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 2.4

Title : **Established new master programme**

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

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

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

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 CONTROL SHEET

Ref. No and Title of Activity	**2.4 Established new master programme**
Title of Deliverable:	**Syllabi of the elective subjects**
Institutions:	UNS, UB
Author/s of the deliverable	UB, UNS, UNI, UBL, UNSA
Status of the document:	final

Study program: Soil erosion and torrential flood prevention

Course title: Land melioration

Teacher/teachers: Radovan Savić, Atila Bezdan, Milica Vranešević, Aleksandar Baumgertel

Course status: elective (1)

Number of ECTS credits: 4

Requirement(s): /

Course objective: Introducing students to hydrotechnical reclamation measures such as irrigation and drainage systems, to ensure optimal water regime of the land, as well as flood protection measures.

Course outcome: The outcome of this course is a complete knowledge of the problems in this area and ways to solve it.

Course content: Melioration problems in the world and in our country. Land melioration of different types of land. Phases, content, and sequence of reclamation works. Irrigation (Irrigation goals; Types of irrigation; Optimal soil moisture, irrigation norm; Water quality for irrigation). Motives and goals of drainage; Water-physical properties of soil; Excess water; Determination of relevant excess water; Water balance; Drainage hydro module. Substrates for drainage system design. Drainage methods. Elements of drainage systems. Surface drainage; Sewer network; Route; Sizing; Transverse and longitudinal profiles; Flow rates; Flow; Channel network density. Underground drainage; Horizontal pipe drainage; Calculation methods; Depths; Space; Diameter; Falls; Filter materials; Critical drainage; Vertical drainage; Drainage wells. Water drainage for protection against erosion and torrential floods; Operation and maintenance of drainage systems; Floods; The allowable power of the water trough; Causes of floods; Floods on lowland alluvial rivers; Floods caused by ice; Torrential floods; Flood protection; Active and passive flood protection measures; Flood defense embankments; Types of embankments; Structural characteristics of the embankment; Protective measures to preserve the functionality of the embankment; Flood damage. Application of GIS and remote sensing in hydro-technical melioration.
Development of a project for a drainage system with an open canal network, Development of a project for a drainage system with horizontal pipe drainage.

Literature:
- Avakumović D. (2005): Drainage, Faculty of Civil Engineering, Belgrade. (in Serbian)
- Belić S., Benka P. (1996): Irrigation and drainage technology, Faculty of Agriculture, Novi Sad. (in Serbian)
- Kolaković S. (2006): Hydrotechnical land reclamation - drainage, University of Novi Sad. (in Serbian)
- Jovanović B.M. (2008): River regulation, river hydraulics, and morphology, Faculty of Civil Engineering, Belgrade. (in Serbian)
- Babić-Mladenović M. (2013): River Regulation, Institute of Water Management Jaroslav Černi, Belgrade. (in Serbian)
- Kolaković S. (2012): Flood Defense, FTN. Novi Sad. (in Serbian)
- Letić Lj. (2001): Bioregulation, Faculty of Forestry, Belgrade. (in Serbian)

Number of teaching hours (per week)	**Theoretical classes: 2**	**Practical classes: 2**

Teaching methods: Lectures; Consultations; Arithmetic exercises; Preparation of assignments and studies **Evaluation of knowledge (maximum score 100)**

Pre-exam obligations	points	**Final exam**	points
Activity during the lectures	**10**	Written exam	
Practical teaching	**40**	oral exam	**40**
seminar paper	**10**		

Project number: 598403-EPP-1-2018-1-RS-EPPKA2-CBHE-JP (2018 – 2579 / 001 – 001)
"This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein"

Study program: Soil erosion and torrential flood prevention

Course title: Conservation of karst terrain

Teacher/teachers: Muhamed Bajrić, Ćemal Višnjić, Emira Hukić

Course status: elective (1)

