SETOF Soil Erosion and TOrrential Flood Prevention: Curriculum Development at the Universities of Western Balkan Countries

Co-funded by the Erasmus+ Programme of the European Union

WP2

Development of curricula

Lead Organisations of WP2**: UNS - Serbia**

Participating Organisation: UB; UNI; UBL; UNSA; INSZASUM; BOKU; UNSCM; UNIRC; FRI-BAS

Deliverable 2.3

Title: **Established new and improved existing subjects of bachelor and master programme**

Participating Organisation: UB; UNS; UNI; UBL; UNSA

Project number: 598403-EPP-1-2018-1-RS-EPPKA2-CBHE-JP (2018 – 2579 / 001 – 001)
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PROJECT INFO

Project title	Soil Erosion and Torrential Flood Prevention: Curriculum Development at the Universities of Western Balkan Countries
Project acronym	SETOF
Project reference number	598403-EPP-1-2018-1-RS-EPPKA2-CBHE-JP(2018-2579/001-001)
Coordinator	University of Belgrade
Project start date	November 15, 2018
Project duration	36 months

DOCUMENT CONTROLSHEET

Ref. No and Title of Activity	**2.3.Established new and improved existing subjects of bachelor and master programme**
Title of Deliverable:	Report on new and improved existing subjects of bachelor and master programme
Institutions:	University of Belgrade
Author/s of the deliverable	Nada Dragović, Mirjana Todosijević, Ratko Ristić, Tijana Vulević
Status of the document:	final

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Study program title: **Ecological engineering for soil and water resources protection**

Type and Level of Study: **Basic Academic Studies (Bachelor)**

The aim of the study program is to train competent staff to analyze and solve complex problems related to natural resources (land, flora and vegetation, water).The development of disciplines in the field of environmental engineering is a response to the growing need to provide technical solutions for socio-economic development while protecting natural resources and the environment. Ecological engineering for soil and water resources protection involves the design and construction of sustainable systems in accordance with ecological principles, which integrate social needs with the natural environment. Successful ecological engineering requires the development of a design methodology that is based on ecological principles while respecting conventional engineering methods, emphasizing diversity, flexibility, and adaptation from a sustainable development perspective.

The study program is designed to guide the student in a logical sequence from basic biological and technical disciplines, through disciplines in which he/she is introduced to the components of ecosystems (forest and agroecosystems) and management techniques, to those in which they complete knowledge of systems for protection and improvement of soil and water resources.

The requirement for admission to undergraduate studies is completed high school with appropriate success and successfully passed the entrance exam.

Professional title after graduation: Based on the Rulebook on the list of professional, academic and scientific names established by the National Council ("Official Gazette of RS, No. 30/2007, 112/2008, 72/2009, 81/2010, 39/2011, 54/2011, 53/17 and 88/17), candidates who complete their basic academic studies in the study program Ecological engineering for soil and water resources protection gain the academic title: Bachelor of Forestry (B.Sc.) - field Ecological engineering for soil and water resources protection.

After completing the basic academic studies, students are fully qualified to continue their master's academic studies in the field of ecological engineering at the Faculty of Forestry, and under certain conditions, they can enroll in other study programs at the Faculty of Forestry or one of the related faculties of biotechnical sciences.

Basic Academic Studies of Ecological engineering for soil and water resources protection lasts 4 years and has a total of 240 ECTS credits. The study program is organized through compulsory and elective courses, professional practice and final thesis.

The list of compulsory and elective study areas, ie subjects, with indicative content is contained within the Curriculum of the Basic Academic Studies Study Program, which is available on the Faculty's website (http://www.sfb.bg.ac.rs/studijski-programi/osnovne-akademske-studije/studijski-programi/ekoloski-inzenjering-u-zastiti-zemljisnih-i-vodnih-resursa/). Credit value of each subject is presented in accordance with the European Credit Transfer System (ECTS).The credit value of the final thesis in Basic Academic Studies is expressed within the Curriculum of the Basic Academic Studies Program.

The prerequisites for enrollment of individual subjects or groups of subjects and the manner of selection of subjects from other study programs are stated in the Rulebook on Studies and Study, also available on the Faculty's website. To transfer or enroll in other study programs within the same or related fields of study, students take the differential exams determined by the Faculty's acts.

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List of **new** subjects included in the study program of basic academic studies Ecological engineering for soil and water resources protection:

1. **Revitalization of Small Water Flows**
2. **Climate change and natural hazards management**
3. **Basics of forest hydrology**
4. **Hydraulics of open channel flow**
5. **Economics of the soil and water resources protection**

