre, P. (2018). Numerical Ecology with R (Use R!), 2nd ed.
6. Kong, Q., Siauw, T., & Bayen, A. (2020). Python Programming and Numerical Methods: A Guide for Engineers and Scientists (1st edition). Academic Press.
7. Steinberg, S. L., & Steinberg, S. J. (2015). GIS Research Methods: Incorporating Spatial Perspectives (1st edition). Esri Press.

Form of knowledge assessment and grading

During the semester, each student will use various statistical, numerical and geospatial methods and applications to perform an analysis of ecosystems in the selected area in the form of a practical project. At the written exam, the student will practically present his knowledge of methods and software applications. The final grade will be formed at the oral exam.

Practical project: 30 Written exam: 20 Oral exam: 50

	University of Banja Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**			
Subject	**Modern principles of planning of primary forest accessibility**			
Professor/professors	**PhD Vladimir Petković, assisstant profesor**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	6	8

Conditionality

No

Aim

Acquiring knowledge and skills by introducing students to scientific achievements in the field of planning of primary forest accessibility using by modern methods and technologies

Outcome

Students should be able to use modern technologies in the planning of primary forest traffic infrastructure through the phases of analysis of actual primary forest accessibility, determination of targeted density of primary forest traffic infrastructure and designing of primary forest traffic infrastructure based on multi-criteria evaluation.

Subject content

1. Quality, quantity and economic analysis of actual primary forest accessibility
2. Methodology of field research and analysis using by modern information technologies (GPS, GIS) for planning primary forest accessibility
3. Multi-criteria evaluation as a decision support in process of planning of primary forest forest accessibility in the focus of determination of targeted density of primary forest traffic infrastructure
4. Multi-criteria evaluation as a decision support in process of defining of suitability of forest area for construction primary forest traffic infrastructure
5. Designing of primary forest traffic infrastructure at general level in the forest areas which are insufficiently accessible and suitable for construction primary forest traffic infrastructure

Teaching methods

Lectures, exercise, consultations, field study

Recommended references

Jeličić V. 1971. Mreže šumskih puteva: planiranje i određivanje gustoće. Beograd, Jugoslovenski poljoprivredno-šumarski centar: 38 p.

Pentek T., Pičman D., Potočnik I., Dvorščak P., Nevečerel H. 2005. Analysis of an existing forest road network. Croatian journal of forest engineering, 26, 1: 39-50

Poršinsky T., Đuka A., Papa I., Bumber Z., Janeš D., Tomašić Ž., Pentek T. 2017. Kriteriji određivanja gustoće primarne šumske prometne infrastrukture – primjeri najčešćih slučajeva. Šumarski list, 11-12: 593-608

Petković V, Potočnik I. 2018. Planning Forest Road Network in Natural Forest Areas: a Case Study in Northern Bosnia and Herzegovina. Croatian Journal of Forest Engineering 39(1):45–56

Rebula E. 1981. Optimal openness of forests. Mehanizacija šumarstva, 3-4, 107-119

Sokolović Dž., Bajrić M. 2013a. Otvaranje šuma. Sarajevo, Univerzitet, Šumarski fakultet: 250 p.

<table>
<tr><td colspan="6">Forms of knowledge testing and evaluation</td></tr>
<tr><td>Activites during studies</td><td>10</td><td>Test 1
Test 2</td><td>20
20</td><td>The final exam</td><td>50</td></tr>
<tr><td colspan="6">Special indication for the subject</td></tr>
<tr><td colspan="6">Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.</td></tr>
<tr><td colspan="4">Name and surname of the teacher who prepared the data</td><td colspan="2">PhD Vladimir Petković , assis. prof</td></tr>
</table>

University of Banja Luka
Faculty of Forestry
PhD studies

F O R E S T R Y

Subject	**Planing forest roads using RoadEng**			
Professor/professors	**PhD Vladimir Petković, assistant professor**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	*6*	8

Conditionality

No conditionality

Aim

Transfer of knowledge and experience in the field of designing of primary forest traffic infrastructure using by RoadEng

Outcome

Training for independent design of primary forest traffic infrastructure using by modern information technologies in the field, transfer collected data into RoadEng and making of project of a route primary forest traffic infrastructure with optimal horizontal and vertical alignments and optimization of earthworks

Subject content

1. Introduction Survey module RoadEng software which is used to enter collected data in the field
2. Methodology of terrain research, actually designing of a route primary forest traffic infrastructure in the field for making the project by RoadEng
3. Setup of horizontal and vertical alignments of the route primary forest infrastructure in the module Location of RoadEng software based on Manual for construction of primary forest traffic infrastructure (2002)
4. Preparing and printing of project of the route primary forest traffic infrastructure

Teaching methods

Lecture, exercise, consultations, field study

Recommended references

1. Lepoglavec K. 2014. Optimizacija primarne i sekundarne šumske prometne infrastructure nagnutih terena: doktorski rad. (Sveučilište u Zagrebu, Šumarski fakultet). Zagreb, self-publish: 266 p.
2. Ljubojević D 2006. Application of RoadEng software in the design of forest roads. Faculty of Forestry, University of Banja Luka.
3. Scientifica papaers concering RoadEng

Forms of knowledge testing and evaluation					
Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject

Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.

Name and surname of the teacher who prepared the data	**PhD Vladimir Petković, assis prof.**

	University of Banja Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**			
Subject	**Modern principles of planning secundary forest accessibility**			
Professor/professors	**PhD Vladimir Petković, assistant professor**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	*6*	8

Conditionality

No conditionality

Aim

Acquiring knowledge and skills by introducing students to scientific achievements in the field of planning of secondary forest traffic infrastructure using by modern methods and technologies

Outcome

Students should be able to use modern technologies in the planning of secondary forest traffic infrastructure through the phases of analysis of actual secondary forest accessibility, determination of targeted secondary forest accessibility and designing of secondary forest traffic infrastructure.

Subject content

1. Quality, quantity and economic analysis of actual secondary forest accessibility
2. Methodology of field research and analysis using by modern information technologies (GPS, GIS) for planning secondary forest traffic infrastructure
3. Determination of targeted secondary forest accessibility from the point of relative secondary forest accessibility
4. Defining of optimal winching distance from the point of environmental, economic and human engineering aspect, as a important criterion on when it depends on relative secondary forest accessibility
5. Designing of primary forest traffic infrastructure at general level in the parts of compartment which are insufficiently accessible

Teaching methods

Lectures, exercise, consultations, field study

Recommended references

Jeličić V., 1983. Otvaranje šuma primarnom i sekundarnom mrežom šumskih puteva, Mehanizacija šumarstva 8 (11-12), Zagreb (1-19).