Study program: Ecological engineering for soil and water resources protection		
Subject name: REVITALIZATION OF SMALL WATER FLOWS		
Teacher(s): Vesna Nikolic Jokanović, Sara Lukić		
Subject status: elective		
ECTS: 5		
Requirement:		
Subject aim Acquiring knowledge about the basic characteristics of aquatic ecosystems, how to revitalize small water flows and coastal zones.		
Subject outcomes Defining the ecological potential of water flows, the degree of threat to certain sections of watercourses and coastal zones and proposing measures for revitalization.		
Subject content Theoretical teaching: Introduction. The importance and basic characteristics of aquatic habitats. Morphology of forest water flows. Living conditions in running waters. The layout and composition of running watersbiocenosis. Coastal and floodplain biocenosis of rivers. Changes in running water as a consequence of anthropogenic influence. Revitalization of small water flows - facilities and works. Coastal zone revitalization. Practical teaching: Determination of the ecological potential of water flow.		
Literature 1. Velašević, V., Djorović, M., Letić, Lj. (2002): Ecological Aspect of Conservation, Regulation and Protection of Forest Waters, Acta Biologica Yugoslavica, Belgrade (in Serbian) 2. Letić, Lj. (2002): Water use in forest areas - Bioregulations, Faculty of Forestry, Belgrade (in Serbian) 3. VránaKarel (2004): Revitalizacemalýchvodníchtoků - součástpéčeokrajinu, Monografie, ProMinisterstvo životnihoprostredi, Prahe. 4. Pavletić, M. (1972): The Life of Our Rivers, The Biology of Running Water - School Book, Zagreb (in Croatian) 5. Milorad Janković (1998) - Aquatic plants - The importance of macrophytes in our waters, Blue dragon - Sremski Karlovci - Green circle – Belgrade (in Serbian) 6. Mihajlović, Lj. (2008): Forest entomology. Faculty of Forestry, University of Belgrade, Belgrade (in Serbian)		
Number of active teaching hours	**Theoretical classes: 2**	**Practical classes: 2**
Teaching Methods: Classes are taught in the form of lectures and exercises. Theoretical teaching is carried out using modern presentation equipment.		

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Evaluation of knowledge (maximum score 100)			
Pre-exam obligations	points	**Final exam**	points
Activity during the lectures	5	Written exam	0
Practical teaching	10	Oral exam	55
Seminar Essay	30		

Study program: Ecological engineering for soil and water resources protection			
Subject name: CLIMATE CHANGE AND NATURAL HAZARDS MANAGEMENT			
Teacher(s): Ratko Ristić; Tijana Vulević			
Subject status: elective			
ECTS: 5			
Requirement: Passed exam in torrential flows and erosion 1 and 2; Hydraulics with hydrology; Hydrogeology with geomorphology.			
Subject aim Introducing students to natural disasters in Serbia and in the world. Introduction to the methods of study and assessment of the risks of natural disasters.			
Subject outcomes Integrated approach in the process of environmental protection from natural disasters, in the function of multi-purpose sustainable use of space.			
Subject content Theoretical teaching: Natural disasters, global, regional and local risks. Types of natural disasters in Serbia. Floods as a most common occurrence, with an emphasis on torrential floods. Other natural disasters occurring in Serbia: droughts, earth mass movements on slopes (landslides, cuttings...), forest fires and avalanches. Risk assessment methodology based on the analysis of natural features of the area. Impact of an anthropogenic factor on the occurrence of natural disasters. Development of the concept of preventive protection. Practical teaching: Development of a study on the exercises, assessment of flood risks (flood zone) and landslides. **Literature** 1. Kostadinov, S. (2011): Lectures material, Faculty of Forestry, Belgrade (in Serbian) 2. Dragićević, S., Filipović, D. (2009): Natural conditions and disasters in spatial planning and protection, University in Belgrade, Faculty of Geography, Belgrade(in Serbian)			
Number of active teaching hours	**Theoretical classes: 2**	**Practical classes: 2**	
Teaching Methods: Lectures, exercises, seminar essays, fieldwork			

Evaluation of knowledge (maximum score 100)			
Pre-exam obligations	points	**Final exam**	points
Activity during the lectures	10	Written exam	
Practical teaching	16	Oral exam	49
colloquium	15	.....	
Seminar Essay	10		

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Study program: Ecological engineering for soil and water resources protection

Subject name: BASICS OF FOREST HYDROLOGY

Teacher(s): Vesna Nikolić Jokanović

Subject status: elective

ECTS: 5

Requirement:

Subject aim

Acquiring basic knowledge of the water cycle, ie.the impact of forest ecosystems on a ground phase of water circulation, with regard to the complex relationship between the atmospheric deposits and forest ecosystems, which results in a yield of the valuable water.

Subject outcomes

The course introduces students to the impact of forest ecosystems on the hydrologic cycle of water circulation on earth.

Subject content

Theoretical teaching:

Introduction. Historical view, the goal, and purpose of the study of forest hydrology. Water cycle in nature (connection of elements of the hydrological cycle and different types of forest phytocenoses).Basic physical and chemical properties of water. Water and its importance for plants.Water regime in different forest habitats. Evapotranspiration in forest ecosystems. The hydrological function of forest ecosystems (impact of forests on runoff and retention; beneficial hydrological effects of forests; the impact of forests on precipitation; water balance of forest areas). Water protection function of the forest (forest as a biofilter; the influence of vegetation on the quality of water flows and reservoirs; criteria for extraction of water protection forests). The impact of forest cover, spatial distribution and ways of forest management on runoff and water retention.

Practical teaching:

Defining hydrological parameters of forest ecosystems, direct measurement of balance elements (precipitation, interception, infiltration, runoff ...)

Literature

1. Macan, G. (1994): Forest Hydrology, Faculty of Forestry, Belgrade(in Serbian)
2. Velašević, V., Djorović, M. (1998): Environmental Impact of Forest Ecosystems, Faculty of Forestry, Belgrade(in Serbian)
3. Velašević, V., Djorović, M., Letić, Lj. (2002): Ecological Aspect of Conservation, Regulation, and Protection of Forest Waters, Acta Biologica Yugoslavica, Belgrade (in Serbian)
4. Prohaska, S. (2003): Hydrology - Part I, Faculty of Mining and Geology, Belgrade(in Serbian)

Number of active teaching hours	**Theoretical classes: 2**	**Practical classes: 2**

Teaching Methods: Classes are taught in the form of lectures and exercises. Theoretical teaching is carried out using modern presentation equipment.

Evaluation of knowledge (maximum score 100)

Pre-exam obligations	points	**Final exam**	points
Activity during the lectures	10	Oral exam	30
Practical teaching	20		
Seminar Essay	40		

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Study program: Ecological engineering for soil and water resources protection

Subject name: HYDRAULICS OF OPEN CHANNEL FLOW

Teacher(s): Vesna Djukić

Subject status: compulsory

ECTS: 5

Requirement: Passed exams in Mathematics and Hydraulics in soil and water resources protection

Subject aim

Acquaintance and understanding of the hydraulic laws of water movement in open streams, as well as in the vicinity of water management facilities, as necessary theoretical bases for the design of facilities for water use and protection and the regulation of water flows.

Subject outcomes

Acquired knowledge about basic hydraulic laws of water flows in open streams near water management facilities, and the ability to make elementary hydraulic calculations when designing facilities for water use and protection and regulation of water flows.

Subject content

Theoretical teaching:

Steady fluid flow in open channels.Basic Maintenance Equations in Open Flows (Continuity Equation, Energy Maintenance Equation, and Motion Amount Maintenance Equation).Level lines at the junction of the channel and the reservoir. Suddenly variable unequal flow. Hydraulic flow characteristics in the object zone.Types of objects on canals and natural watercourses. Running water through openings and under the sluice gate.Sluice gate types.

Hydraulic analysis of the connection between upper and lower water levels in hydraulic structures.Water flow in the cascade zone. Water flowsthrough culverts. Hydraulic analysis of the bridge area. Steady flow in natural streams.Calculation of natural water level lines. Torrential flowhydraulics. Hydraulic analysis of the estuary zone of regulated torrential water flows. The hydraulic aspect of erosion phenomena. Sediment transport in alluvial and torrential water flows, with special reference to analyzes of sedimentation processes near water management facilities. Studying the conditions of starting up a bed load and suspended sediment. Calculation of sediment transport. Calculation of general river bed deformation. Accumulations and deposition. Water management and ecological problems of sedimentation processes (channel backfill and sediment accumulation, impairment of water quality). Practical teaching:

Development of a study of practical tasks and experimental measurements related to the problems that are covered within the framework of theoretical instruction. The elaboration of practical tasks includes solving various problems in the field of uneven flow in open streams, as well as near water management facilities (sluice gate, overflows, cascades, culverts, in the bridge area).Hydraulic analysis of the connection between upper and lower water levels in hydraulic structures. Steady flow in natural water flows. Analysis of startup conditions of bed load and suspended sediment and calculation of sediment transport. Calculation of general river bed deformation.

Literature

1. Petković, S. (1992): Selected Chapters of Open Channel Flow Hydraulics, Belgrade(in Serbian)
2. Hajdin, G. (2000): Fluid Mechanics(in Serbian)
3. Prodanovic, D. (2007): Fluid Mechanics for Students of the Faculty of Civil Engineering, University of Belgrade, Faculty of Civil Engineering(in Serbian)
4. Đukić, V. (2016) Practicum for Hydraulics(in Serbian)

Number of active teaching hours	**Theoretical classes: 2**	**Practical classes: 2**

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Teaching Methods: Lectures, exercises, seminar essays, fieldwork			
Evaluation of knowledge (maximum score 100)			
Pre-exam obligations	points	**Final exam**	points
Activity during the lectures	5	Written exam	35
Practical teaching	10	Oral exam	35
colloquium	15		
Seminar Essay			

Study program: Ecological engineering for soil and water resources protection

Subject name: ECONOMICS OF THE OF SOIL AND WATER RESOURCES PROTECTION

Teacher(s): Miodrag Zlatić, Mirjana Todosijević

Subject status: compulsory

ECTS: 6

Requirement:

Subject aim

Mastering the economic laws and regularities in the area of river basin management from the aspect of protection of soil and water resources by studying the methods of solving the mentioned problems and other phenomena that are relevant for economic considerations and social expediency of certain variant solutions and their effects in practice.

Subject outcomes

The acquired knowledge in the field of evaluation of works on the protection of soil and water resources by applying modern methods will enable the proper preparation of investment programs in this field.

Subject content

Theoretical teaching:

The concept and importance of studying the economics of soil and water resources protection; Environmental perspective framework; Microeconomics and Macro Economics of the Environment; Natural Resources Economics; Soil and water resources and economic development; The importance of rural sociology in the field of soil and water resources protection; Water management postulates - a precursor to the public-law function of water management and erosion protection; Social relations in the field of water; Valorisation of the effects of erosion processes and soil conservation; Economic function of regulation of water and waterflows; Production factors in anti-erosion amelioration systems; Company funds; Costs and cost classification; Investments; Financing of water management and protection against erosion and regulation of torrential flows; Business success assessment; Methods for evaluating the cost-effectiveness of projects; Valuation of ecosystem services; Sustainable development and natural resources; Socio-economic aspects of climate change; Flood and natural disaster insurance; Basics of Econometrics. Final work

Practical teaching:

Practical classes include exercises in theoretical units as well as the writing of seminar essays from specific units.
Professional practice is compulsory within the subject.