Ljubojević D., Danilović M., Marčeta D., Petković V., 2018. Winching distance in function of the optimization of skid network. SEEFOR, 9 (2): 97-106

Marčeta D., Petković, V., Košir, B., 2014. Comparison of two skidding methods in beech forests in mountainus conditions. Nova Mehanizacija Šumarstva, 35, 51-62.

Pentek T., Nevečerel H., Poršinsky T., Pičman D., Lepoglave c K ., Potočnik I., 2008. Methodology for development of secondary forest traffic infrastructure cadastre, Croatian Journal of Forest Engineering 29 (1), Zagreb (75-83).

Petković, V., Marčeta, D., Španjić S., Kosović, M. 2015. Određivanje srednje distance privlačenja primjenom GIS-a u nizijsko-brdskim uslovima, Glasnik Šumarskog fakulteta u Banjoj Luci, br. 23, str. 5-14 Petković, V., Potočnik, I., (2019).

Pičman D., Pentek T., Nevečerel H., Papa I., Lepoglavec K., 2011. Possibilities of application

of relative openness in secondary forest opening of slope forests in Croatia, Croatian Journal of Forest Engineering 32(1), (417-427).
Sokolović Dž., Bajrić M. 2013a. Otvaranje šuma. Sarajevo, Univerzitet, Šumarski fakultet: 250 p.
Sokolović Dž., Pičman D., Lojo A., Gurda S., Bajrić M., Koljić H., 2013. Određivanje optimalnog prostornog rasporeda mreže sekundarnih šumskih prometnica. Šumarski list, 1 -2, 7-23

Forms of knowledge testing and evaluation					
Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject
Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.

Name and surname of the teacher who prepared the data	**PhD Vladimir Petković, assis. prof.**

University of Banja Luka
Faculty of Forestry
PhD studies

F O R E S T R Y

Subject	**Multicriteria planning in use of forests**			
Professor/professors	**PhD Dane Marčeta, associate professor**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	*6*	8

Conditionality

None

Aim

Acquiring advanced knowledge in the field of tactical and operational planning in forest use.

Ishod predmeta

Students will be trained for use of modern technologies in forest use planning, based on GIS and methods of multicriteria analysis.

Subject content

1. About tactical and operational planning of operations in forestry
2. Criteria influencing on the selection of forest harvesting systems
3. Classification of forest areas from aspects that are important for planning of technologies
4. Multicriteria decision making methods and their application in forestry
5. Application of GIS in forest use planning
6. Integration of GIS and multicriteria analysis methods into the decision-making system.

Teaching methods

Lectures, exercise, consultations, field study

Recommended references

Tiernan, D., Owende, P. M., Kanali, C. L., Spinelli, R., Lyons, J., & Ward, S. M. (2002). Development of a protocol for ecoefficient wood harvesting on sensitive sites (Ecowood). European Commission Fifth Framework Programme 9FP5) on Quality of Life and Managment of Living Resources.

Marčeta, D., Petković, V., Ljubojević, D., & Potočnik, I. (2020). Harvesting System Suitability as Decision Support in Selection Cutting Forest Management in Northwest Bosnia and Herzegovina. Croatian Journal of Forest Engineering: Journal for Theory and Application of Forestry Engineering, 41(2), 1-17.

Çalişkan, E., Karahalil, U. 2017: Evaluation of Forest Road Network and Determining Timber Extraction System Using GIS: A Case Study in Anbardağ Planning Unit. Šumarski list 141(3-4): 163-171. https://doi.org/10.31298/sl.141.3-4.6

Diaz-Balteiro, L., Romero, C. 2008: Making forestry decisions with multiple criteria: A review and an assessment. Forest ecology and management 255(8-9): 3222-3241. doi:10.1016/j.foreco.2008.01.038

Ezzati, S., Najafi, A., Bettinger, P. 2016: Finding feasible harvest zones in mountainous areas using integrated spatial multi-criteria decision analysis. Land Use Policy 59: 478-491. https://doi.org/10.1016/j.landusepol.2016.09.020

Kangas, J., Kangas, A. 2005: Multiple criteria decision support in forest management—the approach, methods applied, and experiences gained. Forest ecology and management, 207(1-2), 133-143. https://doi.org/10.1007/978-94-015-9906-1_3

Perez-Rodriguez, F., Rojo-Alboreca, A. 2012: Forestry application of the AHP by use of MPC© software. Forest Systems: 21(3) 418-425. https://DOI: 10.5424/fs/2012213-02641

<table>
<tr><td colspan="6">Kühmaier, M., Stampfer, K. 2010: Development of a multi-attribute spatial decision support system in selecting timber harvesting systems. Croatian Journal of Forest Engineering: Journal for Theory and Application of Forestry Engineering 31(2): 75-88.</td></tr>
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<tr><td colspan="4">Name and surname of the teacher who prepared the data</td><td colspan="2">PhD Dane Marčeta, assoc. prof</td></tr>
</table>

	University of Banja Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**	

Subject	**Forest Entomology**			
Professor/professors	**PhD Zoran Stanivuković, Full Prof.**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	*6*	8

Conditionality

None

Aim

Introducing students to the most important groups of insects of the greatest economic importance.

Outcome

Students specialise in working with certain groups of insects. Introducing students to the change in the behaviour of harmful insect species in accordance with the change in environmental conditions in which they occur. Introduction to the latest ways to control harmful insect species.

Subject content

Lectures: Within this course, students are introduced in detail to the systematics, diversity, morphological characteristics, bionomy, population dynamics, and the possibility of controlling those groups of insects that are important for the preparation of the doctoral thesis.
Practical classes: Insect recognition

Teaching methods

Lectures in the classroom through a video-beam presentation, work in the laboratory.