Literature

1. Gittinger, J.P. (1982): Economic Analysis of Agricultural Projects, Second Edition, Johns

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Hopkins University Press, Baltimore

2. Harris M. J. (2006): Environmental and Natural Resource Economics – A Contemprorary Approach, HOUGHTON MIFFLIN COMPANY, Boston, New York
3. Zlatić, M., Todosijević, M. (2019): Economics of Soil and Water Resources Protection (textbook in print), Faculty of Forestry, Belgrade (in Serbian)
4. Zlatić, M., Todosijević, M. (2017):Practicum: Economics of Natural Resources Conservation, Faculty of Forestry, Belgrade(in Serbian)
5. Pešić, R. (2012): Environmental Economics and Natural Resources Economics, University of Belgrade, Faculty of Agriculture, Institute of Textbooks Belgrade(in Serbian)
6. Rebecca Clark (2013): Methodologies for the economic analysis of soil erosion and conservation, CSERGE Working Paper GEC 96-13, Overseas Development Group University of East Anglia Norwich
7. Zlatić, M., Kostadinov, S. (editors) (2018): Soil and Water Resources Protection in the Changing Environment, CATENA Soil Sciences, Advances in GeoEcology 45,Imprint of Schweizerbart Science Publisher, Stutgart.
8. Environment and Energy, 2015, Guide to Financing Protected Areas, UN Development Program(in Serbian)
9. Pascual U., Muradian R. (2010): The Economics of Ecosystems and Biodiversity: The Ecological and Economic Foundations
10. Serbia's Biodiversity Strategy 2011-2011, Ministry of Environment and Spatial Planning(in Serbian)
11. A. Belullo (2011): Introduction to Econometrics, Juraj Dobrila University of Pula, Department of Economics and Tourism „Dr. Mijo Mirković“ (in Croatian)

Number of active teaching hours	**Theoretical classes: 2**	**Practical classes: 2**

Teaching Methods: Lectures with the interaction between professors and students, as well as between students themselves; preparation of studies and acquisition of practical knowledge in the preparation of investment programs in exercises; fieldwork

Evaluation of knowledge (maximum score 100)

Pre-exam obligations	points	**Final exam**	points
Activity during the lectures	**5**	Written exam	
Practical teaching	**15**	Oral exam	51
colloquium	**15**	.....	
Seminar Essay	**14**		

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List of **modernized** subjects included in the study program of basic academic studies Ecological engineering for soil and water resources protection:

1. Soil conservation
2. Organization of anti-erosion works
3. Management of soil and water resources in protected areas

Study program: Ecological engineering for soil and water resources protection
Subject name: Soil conservation
Teacher(s): Snežana Belanović Simić, Mirjana Todosijević
Subject status: compulsory
ECTS: 6
Requirement:
Subject aim: The study of methods and strategies for sustainable land management; designing a soil conservation system
Subject outcomes: Upon completion of the program in the subject of soil conservation, students will be able to: - Describe the direct and indirect effects of the soil degradation process; - analyse models and carry out the calculation of soil loss; - describe the system of measures for soil conservation; - design systems for soil conservation using IT, analyse the complex of the problem of the erosion control organization of the territory and sustainable land management; - full ability of students for practical solving of problems in the field of soil conservation and preparation for master studies.
Subject content: Theoretical learning: SOIL AS A NATURAL RESOURCE: Definition of natural resources, Classification of natural resources (according to sources: biotic, abiotic; according to the state of evolvement - potential resources, current resources, reserves of resources; according to renewability - renewable, non-renewable), Natural capital, natural resources utilization, Natural resource limitations, Protecting natural resources. SOIL AS AN ECOSYSTEM: Definition, Functions, Role of soil cover in the biosphere, Soil resource constraints, Soil degradation processes, Soil degradation dynamics, Soil dynamics in natural and agro-ecosystems, Types of Soil degradation. SOIL QUALITY: Concepts of soil quality and safety, Concept of conservation in agriculture, Soil management in the 21st century. ASSESSMENT OF PRODUCTION, VALUES OF SOIL SPACE AND ORGANIZATION OF TERRITORY (US classification, Classification of soil use according to the - FAO, Yugoslav classification of soil for plant production. EROSION AND SOIL PRODUCTIVITY: changes in soil properties due to erosion; the complexity of the erosion-productivity relationship; estimates of the long-term effects of erosion on productivity; directions for future consideration of the erosion-soil relationship ductility. MODELS FOR SOIL EROSION LOSS: Methods for Estimating Soil Loss; Empirical Models; Water Erosion: USLE / RUSLE; Morgan and Morgan-Finney Method; Eolian Erosion: Woodruff and Siddoway Method; Pasak Method; Models Based on Physical Laws, WATEM / SEDEM. SOIL CONSERVATION: Soil and Water Conservation as a Basis for Sustainable Soil Quality Management and Improvement Approaches to Soil Conservation; Strategies for controlling soil erosion and improving soil quality in agro-ecosystems. Soil Erosion and Quality, Tolerant Soil Loss; Soil conservation systems; Planning/analysis process for selection of conservation strategy: Arable soil; Pastures; Forest soil; Marginal (unproductive) soils; Agroforestry systems; Urban areas. System of soil conservation measures: Agromeliorative measures (phytomeliorative measures); Pastures as a measure of erosion protection (functions of grass ecosystems, structural units of grass ecosystems, grassland); Soil management measures, Technical

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measures (terracing of land). Soil degradation and economic consequences.
Practical lessons:

Practical training focuses on the analysis of particular forms of soil degradation, the choice of a classification system for assessing the suitability of soil for use in terms of the development of certain degradation processes as limiting factors, the selection and application of selected models for the calculation of soil loss, analysis of individual components of the model. Design of soil conservation system, selection of best management measures and analysis of anti-erosion effects in soil conservation system. To create the project, students use open source GIS programs as well as remote sensing data for specific parameters (coverage, exposure, altitude, slope, etc.). Students present their results in final projects.