Recommended references

Živojinović, S., 1968: Šumarska entomologija. Zavod za udžbenike i nastavna sredstva, Beograd.
Maceljski, M., 2002: Poljoprivredna entomologija II dopunjeno izdanje. Zrinjski, Čakovec.
Mihajlović, Lj., 2015: Šumarska entomologija. Šumarski fakultet Univerziteta u Beogradu, Beograd.
Kristek, J., Urban, J., 2004: Lesnicka entomologia. Academie ved Česke republikz. Praha.
Schwenke, W., 1972: Die forstschadlinge Europas. Band, I Verlag Paul Parey. Hamburg und Berlin.
Schwenke, W., 1974: Die forstschadlinge Europas. Band, II Verlag Paul Parey. Hamburg und Berlin.
Schwenke, W., 1978: Die forstschadlinge Europas. Band, III Verlag Paul Parey. Hamburg und Berlin.
Schwenke, W., 1982: Die forstschadlinge Europas. Band, IV Verlag Paul Parey. Hamburg und Berlin.

Forms of knowledge testing and evaluation

Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject

Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.

Name and surname of the teacher who prepared the data	**PhD Zoran Stanivuković, Full Prof.**

	University of Banja Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**	

Subject	**Forest Phytopharmacy**			
Professor/professors	**Dr Zoran Stanivuković, Full Professor** **Dr Slobodan Milanović, Associate Professor** **Dr Ivan Milenković, Assistant Professor**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	*6*	8

Conditionality

None

Aim

Introducing students to the production process, manipulation, and ecological basis for applying chemical agents (pesticides) in forestry.

Outcome

Students are entirely able to perceive the problem, develop a protection program, and provide guidelines for applying pesticides for the protection of forest nurseries, crops, and forest ecosystems.

Subject content

Lectures: During the course, students will be introduced to the basic physical and chemical properties of pesticides and non-pesticidal substances, including their granulometric composition, solubility, colour, scent, etc. Forms of pesticide production and their formulations will be shown both in theory and practice. The methods of penetration, movement, deposition of pesticide residues, as well as persistence, phytotoxicity, and changes that pesticides can cause on the roots, stem, and leaves of plants will be studied in detail. In addition, pesticide metabolism in trees and other living organisms will be studied in parallel with the mechanisms of action of individual pesticides. The kinetics of pesticide degradation, the role of microorganisms in the degradation and transformation of pesticides in plants and soil, as well as the damage that can occur when applying chemicals in complex forest ecosystems will be developed theoretically and in the interactive part of the course through discussion with students.

Practical classes: The most important groups of pesticides, their characteristics, and their use against the most important pests in forests will be presented to students. Special attention will be paid to modern understandings of pesticide use in forests, as well as to the ecological basis of pesticide change in these complex ecosystems.

Teaching methods

Lectures in the classroom through a video-beam presentation and work in the laboratory

Recommended references

Janjić, V., Marković, Č., Keča, N. (2010): Šumarska fitofarmacija. Univerzitet u Beogradu-Šumarski fakultet, Beograd.

Šovljanski, R., Lazić, S.(2007): Osnovi fitofarmacije. Poljoprivredni fakultet Univerziteta u Novom Sadu, Novi Sad, pp. 421.

Janjić, V. (2009): Mehanizam delovanja pesticida. Akademija nauka i umetnosti Republike Srpske, Banja Luka, 427.

Janjić, V. (2005): Fitofarmacija. Društvo za zaštitu bilja Srbije, Beograd, pp. 1229.

Forms of knowledge testing and evaluation

Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject	
Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.	
Name and surname of the teacher who prepared the data	**Dr Zoran Stanivuković, Full Prof.** **Dr Slobodan Milanović, Assoc. Prof.** **Dr Ivan Milenković, Assis Prof.**

	University of Banja Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**			
Subject	**Danger Prediction and Early Forest Fire Detection**			
Professor/professors	**PhD Slobodan Milanović, Associate Professor**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	*6*	8

Conditionality

Completed basic academic studies at the Faculty of Forestry and graduate academic studies in Forestry, plant production, protection and ecology

Aim

Introducing forest engineers to warning systems for the danger prediction and early forest fire detection.

Outcome

Students are able to create fire danger forecasting, design early warning system for fire detection, and apply collected data in the fight against forest fires.

Subject content

Lecture: Introducing students to existing fire danger forecasting systems: Canadian Forest Fire Weather Index (FWI), McArthur Forest Fire Danger Index, Nester Index, US National Fire Danger Rating System (NFDRS), etc.; study of factors influencing the occurrence and behaviour of forest fires, which can be divided into anthropogenic and abiotic. It is known that man causes fires in 95-98 percent of cases, so it is necessary to pay attention to the influence of population density, distance from settlements, and communications on fire occurrence. Regarding natural factors, the most important factors are: type (vegetation), condition of combustible material (temperature, relative humidity, precipitation, and wind speed) and orographic factors (slope, altitude, and exposure).

In addition to danger prediction, their early detection also has a great impact on reducing fire damage. All early fire detection systems can be divided into those where the observation is performed from the ground or from the air (space). Surveillance from the ground can be made by trained observers or with the assistance of optical aids such as video cameras, IR cameras, IR spectrometers, LIDAR systems that are more or less automated in fire detection. In the last few years, more attention has been paid to the research on the possibility of applying a network of sensors for early forest fire detection that communicate with each other and with central units using wireless technology (Wireless Sensor Networks - WSN). Regarding early fire detection from the air, the current knowledge about the possibility of using airplanes, drones, and satellite technology will be presented.

Practical classes: Making a fire danger map. Design of observation places for early forest fire detection.

Teaching methods

Lecture, laboratory work, practical research work under the supervision of a teacher.

Recommended references

deGroot, W.J.; Wotton, B.M.; Flannigan, M.D. 2015. Wild land fire danger rating and early warning systems. Pages 207-228 in Hazards and Disasters Series: Wildfire Hazards, Risks and Disasters. (Chapter 11). DouglasPaton, volume editor. Amsterdam, Netherlands.

Noble, I.R., Bary, G.A.V., Gill. A.M.. 1980. McArthur's fire-danger meters expressed as

equations. Aust. J. Ecol. 5. 201-203.
Vasić, M. 1992, Šumski požari, Šumarski fakultet Univerziteta u Beogradu.p. 105. Beograd
Brovkina, O., Stojanović, M., Milanović, S.,Latypov, I., Marković, N., Cienciala, E. 2020. Monitoring of post-fire forest scars in Serbia based on satellite Sentinel-2 data. Geomatics, Natural Hazards and Risk,

Forms of knowledge testing and evaluation					
Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject
Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.