Literature:

1. Kadović R. (1999): Anti-erosion Agro-Ecosystems - Land Conservation, Faculty of Forestry, the University of Belgrade (In Serbian)
2. Belanović Simić, S. (2017): Land Quality and Safety in the 21st Century, Chapter in the Book - Land Quality - Challenges of the Utilization System, University of Belgrade - Faculty of Forestry, CD-ROM, ISBN 978-86-7299-258-8, p. 71-103 pages. (In Serbian)
3. Morgan, R.P.C. (2009): Soil Erosion and Conservation. Blackwell Publishing

Number of active teaching hours	**Theoretical classes: 2**	**Practical classes: 3**

Teaching Methods:

Evaluation of knowledge (maximum score 100)

Pre-exam obligations	Points	**Final exam**	points
Activity during the lectures	**5**	Written exam	
Practical teaching	**15**	Oral exam	51
Seminar Essay	**15**	.....	
Pre-exam obligations	**14**		

Study program: Ecological engineering for soil and water resources protection

Subject name: Organization of erosion control works

Teacher(s): Nada Dragović, Tijana Vulević

Subject status: compulsory

ECTS: 6

Requirement:

Subject aim

Knowledge in the field of planning and execution of works on the protection of soil and water resources with the application of modern organizational methods.

Subject outcomes

Acquired knowledge from the general principles of organization of work, measurement, and standardization of work and specific technologies of carrying out works on the protection of water and soil resources. The student acquires knowledge about the preparation of works and the development of a construction organization project that would include knowledge of planning methods with the development of static and dynamic plans. In addition, the student acquires knowledge about the organization of the company, as well as the laws and regulations.

Subject content

Theoretical Teaching

Specific object construction in torrential watershed; General principles of work organization; Project

management for river basin management; Preparation of construction of erosion controlobejcts - Work study; Technological process study; Valuation and rewards; Quality control; Measuring and standardizing work; Rationalization in the field of erosion control works; work distributions: preparatory, main (earth, masonry, concrete, carpentry, etc.) and final works; Project of organization and technology of construction of erosio conrol objects; Workflow technology.

Planning of erosion control works - Time and Resource Planning; Work duration calculation; Resource needs calculation; Static and dynamic plans; Network planning; Application of computer programs in the planning of erosion control works

Fundamentals of Operations Research and Methods (Dynamic Programming, Linear Programming); Optimization of time and resources in the construction of erosion control objects; Organization of a river basin management company; Laws and regulations for the construction of structures for the regulation of torrential catchments and protection of soil from erosion; Ergonomics in anti-erosion works.

Practical classes

Working days fund analysis; Technological process study; Calculation of duration of works (civil engineering, biological and agro-technical works); Resource needs calculation; Static plans; Dynamic plans (Gantt charts); Network planning; Application of computer programs in planning of erosion control work-MS Project; Optimization of resources (manpower, materials and machinery and financial resources).

Professional practice is compulsory within the subject.

Literature:

1. Dragović, N. (2012): Organization of Erosion Control Works, Exam Preparation Material, University of Belgrade Faculty of Forestry, Belgrade (In Serbian) Ivković, B., Arizanović, D. (1990): Organization and Technology of Construction Works, Faculty of Civil Engineering, Belgrade
2. Arizanović, D. (2008): Building Technology, Learning Materials, University of Belgrade Faculty of Civil Engineering, Belgrade (In Serbian)
3. Ćirović, G. (2002): Problems of planning, organization, and technology of construction, College of Civil Engineering and Geodesy in Belgrade
4. Čomic, R. (1999): Production Organization and Management in Forestry, Faculty of Forestry, University of Banja Luka, Banja Luka

Number of active teaching hours	**Theoretical classes: 3**	**Practical classes: 3**

Teaching Methods:

Lectures with an introduction to the literature in this discipline. Students gain practical knowledge in organizing and planning the execution of works for the protection of soil and water resources, and through the production of the seminar, papers show a personal initiative in solving problems in the rational and economical construction of buildings.

Evaluation of knowledge (maximum score 100)

Pre-exam obligations	points	**Final exam**	points
Activity during the lectures	8	Written exam	
Practical teaching	20	Oral exam	*45*
colloquium	15	.....	
Seminar Essay	12		

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Study program: Ecological engineering for soil and water resources protection

Subject name: Management of soil and water resources in protected areas

Teacher(s): Ratko Ristić, Mirjana Todosijević

Subject status: elective

ECTS: 5

Requirement:

Subject aim

Familiarity with the methods and techniques used to manage land and water resources in protected areas, in accordance with the category and dominant conditions in the protected area.

Subject outcomes

Acquired knowledge about ways of managing land and water resources in protected areas.

Subject content

Theoretical Teaching:

Introduction to the categorization of protected areas and the criteria by which they are allocated (strict and special nature reserve, national park, nature monument, protected habitat, landscape of exceptional features, nature park); analysis of opportunities for degradation of soil and water resources in protected areas; the level of tolerable load of space in protected areas; methods and techniques for managing soil and water resources in protected areas. Practical classes:

Exercises, Other forms of teaching, Study research work. Defining opportunities for degradation of land and water resources in protected areas; the influence of natural and anthropogenic factors; examples of sustainable management based on case study analyzes; determining optimal management techniques according to the category of the protected area.

Literature

1. Ristić, R. (2013): Management of soil and water resources in protected areas. Lecture material (in preparation). Faculty of Forestry. Belgrade.
2. Worboys, G., LockwoodM., DeLacyT. (2001): **Protected area management: principles and practice**, Oxford University Press Australia & New Zealand; LockwoodM., WorboysG.,KothariA. (2012): Managing protected areas-a global guide, Routledge.

Number of active teaching hours	**Theoretical classes: 2**	**Practical classes: 2**

Teaching Methods

Lectures, exercises, seminar papers, fieldwork

Evaluation of knowledge (maximum score 100)

Pre-exam obligations	points	**Final exam**	points
Activity during the lectures	10	Written exam	
Practical teaching	15	Oral exam	49
colloquium	16	.....	
Seminar Essay	10		

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Name of the study program: **Ecological engineering for soil and water resources protection**

Type and level of study: **master's degree studies**

The Faculty of Forestry has adopted the structure of study programs for 4 + 1 + 3 years. According to the approved structure of the Master's academic studies, they last one year or 2 semesters with a total of 60 ECTS. Master of Academic Studies in Ecological engineering for soil and water resources protection are organized through three modules:

- Module 1- Protection of water resources of mountainous areas,
- Module 2 - Degradation and protection of soil resources,
- Module 3 - Managing sustainable development in degraded areas.

The Master's Degree Moduls in Ecological engineering for soil and water resources protection have five compulsory subjects, one of which is a common subject for all three modules. The master study program (modules) also have a number of elective courses on the basis of which students expand their knowledge in the chosen direction. The teaching process in this study program is carried out through lectures, exercises, seminars, colloquiums, exams, study research work, professional practice, and master's thesis. The Master's thesis is done in conjunction with the study research work in the second semester, with a topic in the field of the chosen module and has 15 ECTS.

The list of compulsory and elective study areas, i.e subjects, with indicative content is contained within the Curriculum of the Master Academic Studies Program (http://www.sfb.bg.ac.rs/study-programs/master-studije/studijski-programi/ environmental-engineering-in-protection-of-land-and-water-resources /) available on the Faculty website. The credit score of each item is reported in accordance with the European Credit Transfer System (ECTS).

Prerequisites for enrollment in the Master Academic Studies in Ecological engineering for soil and water resources protection are basic academic studies with 240 ECTS at the Faculty of Forestry or similar study programs of other faculties, ie universities in the country and abroad, with which the programs of this faculty are aligned. To transfer or enroll in other study programs within the same or related fields of study, students take the differential exams provided for by the Faculty's acts.

After completing their studies, candidates are given a professional, or academic title - Master Forestry Engineer for the field of Ecological engineering for soil and water resources protection. Candidates who complete the Master of Academic Studies in the Environmental Engineering Program in Ecological engineering for soil and water resources protection acquire an academic title (based on the Rulebook on the list of professional, academic and scientific names established by the National Council ("Official Gazette of the RS, No. 30/2007, 112/2008, 72/2009, 81/2010, 39/2011, 54/2011, 53/17 and 88/17): master forestry engineer and the diploma supplement contains the name of the field - Ecological engineering for soil and water resources protection.

List of new subjects included in the Master's Degree Program in Ecological engineering for soil and water resources protection:

1. Surface water resources
2. Stabilization of the terrain

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Study program: Ecological engineering for soil and water resources protection

Subject name: Sruface water resources

Teacher(s): Vesna Đukić

Subject status: compulsory

ECTS: 6

Requirement

Subject aim

The objective of the course is to study in more detail the surface water resources from the water management aspect. Bearing in mind the strategic importance of the water resources of the mountainous areas for water management of Serbia, special attention is paid to the study of water resources of these areas, as well as water management facilities in these areas - dams and reservoirs

Subject outcomes

Accomplishing course goals

Subject content

Theoretical Teaching

Complex study of Serbian water resources. Utilization of water resources in particular regions (supply of population and industry with water, hydropower use of water resources, irrigation, fisheries, tourism). The importance of multifunctional regional hydrosystems. Water resource protection (pollution source analysis, water quality control and water protection strategy). Impact of erosion, transport and sediment deposition on water quality. Regulation of water resources, especially, erosion and torrential defenses in mountainous areas. Consideration of the basic factors of the water balance of hilly and mountainous areas, as well as the types of surface water presence. The role of reservoirs in the integral regulation and management of water resources. Analysis of rainfall, runoff and water potentials of basins and watercourses. Sizing up the reservoir. Accumulations and deposition. Distribution of deposits within reservoirs. Calculation of sediment accumulation backfill intensity and forecast of probable accumulation life. Analysis of the possibility of occurrence and cause of the process of eutrophication of water in reservoirs. Application of hydraulic and hydrological models in analyzes of water resources. Analysis of transport and sedimentation processes in water resources using hydraulic models. Application of theoretical knowledge in the analysis of water resources and water management issues.

Practical classes

The hydrological potential and conditions of water use and protection in particular mountainous areas are considered. Analysis of possibilities for solving water resource management tasks by establishing mathematical models of reservoirs. Sizing up reservoirs. Calculation of sediment accumulation backfill intensity and forecast of probable accumulation life. Modeling of movement of water and sediment within water resources using hydraulic and hydrological models.