Name and surname of the teacher who prepared the data	**PhD Slobodan Milanović, Associate Professor**

University of Banja Luka
Faculty of Forestry
PhD studies

F O R E S T R Y

Subject	Forest Protection			
Professor/professors	**PhD Zoran Stanivuković, Full Professor**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	*6*	8

Conditionality

Completed basic academic studies at the Faculty of Forestry and graduate academic studies in Forestry, plant production, protection, and ecology

Aim

Enhancing knowledge on harmful factors (abiotic, biotic, and anthropogenic) that have a harmful effect on forest ecosystems, as well as on integrated protection measures. Deepening knowledge on methods of scientific research in the field of biology, ecology, and pest control in forest ecosystems.

Outcome

Candidates are trained for the independent scientific and highest degree of professional work in the field of forest protection.

Subject content

Lectures: The program includes the study of abiotic, biotic, and anthropogenic harmful effects on the forest ecosystem. Abiotic factors include weeds and pests (game, livestock, rodents, birds, nematodes, etc.).

Biology, ecology, economic, and ecological influences are researched within biotic influences. The nature and mechanism of their action, harmful consequences, significance, as well as modern control measures (preventive and repressive) will be researched for all harmful factors within forest protection. In addition, methods of long-term monitoring of ecological impacts of economically important organisms in forest ecosystems will be researched.

Practical classes: Development of a protection program for a specific forest area or a lower organisational unit.

Teaching methods

Lectures, laboratory work, practical research work under the supervision of a professor.

Recommended references

Karadžić, D., Mihajlović, Lj., Milanović, S., Stanivuković, Z. (2011): Priručnik izveštajne i dijagnostičko prognozne službe zaštite šuma. Univerzitet u Banjoj Luci, Šumarski fakultet.

Petrović, N. (1962): Zaštita četinara od divljači i sitnih glodara. Zaštita četinara. Jugoslovenski poljoprivredno-šumarski centar, br. 7. Beograd.

Živojinović, S. (1981): Zaštita šuma. Naučna knjiga. Beograd.

Grupa autora (1981): Priručnik izveštajne i dijagnstičko-prognozne službe zaštite šuma. Savez inž. i teh. Šumarstva i industrije za preradu drveta Jugoslavije.

Forms of knowledge testing and evaluation

Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject

Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.

Name and surname of the teacher who prepared the data	**PhD Zoran Stanivuković, Full Professor**

	University of Banja Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**			
Subject	Forest phytopathology			
Professor/professors	PhD Ivan Milenković, Assistant professor			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1/2	*It will be assigned later*	8

Conditionality

Aim

The aim of the subject is to introduce students with the most important causes of diseases of forest tree species and methods of protection.

Outcome

Enabling students to determine fungi that cause diseases of forest trees, symptoms of their presence, monitor their incidence and control them.

Subject content

Within this course, studentson doctoral studies will get familiar with all the most important causes of diseases of forest trees and shrubs (parasitic fungi, bacteria, viruses, mycoplasma-like organisms, algae, lichens and parasitic flowering plants) in our forests. Mycoses will be studied in detail, ie. diseases caused by parasitic fungi. The systematic position of parasitic fungi, the appearance of their fruiting bodies, spore-bearing organs and spores, the mode of transmission, contamination, penetration into host tissues, critical time for infections, reproduction, appearance and development of symptoms, etc. are studiedstudied.
Also, the environmental conditions (climatic and edaphic) that lead to the appearance of epiphytosesand great economic damage to trees will be studied in detail. Within the course, students will be introduced with the biology of pathogens, prognosis of disease development and measures for control and protection of forest tree species, all in order to preserve forest ecosystems and increase the production of quality wood.

Teaching methods

Use of state-of-the-art presentation equipment; work in the phytopathological laboratory on the isolation, identification and methods of storage of pathogenic fungi causing forest tree diseases; introduction to basic mycological techniques needed to work with pathogenic fungi; introduction to direct protection measures using fungicides and application equipment.
External conditions (climatic and edaphic) that lead to the appearance of epiphytoses and great economic damage to trees are also studied in detail. Within the course, students are introduced to the biology of pathogens, the prognosis of disease development and measures to control and protect forest tree species, all in order to preserve forest ecosystems and increase the production of quality wood.

Recommended references

Karadžić, D., Milenković, I. (2020): Šumska fitopatologija – Priručnik sa praktikumom. Univerzitet u Beogradu-Šumarski fakultet, 1-359..
Karadžić D., Stanivuković Z., Milanović S., Sikora K., Radulović Z., Račko V., Kardošová

M., Durkovič J., Milenković I. (2020): Development of Neonectria punicea Pathogenic Symptoms in Juvenile Fraxinus excelsior Trees. Front. Plant Sci. 11:592260. (https://doi.org/10.3389/fpls.2020.592260)
Milenković I., Keča N., Karadžić D., Nowakowska J.A., Oszako T., Sikora K., Corcobado T., Jung T. (2018): Isolation and pathogenicity of Phytophthora species from poplar plantations in Serbia. Forests, 9 (6): 330.
Karadžić, D., Radulović, Z., Sikora, K., Stanivuković, Z., Golubović Ćurguz, V., Oszako, T., Milenković, I. (2019): Characterisation and Pathogenicity of Cryphonectria parasitica on Sweet Chestnut and Sessile Oak trees in Serbia. Plant Protection Science, 55(3): 191-201.
Карадић, Д., Голубовић Ћургуз, В., Миленковић И. (2019): Најзначајније болести дрвенастих врста урбаног зеленила -узроци и контрола-. Универзитет у Београду-Шумарски факултет, 1-406.
Karadžić D., Stanivuković Z., Milanović S., Milenković I. (2019): Najznačajniji prouzroovači infektivnih bolesti u šumama Republike Srpske. Univerzitet u Banjoj Luci, Šumarski fakultet, 1-324.
Keča N. (2015): Truležnice korena i pridanka. Univerzitet u Beogradu-Šumarski fakultet, 1-135.
Gonthier, P.; Nicolotti, G., 2013: Infectious Forest Diseases. Ed. by P. Gonthier; G. Nicolotti CABI: Wallingford, UK; Boston, MA, 1-644.
Карадић Д. (2010): Шумска фитопатологија. Универзитет у Београду-Шумарски факултет, 1-774.
Agrios, G. (2005): Plant Pathology. Academic Press, New York, london, San Diego,p. 1-922.