Литература

1. (2002): Water management basis of the Republic of Serbia
2. Djordjević, B. (1990): Water Management Systems, Scientific Book, Belgrade Water Law, Official Gazette of the RS. No. 46, 1991Zelenhasic, E., Ruski, M. (1991): Engineering Hydrology, Scientific book, Belgrade. (In Serbian)
3. Zelenhasic, E., Ruski M. (1991): Engineering Hydrology, Scientific book, Belgrade, (In Serbian)

Number of active teaching hours	**Theoretical classes: 2**	**Practical classes: 2**

Teaching Methods

Lectures, exercises, seminar esseys, fieldwork			
Evaluation of knowledge (maximum score 100)			
Pre-exam obligations	points	**Final exam**	points
Activity during the lectures	10	Written exam	
Practical teaching	15	Oral exam	49
Colloquium	16	.....	
Seminar Essay(s)	10		

Study program: Ecological engineering for soil and water resources protection

Type and level of study

Subject name: Stabilization of terrain

Teacher(s): Grozdana Gajić

Subject status: elective

ECTS: 4

Requirement:

Subject aim

Acquiring knowledge about methods of stabilizing conditionally stable and unstable terrain. The curriculum includes methods of study, mapping, and observation, which will serve to decide on the application of measures and techniques for establishing the stability and functionality of terrain degraded by unstable phenomena and erosion processes. In addition, the goal is to gain knowledge on measures to use and maintain a stabilized terrain as a final project for the stabilization of the terrain.

Subject outcomes

Acquired knowledge of studying conditionally stable and unstable terrain; knowledge of stabilization procedures, measures, and techniques, as well as measures of use and maintenance of stabilized terrain.

Subject content

Theoretical Teaching

General on Terrain Stabilization; Stable and unstable terrains; Methodology for the study of terrain stabilization; indications of unstable terrain; research sequence; criteria for applying stabilization. Stabilization of terrain for the purpose of construction of erosion protection structures and torrents protection; stabilization for the purpose of rehabilitation of terrain affected by erosion.

Mechanical stabilization - Terrain stabilization by compaction: the behavior of different types of soil during compaction, surface compaction, deep compaction. Stabilization by replacing the layer of bad characteristics with a layer of better physical-mechanical characteristics: determining the composition of the mixture according to the criterion of the assumed granulometric composition, determining the composition of the mixture according to the criterion of the assumed plasticity. Perform mechanical stabilization.

Lime soil stabilization - Lime terrain stabilization, lime terrain stabilization mechanism, lime stabilization suitability, lime impact on physical mechanical characteristics of a stabilized mixture, determination of stabilization mixture composition, lime stabilization performance, the role of lime soil stabilization in the construction of spilled objects. Soil cement stabilization: mechanism of soil stabilization with cement, the suitability of the soil for stabilization with cement, determination of the composition of the mixture for stabilization, the performance of stabilization with cement.

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Bitumen stabilization.

Stabilization with geosynthetics: Primary functions of geosynthetics, Division of geosynthetics: geotextiles, geogrids, geomembranes, geocomposites; criteria for application of geosynthetics for terrain stabilization, use of geosynthetics for stabilization of erodible terrains, use of geosynthetics for stabilization of poorly bearing and deformable terrains. Measures of use and maintenance of stabilized terrain.

Production of Master Work.

Practical classes

Research sequence and required research works; Geotechnical research report for terrain stabilization. Defining criteria for selecting terrain stabilization. Design of a stabilization project and implementation of projected measures of terrain stabilization. Professional practice is compulsory within the subject

Literature

1. Gajić G. (2010): Laboratory geotechnical testing - determination of physical and mechanical properties of soil. University textbook, Faculty of Forestry, Belgrade. (In Serbian)
2. Todorović T. (1991): Fundamentals of geotechnics in torrents. University textbook, Faculty of Forestry, Belgrade. (In Serbian)
3. Gajić G. - lecture materials, Faculty of Forestry in Belgrade. (In Serbian)
4. Spasić M. (2017): Improvement of physical-mechanical properties of soil in the function of landslide remediation. Master thesis, Faculty of Forestry, Belgrade
5. Fu Hua Chen (2000) „SOIL ENGINEERING: TESTING, DESIGN, AND REMEDIATION“ CRC Press LLC, 2000 Corporate Blvd., N.W., Boca Raton, Florida
6. Bujang B.K. Huat, Arun Prasad, Afshin Asadi, Sina Kazemian (2014) „Geotechnics of Organic Soilsand Peat“ CRC Press/Balkema Taylor & Francis Group, London, UK
7. Stokes A., Spanos I., Norris J.E., Cammeraat E. (2007) „ECO- AND GROUND BIO-ENGINEERING: THE USE OF VEGETATION TO IMPROVE SLOPE STABILITY“ Proceedings of the First International Conference on Eco-Engineering 13–17 September 2004

Number of active teaching hours				Other classes
Theoretical classes	Practical teaching	Other forms of teaching	Study and research work	

Teaching methods

Lectures, interactive forms of teaching and presentations of each methodological unit with examples from practice. Through practical teaching, students gain knowledge and first experience in designing, elaborating on the necessary tests for degraded terrain and designing a project for stabilizing the terrain on given examples.