Forms of knowledge testing and evaluation					
Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject
Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.

Name and surname of the teacher who prepared the data	PhD Ivan Milenković, Assis. prof

	University of Banja Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**	

Subject	**Forest mycology**			
Professor/professors	PhD Ivan Milenković Assistant professor			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	*6*	8

Conditionality

No any.

Aim

The aim is that students get basic knowledge about mycology and get familiar with morphological characteristics of micro and macrofungi (fruiting bodies as conks or mushrooms), as well as with the general importance of fungi.

Outcome

Ability of students to determine the most common macrofungi in our forests, including conks, edible or poisonous fungi, or fungi that could be used in medicine or pharmacy. Students will get familiar with methods of sampling, keeping and conserving of fungi, as well as with possibilities of using different fungal species for different purposes.

Subject content

Mycology is a scientific discipline that studies organisms known as Fungi (Greek: Mykota; Latin: Fungi).It is estimated that there are about 1.5 million species of fungi, however, about 80,000 have been described so far.Students will be introduced to the general characteristics of fungi and their historical significance, as well as the possibilities for their use. The position of fungi in the system of living organisms will be presented. Morphological characteristics will be presented with special emphasis to the fungal cell, the appearance and development of colonies, as well as the ways of reproduction and colonization of different substrates. The ecology of fungi and their spread, as well as pleomorphism, will be presented in detail. The classification will show the most important phyla, classes, ranks and families. In a special section, the most important fungal representatives of different systematic categories, that areappearing in forest ecosystems, will be presented.

Students will work on the general characteristics of the kingdom of Fungi during practical classes. They will get familiar with the ways of sporulation of fungi, as well as with the preparation of artificial media for isolation and work with fungal cultures. They will study ways to maintain and grow fungal cultures. After getting acquainted with the basic characteristics of certain systematic categories, the study of the most important saprophytic, parasitic, as well as edible and poisonous fungi will be performed. The ecological characteristics that influence the appearance and fruiting of fungi will be studied. Students will be introduced to the most important fungi that can be found in forest ecosystems.

Teaching methods

Use of state-of-the-art presentation equipment; use of a microscope, work in a phytopathological laboratory (making nutrient media, isolation of fungi on various nutrient media and their identification).

Recommended references

Crous, P. W., Verkley, G. J. M., Groenewald, J. Z., Samson, R. A.(2019): Fungal Biodiversity. CBS Laboratory Manual Series – Volume 1. Westerdijk Fungal Biodiversity Institute. p.

425.
Карацић, Д., Ненад, К., Миленковић, И., Милановић, С., Станивуковић, З. (2016): Шумскамикологија. Издавач: Универзитет у БањојЛуци-Шумарскифакултет, БањаЛука, 1- 595.
Webster J., Weber R. W. S. (2007): Introduction to Fungi. Third Edition. Cambridge University Press, The Edinburgh Buil., Cambridge CB2 8RU, UK, 1-841.
Alexopoulos, C.J., Mims, C.W., Blackwell, M., 1996. Introductory mycology. Wiley & Sons., New York, USA, p. 869.
Muntanola-Cvetković, M. 1990. Opštamikologija. Naučnaknjiga, Beograd str. 320.

Forms of knowledge testing and evaluation					
Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		
Special indication for the subject					
Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.					
Name and surname of the teacher who prepared the data				PhD Ivan Milenković Assistant professor	

UNIVERSITY OF BANJA LUKA
FACULTY OF FORESTRY
PhD studies

F O R E S T R Y

Subject	**Economic aspects of forestry in Climate Change**			
Professor/professors	**Dragan Čomić, Assistant Professor**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
To be assigned later	Elective	1	*6*	8

Conditionality

There is no conditionality.

Objective

Acquisition of theoretical and applied knowledge aimed at identifying and using both economic and financial potentials of the forestry sector in current climate change issues, thus developing practical skills for quantification and profitability assessment of investments in carbon credit generation.

Outcome

Students will be able to correctly identify, interpret, critically analyze and conclude, as well as to actively discuss and conduct independent scientific-research activities related to the impact of climate change on the forestry sector, focusing on regulatory, economic, market and project aspects. Moreover, students will acquire the necessary knowledge related to the inventory and quantification of carbon storage in different scenarios, as well as necessary competencies to independently or in team work initiate and implement activities related to the development and implementation of business plans and project applications of domestic and foreign funds.initiate and implement carbon projects in the field of forestry and related sectors.

Content

1. Fundamentals of climate change and the impact on the forestry sector, 2. Climate change regulatory framework at the global and national levels, 3. Economic and financial aspects of climate change, 4. Carbon markets, 5. Forestry sector on carbon markets, 6. Carbon projects with a focus on the forestry sector and related sectors, 7. Methods of quantitative assessment of carbon stocks in forest ecosystems, 8. Profitability assessment of investments in carbon credit generation, 9. Carbon credit generation in plantations of fast-growing species, 10. Software for calculation and inventory of greenhouse gases, applied in the forestry sector.

Teaching methods

Lectures with practical exercises, discussion and case studies; consultations; guest lecturers; study visits to relevant organizations with active discussion; attending online courses. Teaching (lectures and consultations) can be organized in the form of a distance learning (online).

Recommended references

- Čomić, D. (2021). Economic aspects of Forestry in Climate Change. Banja Luka: Faculty of Forestry, University of Banja Luka.
- Economides, G., Papandreou, A., Sartzetakis, E., Xepapadeas, A. (2018). The Economics of Climate Change. Athens: Bank of Greece.
- CEPOS (2011). Forests and Climate Change. Sarajevo: Center for support of sustainable forest management support.
- Kadović, R., Medarević, M. (2007). Forests and Climate Change. Belgrade: Faculty of Forestry, University of Belgrade.
- European Commission (2019). The European Green Deal. Brussels: European Commission.

<table>
<tr><td colspan="6">• Stern, N. (2007). The Economics of Climate Change: The Stern Review. Cambridge and New York: Cambridge University Press.</td></tr>
<tr><td colspan="6">Forms of knowledge testing and evaluation</td></tr>
<tr><td rowspan="2">Activites during studies</td><td rowspan="2">10</td><td>Test 1</td><td>20</td><td rowspan="2">The final exam</td><td rowspan="2">50</td></tr>
<tr><td>Test 2</td><td>20</td></tr>
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<tr><td colspan="6">Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.</td></tr>
<tr><td colspan="3">Name and surname of the teacher who prepared the data</td><td colspan="3">PhD Dragan Čomić, assis. prof</td></tr>
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UNIVERSITY OF BANJA LUKA
FACULTY OF FORESTRY
PhD studies

F O R E S T R Y

Subject	**Forest-based circular bio-economy**			
Teacher(s) in charge	**Dragan Čomić, Assistant Professor**			
Subject Code	**Subject status**	**Semester**	**Total number of working hours / number of teaching hours**	**ECTS points**
To be assigned later	Elective	1/2	*To be assigned later*	8

Conditionality

There is no conditionality.

Objective

To adopt theoretical and applied knowledge in the field of leading global economic trends of green, circular and bio-economy, with a focus on the political-legal and economic-financial framework of the forestry sector and related sectors.

Outcome

Students will be able to properly identify, interpret, critically analyze and conclude, as well as to actively discuss and conduct independent scientific-research activities related to the strategic, regulatory, organizational, managerial, financial and marketing aspects of the forestry sector within the concept of circular bioeconomy. Students will also acquire the necessary competencies to assess the total value of forest ecosystems and assess the profitability of investments, together with the application of acquired knowledge in research, development and investment projects of the forestry sector and related sectors.

Content

1. Conceptual framework of green, circular and bio-economy; 2. Strategic and regulatory framework of forest-based circular bioeconomy; 3. Forestry potentials with new value chains in circular bio-economy; 4. Forestry policy in circular bio-economy; 5. Institutional framework and classification of business systems in forestry; 6. Application of the good forest management concept (Forest Governance); 7. Economic and financial aspects of forest-based circular bio-economy; 8. Economic and total value of forest ecosystems; 9. Investment management in the forestry sector; 10. Marketing aspects of forest-based circular bio-economy.

Teaching methods

Lectures including practical exercises, discussion and case studies; consultations; guest lecturers; study visits to relevant organizations including active discussion; attending online courses. Teaching (lectures and consultations) can be organized in the form of a distance learning (online).

Recommended references

- Čomić, D. (2021). Ekonomski aspekti šumarstva u klimatskim promjenama. Banja Luka: Šumarski fakultet Univerziteta u Banjoj Luci.
- de Arano, I. M., Muys, B., Topi, C., Pettenella, D., Feliciano, D., Rigolot, E., Lefevre, F., Prokofieva, I., Labidi, J., Carnus, JM., Secco, L., Fragiacomo, M., Follesa,M., Mauro Masiero, D., Llano-Ponte, R. (2018). A Forest-based Circular Bio-economy for Southern Europe: visions, opportunities and challenges.

- Panwar, R., Kozak, R., Hansen, E. (2018). Forests, business and sustainability. London: Routledge.
- Wolfslehner, B., Linser, S., Pülzl, H., Bastrup-Birk, A., Camia, A., Marchetti, M. (2016). Forest Bio-economy – a new scope for sustainability indicators. From Science to Policy 4. Joensuu: European Forest Institute.
- UN (2014). Rovaniemi Action Plan for the Forest Sector in a Green Economy. New York and Genève: United Nations.
- Klemperer, W.D. (2003). Forest Resource Economics and Finance. Virginia: College of Natural Resouces.
- Krott, M. (2005). Forest Policy Analysis. Nederland: Springer.
- FAO (2011). Framework for Assessing and Monitoring Forest Governance. Rome: FAO of the UN.
- Orsag, S., Dedi, L. (2011). Budžetiranje kapitala. Zagreb, Masmedia
- Kotler, P., Wong, V., Saunders, J., Armstrong, G. (2006). Osnove marketinga. Četvrto evropske izdanje. Zagreb. Mate
- European Commission (2019). The European Green Deal. Brussels: European Commission.

Forms of knowledge testing and evaluation					
Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		
Special indication for the subject					
Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.					
Name and surname of the teacher who prepared the data	**Dragan Čomić, Assis. Prof**				

	UNIVERSITY OF BANJA LUKA **FACULTY OF FORESTRY** **PhD studies** **F O R E S T R Y**	

Subject	**Green entrepreneurship and project management in forestry**			
Teacher(s) in charge	**Dragan Čomić, Assistant Professor**			
Subject Code	**Subject status**	**Semester**	**Total number of working hours / number of teaching hours**	**ECTS points**
To be assigned later	Elective	1	*6*	8

Conditionality

Forest-based Circular Bio-economy exam passed

Objective

Acquisition of theoretical and applied knowledge in the field of green entrepreneurship and project management, developing skills and opportunities to apply practical tools for the development and implementation of innovations, business ideas and project applications in the field of forestry and related sectors.

Outcome

Students will be able to correctly identify, interpret, critically analyze and conclude, as well as to actively discuss and conduct independent scientific-research activities related to the modern concept of entrepreneurship and project management based on the harmonization of economic, environmental and social aspects. Moreover, students will acquire the necessary competencies to independently or in team work initiate and implement activities related to the development and implementation of business plans and project applications of domestic and foreign funds.

Content

1. Contemporary concepts of *green* entrepreneurship; 2. Strategic and regulatory framework of entrepreneurial activities; 3. Innovative value chains and *green* jobs in the forestry sector and related sectors; 4. Business idea generation methods and techniques; 5. Initiation and implementation of business ventures; 6. Sources of entrepreneurial ventures funding; 7. Entrepreneurial infrastructure; 8. Business plan; 9. Theoretical foundations of project management; 10. Project life cycle; 11. Methods, techniques and tools of project management; 12. Sources of project activities funding; 13. Current project trends in the forestry sector and related sectors; 14. Preparation and development of project applications.

Teaching methods

Lectures with practical exercises, discussion and case studies; consultations; guest lecturers; study visits to relevant organizations with active discussion; attending online courses. Teaching (lectures and consultations) can be organized in the form of a distance learning (online).