Evaluation of knowledge (maximum score 100)

Pre-exam obligations	Points	Final exam	Points
Activity during the lectures	**5**	Written exam	**20**
Practical teaching	**20**	Oral exam	**40**
Colloquium	**10**	.....	
Seminar Essay(s)	**5**		

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List of advanced subjects incorporated in the Master's Degree Program in Environmental Engineering in Soil and Water Resources Protection:

1. Quality management in the protection of soil and water resources
2. Valuation of natural resources

Study program: Ecological engineering for soil and water resources protection

Type and level of study

Subject name: Quality management in soil and water resources protection

Teacher(s): Nada Dragović, Tijana Vulević

Subject status:

ECTS: 8

Requirement:

Subject aim

Acquiring basic knowledge of the characteristics and importance of quality for the successful implementation of projects for the protection of soil and water resources. The aim of the course is to acquire the skills needed for quality management, quality engineering and environmental quality system, from the basic characteristics of the quality management process to the principles, tools and standards for quality management and protection of soil and water resources.

Subject outcomes

Acquired knowledge of approaches, principles and strategies for successful quality management in the protection of soil and water resources. Acquired knowledge for development of quality strategy and policy in protection of soil and water resources and application of methods for planning, ensuring and quality control of technological processes in realization of conservation measures and works. Skills acquired to apply quality standards in the protection of soil and water resources.

Subject content

Theoretical Teaching

Definitions of quality, Basic phases of definition and determination of quality, Quantitative and qualitative characteristics of quality, Quality management processes in the protection of soil and water resources, Strategic planning and quality, Quality management processes, Quality planning (process of defining projected quality), Quality Planning Tools and Techniques, Quality Assurance, Quality Control, Quality Control Tools and Techniques, Costs of Quality (Costs causes by errors, Error Prevention Costs), Quality Management System (QMS) - Subsystems, Evidence of Compliance with Quality Standards - Certification , accreditation, Quality of soil and water conservation projects.

Practical classes

Solution of practical tasks in the field of application of quality tools (checklists, flowchart, Pareto diagram, cause and effect diagram, scatter diagram) and quality techniques (statistical process management, FMEA failure mode and effects analysis, QFD technique and type of QFD matrix), ISO Standards - Environmental Standards, series of standards ISO 14000.

Literature

1. Filipović, J., Djurić, M. (2010): Quality Management System, University Textbook, University of Belgrade Faculty of Organizational Sciences, Belgrade (In Serbian)
2. Ivkovic, B., Popovic, J. (2005): Project Management in Construction, Measurement Book, Belgrade (In Serbian)
3. Ćirovic, G., Lazić Vojinović, S. (2006): Quality Management in Construction (Sixth Edition), College of Civil Engineering and Geodesy, Belgrade (In Serbian)

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4. Mijatović, I. (2009): Quality Management Technology, Authorized Script, University of Belgrade Faculty of Organizational Sciences, Belgrade (In Serbian)

Number of active teaching hours				Other classes
Theoretical classes 2	Practical teaching 2	Other forms of teaching	Study and research work	

Teaching methods

Lectures with introduction to the literature in this discipline. Through the exercises, students gain practical knowledge in the application of quality management tools and standards in this field, and through the production of seminar essays show a personal initiative in solving quality problems in the protection of soil and water resources.

Evaluation of knowledge (maximum score 100)

Pre-exam obligations	Points	Final exam	Points
Activity during the lectures	**10**	Written exam	
Practical teaching	**10**	Oral exam	**45**
Colloquium	**15**	.....	
Seminar Essay(s)	**20**		

Study program: Ecological engineering for soil and water resources protection

Type and level of study

Subject name: Natural capital valuation

Teacher(s): Mirjana Todosijević, Miodrag Zlatić, Katarina Lazarević

Subject status: compulsory

ECTS: 6

Requrement:

Subject aim

Complementing the spectrum of knowledge in the field of economics and the evaluation of natural resources

Subject outcomes

The acquired knowledge in this field will enable students to make the right decisions regarding environmental problems

Subject content

Theoretical Teaching

Economics of renewable resources; Economics of non-renewable resources; Macroeconomic evaluation of natural resources; Valuation techniques; Economic effects of climate change.

Production of Master Work.

Practical classes

Practical classes include exercises in theoretical units as well as the production of seminar essays from specific units.

Literature

1. Perman, R., Ma, Y., Common, M., Maddison, D., McGilvray, J. (2011): Natural Resource and Environmental Economics, 4th edition, Pearson Education Limited, Essex, England
2. Goodstein, S., (2011): Economics and the Environment, 6th edition, John Willey & Sons, USA
3. Pešić, R. (2012): Environmental Economics and Natural Resources, University of Belgrade, Faculty of Agriculture, Institute of Textbooks, Belgrade (In Serbian)

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4. Zlatić, M. (2010): Socio-Economic Issues of Sustainable Land Management in Serbia, Global Change Challenges for Soil Management, Editor: Zlatić, M., Advances in Geoecology, Volume 41, Catena Verlag, Reiskirchen.

Number of active teaching hours				Other classes
Theoretical classes	Practical teaching	Other forms of teaching	Study and research work	

Teaching methods

Lectures with an introduction to the literature in this discipline. Students acquire practical knowledge in the application of natural capital valuation through exercises, and through the production of the seminar, essays show a personal initiative in solving problems in this field.

Evaluation of knowledge (maximum score 100)

Pre-exam obligations	Points	Final exam	Points
Activity during the lectures	**10**	Written exam	
Practical teaching	**10**	Oral exam	**40**
Colloquium	**20**	.....	
Seminar Essay(s)	**20**		

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