Recommended references

- Čomić, D. (2021). Ekonomski aspekti šumarstva u klimatskim promjenama. Banja Luka: Šumarski fakultet Univerziteta u Banjoj Luci.
- Schmithusen, F., Kaiser, B., Schmidhauser, A., Mellinghoff, S., Perchthaler, K., Kammerhofer, A. (2006). Preduzetništvo u šumarstvu i drvnoj industriji – Osnove menadžmenta i poslovanja. Beograd: Centar za izdavačku delatnost Ekonomskog fakulteta u Beogradu (prevod).
- Niskanen, A., Slee, B., Ollonqvist, P., Pettenella, D., Bouriaud, L. ja Rametsteiner, E. (2007). Entrepreneurship in the forest sector in Europe. Joensuu, FI: Faculty of Forestry University of Joensuu.
- Петковић, С. (2021). Предузетништво и иновације у дигиталној ери. Бања Лука: Економски факултет

<table>
<tr><td colspan="6">Универзитета у Бањој Луци.
• Петковић, С., Милановић, М. (2017). Лабораторија идеја - Од идеје до предузетничког подухвата. Бања Лука: Економски факултет Универзитета у Бањој Луци.
• UNECE/FAO (2018). Green Jobs in the Forest Sector. New York and Geneva: United Nations.
• Project Management Institute (2021). PMBOK Guide – A Guide to the Project Management Body of Knowledge. Newtown Square, USA: Project Management Institute.</td></tr>
<tr><td colspan="6">Forms of knowledge testing and evaluation</td></tr>
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20</td><td>The final exam</td><td>50</td></tr>
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<tr><td colspan="4">Name and surname of the teacher who prepared the data</td><td colspan="2">Dragan Čomić, Assis. Prof.</td></tr>
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	University of Вања Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**			
Subject	**Forest products trade management**			
Professor/professors	**PhD Branko Glavonjić, Full Professor**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	*6*	8

Conditionality

without

Aim

Introducing students to the key technics of forest products trade management and training them to practically apply them in their work.

Outcome

Enabling students to apply appropriate methods and techniques for modeling forest products supply and demand and optimization of the wood supply chain on selected examples from practice.

Subject content

Timber trade flows on a global level, by regions and the most important countries in the world: wood from the tropical and temperate climate zone. Modeling the supply and demand of selected wood assortments on the example of chosen countries.

Wood supply chain management: participants in the supply chain and their characteristics: producers of wood raw materials, transport companies, wood processing companies, maritime shipping warehouses, freight forwarders, shipping agents. Quantitative methods of optimizing wood transport within the supply chain.

Direct and indirect export of forest products: trade channels and intermediaries in the export of forest products. Export calculations for forest products: models for calculating the value of forest products in foreign trade, calculation of taxes and fees, margins, and sales prices.

The role of banks and banking in forest products trade: instruments of collection of foreign trade transactions.

EU and FLEGT directives relevant to timber trade. Forest certification and trade in certified wood.

Teaching methods

Lectures, discussions, good practice, Seminar paper on a chosen topic.

Recommended references

- Hansen, E, Juslin, H.: Strategic Marketing in the Global Forest Industries, Oregon State University, USA (selected chapters)
- Krčevinac, S. et al .: Operational Research, FON Belgrade, 2004
- Forest Products Annual Market Review, UNECE, Geneva (different years),(selected chapters)
- Tropical timber market report, (2013-2021), ITTO
- Kogler C., Rauch, P. (2018): Wood Procurement in Austria, Symposium for Operations Management in Wood Products Industries, University of Natural Resources and Life Sciences, Vienna
- Vlosky R., Chance P. (2001): Employment structure and training needs in the Louisiana value-added wood product industry, Forest product journal vol. 51, USA

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- FLEGT Action plan;
- Forest certification; web sites and reviews.
- web sites and data bases (EU, FAO, UNECE, ITTO,...)
- Publications and scientific papers from other sources depending on the chosen topic of the student

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<tr><td colspan="6">Forms of knowledge testing and evaluation</td></tr>
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<tr><td colspan="4">Name and surname of the teacher who prepared the data</td><td colspan="2">PhD Branko Glavonjić, Full Prof.</td></tr>
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	University of Вања Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**			
Subject	**Modeling and Optimization of Woody Biomass Value Chains**			
Professor/professors	**PhD Branko Glavonjić, Full Professor**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	6	8

Conditionality

without

Aim

Enabling students to apply appropriate methods and techniques for modeling and optimization of wood biomass value chain parameters in order to obtain optimal models of energy production in real systems.

Outcome

Woody biomass is one of the renewable and sustainable sources of energy that can be used for producing electricity, heat, and biofuels. The complex supply chain of woody biomass for energy generation, which consists of different players and products and is affected by biomass characteristics, such as low density and unpredictable quality, makes the energy generation cost from biomass higher than that of the conventional sources of energy, such as fossil fuels. In that context, the main outcome of the course is the training of students to apply different methods and techniques of modeling, optimization and design of biomass supply chains in the production of various types of wood energy.

Subject content

1. Introduction, types and characteristics of woody biomass and wood biofuels: wood chips, wood briquettes, wood pellets. Charcoal: production and characteristics. Calorific value of certain types of wood biofuels and moisture content. Units of measurement and conversion factors. 2. Biomass quality: testing, certificates and declarations of producers in the supply chain. EN and ISO standards for wood biofuels. European eco-certification schemes for wood biofuels: EN plus certification scheme. SWAN, "Blue Angel "and "UZ 38". Nordic certification scheme.

3. Sources and supply chain of biomass. Econometric modeling and multicriteria optimization of woody biomass supply and demand for selected supply chains. Logistics models in the biomass supply chain. Cost / benefit ratio.

4. Biomass and climate change: biomass humidity and greenhouse gas emissions in the combustion process. Emission calculation methodology. IPCC and FAO applications. Balances of consumed and useful energy in selected biomass supply chains.

Teaching methods

Lectures, discussions, good practice, visits to selected participants in the biomass supply chain in the production of heat and electricity. Seminar paper on a chosen topic.

Recommended references

- Panoutsou, C. et al.(2017): Modeling and Optimization of Biomass Supply Chains, Elsevier
- Glavonjić B. (2008): Woody biomass: types, characteristics and opportunities for heating, Faculty of Forestry, Belgrade
- Glavonjić B. (2013): Use of wood residue for the needs of wood energy production and

<table>
<tr><td colspan="6">replacement of fossil fuels in the district heating system of Kolubara, Faculty of Forestry, Belgrade
• Vasković S. (2016): RAZVOJ MODELA ZA OCJENU PRIHVATLjIVOSTI ENERGETSKIH LANACA PRI PROIZVODNjI ENERGIJE I ENERGENATA IZ BIOMASE, doktorska disertacija, Univerzitet u Istočnom Sarajevu, Mašinski fakultet
• IEA Bioenergy (2020): Developing business models for efficient use of biomass
• IEA Bioenergy (2020): Advanced Biofuels – Potential for Cost Reduction
• COMMISSION REGULATION (EU) (2015): 2015/1185: Implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for solid fuel local space heaters, Official Journal of the European Union
• Publications and scientific papers from other sources depending on the chosen topic of the student</td></tr>
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<tr><td colspan="4">Name and surname of the teacher who prepared the data</td><td colspan="2">PhD Branko Glavonjić, Full Prof.</td></tr>
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	University of Banja Luka **Faculty of Forestry** **PhD studies** **F O R E S T R Y**			
Subject	**Corporate Governance and Sustainable Development**			
Professor/professors	**PhD Igor Todorović associate professor**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	6	8

Conditionality

No conditions.

Aim

This course explores the key link between corporate governance and sustainable development. The course examines the contested nature of both of these concepts and explores how they combine in local, national, regional and international environmental policy-making and development challenges such as poverty, global inequalities, biodiversity loss, deteriorating global ecosystems, and the threat of climate change for human societies. Modern environmental problems and crises are mainly the result of inefficient management. Therefore, the main purpose of the course is to examine the way in which the state, private sector and civil society interact nationally and internationally to address environmental and development issues through better governance models and sustainability frameworks.

Outcome

Students will be able to correctly identify, interpret, critically analyze, draw conclusions, actively discuss and conduct independent scientific research work related to corporate governance, social responsibility and sustainable development. The student should understand and critically analyze the corporate social responsibility of modern enterprises, appreciating the economic, environmental and social aspects of sustainable development, taking into account the expectations of stakeholders in accordance with applicable laws and international standards of conduct.

Subject content

This course explores the key link between corporate governance and sustainable development. 1. Corporate governance, 2. Corporate social responsibility. 3. Sustainable development, 4. Key links between corporate governance and sustainable development. 5. Standards of corporate governance and corporate social responsibility. 6. Application of the concept of good governance, 7. Contemporary environmental problems and crises as a result of inefficient governance, 8. "good governance" and international development, 9. management of environmental conflicts and disasters.

Modern environmental problems and crises are mainly the result of inefficient management. Therefore, the main purpose of the course is to examine the way in which the state, the private sector and civil society interact nationally and internationally to address environmental and development issues through better governance models and sustainability frameworks. The main issues and concepts covered by the course include: understanding the concepts of corporate governance and sustainability; "Good governance" and international development; urban governance and sustainability; environmental conflict and disaster management; e-governance and sustainability; and global environmental governance, especially with regard to climate change. These issues are explored through case studies.

Teaching methods

Lectures with practical exercises, discussion and case studies; consultations; guest lecturers; study visit to relevant organizations with active discussion, attending online courses. Teaching (lectures and consultations) can be organized in the form of distance learning (online).

Recommended references

- Corporate social responsibility, Filip Kotler and Nensi Li, 2007
- Case study of Corporate social responsibility - doc. dr. sc. Mislav Ante Omazić and associates
- Beyond Rio+20: Governance for a Green Economy. Pardee Center, 2011. by: Boston University, Pardee Center
- Monks R.A,G., and N. Minow (2000) Corporate Governance, Blackwell Publishers, UK
- Introduction to business ethics, corporate social responsibility and sustainability, Borna Jalšenjak and Kristijan Krkač, Mate, Zagreb, 2016.
- Corporate Social Responsibility for All (CSR for All) - Handbook for Employers' Organizations, Croatian Employers' Association, 2014

Forms of knowledge testing and evaluation

Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject

Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.

Name and surname of the teacher who prepared the data	**PhD Igor Todorović assoc. prof.**

University of Banja Luka
Faculty of Forestry
PhD studies

F O R E S T R Y

Subject	**Climate Smart Forestry**			
Professor/professors	**Michal V. Marek, professor**			
Subject code	**Status**	**Semestar**	**Number of teaching hours**	**ECTS**
It will be assigned later	Elective	1	*6*	8

Conditionality

No

Aim

To introduce new term of Climate Smart Forestry (CSF) into common forest practise. Recognize the main points of the carbon cycle and interaction between carbon sources/sinks. Implementation the principles of CSF into every day sylviculture on the all step of forestry activates. i.e. forest establishment, thinning, harvest and transport of logs. Estimate possible ways how to affect carbon track of forestry and sylvicultural technics

Outcome

New on system and processes based forestry practical activities oriented on the maximal and long-term capture of carbon in forest trees, forest soils and woody products

Subject content

Forest stand – atmosphere interaction, carbon cycle, carbon „pumping“ by the forest trees, Forestry practices events and carbon storage, evaluation of forests types from the point of point of view of Climate Smart Forestry, concrete sylvicultural activities suitable for CSF

Teaching methods

Lectures, practical exercises, consultations.

Recommended references

Maximov, NA., Murnek, AE., Harvey, RB: A Textbook of Plant Physiology, Hassell Street Press, 2021
Miah, D., Man Yong Shin, Koike M.: Forests to Climate Change Mitigation, Springer, 2010

Grebner, D.L., Betinger, P.,Jacek P., Introduction to Forestry and Natural Resources, Elsevier Science Publishing Comp.. 2013

Tognetti, R., Smith, M., Panzacchi P.: Climate-Smart Forestry in Mountain Region, Springer Nature Switzerland AG, 2021

Forms of knowledge testing and evaluation

Activites during studies	10	Test 1	20	The final exam	50
		Test 2	20		

Special indication for the subject

Instead of tests, the student can opt for a seminar paper with a specific topic from the field in which he is doing his doctorate.

Name and surname of the teacher who prepared the data	**PhD Michal V. Marek, professor**