Number of ECTS credits: 4

Requirement(s): /

Course objective: Anthropogenic impacts have left an indelible mark on forest ecosystems, especially on karst terrains ranging from sub-Mediterranean areas to high mountain forest ecosystems in Bosnia and Herzegovina. Overgrown with forest vegetation, these habitats show resistance to the effects of changes in environmental factors, and due to afforestation, they are exposed to rapid processes of erosion by wind and water and complete desertification. Therefore, the course explains the specifics of the development of different types of soil on karst terrain, as well as the development of special forms of erosion processes. Also, students will have a clear idea of the problems of space management, and above all soil resources in the karst terrain, through the completed course in this subject and applying the acquired knowledge from the same subject.

Course outcome: After mastering the discipline, students should understand the dynamics of the formation and mechanisms of development of the karst erosion process with all its specifics.

Course content: In the introductory part, the course deals with the geomorphology and hydrology of karst terrains, natural pedogenetic factors, and soil characteristics of karst terrains. Special emphasis should be placed on the water-mechanical properties of the soil, which predispose to erosion processes and soil degradation in karst terrain in general. Then, the mechanisms of karst processes, types of karst erosion, specifics of karst transport and accumulation, development of specific forms of surface and underground karst relief, hydrogeology of karst areas, and causes and phenomena and condition of forest pigeons on karst in Bosnia and Herzegovina are discussed. The main part of the course is focused on breeding measures that prevent the degradation of forest ecosystems on karst or deal with afforestation of forest barren land on degraded land, the importance of afforestation of forests on karst. The aim of these measures is ecological, sociological and production function, ways of growing forest crops on karst, forest vegetation on karst, various forms of degraded forest (forests, shrubs, bushes), forest bare on karst, selection of karst afforestation species, native species trees, models of tree species optimization for afforestation according to dominant habitat factors. Surface preparation for karst afforestation, surface cleaning, removal of weeds, soil preparation. Methods of raising forest crops, methods of growing forest crops by sowing seeds. Ways of raising forest crops on karst by planting seedlings, special planting techniques - use of superabsorbers when planting seedlings on karst, special methods of covering the root system of seedlings with soil bales just before planting.
Practical classes are led through practical tasks in which the student conducts field research and applies field methods and creates a study.

Literature:

- Jahić Munir (2008): Editing torrents, Faculty of Forestry in Sarajevo. (in Bosnian)
- Kostadinov Stanimir (2006): Torrents and erosion, Faculty of Forestry in Belgrade. (in Serbian)
- Study on karst management (2011): Prepared by CEPOS - Center for Support to Sustainable Management of Forest Resources, Client: Federal Ministry of Agriculture, Water Management and Forestry of FBiH, Sarajevo. (in Bosnian)
- Nikić Zoran, Pavlović Radmila (2012): Hydrogeology with geomorphology, University of Belgrade, Faculty of Forestry in Belgrade (in Serbian)

Number of teaching hours (per week)	**Theoretical classes: 2**	**Practical classes: 2**

Teaching methods: Lectures. Consultations. Field and seminar paper and presentation.

Evaluation of knowledge (maximum score 100)

Pre-exam obligations	points	**Final exam**	points
Activity during the lectures	**10**	Oral exam	**60**
seminar paper	**20**		
project presentation	**10**		

Study program: Soil erosion and torrential flood prevention

Course title: Climate change adaptation

Teacher/teachers: Slobodan J. Milutinović

Course status: elective (1)

Number of ECTS credits: 4

Requirement(s): /

Course objective: Enabling students to understand existing climate change-related problems caused by anthropogenic impacts, and the role adaptation measures play as a key to addressing these issues.

Course outcome: Students' competence and acquisition of skills for:

independent study of the ecological and evolutionary implications of climate change on natural systems, as well as human and cultural implications for social and socio-economic systems;

implementation of different adaptation frameworks, as well as specific adaptation measures to policies in different sectors, to more effectively manage climate change risk, reduce system vulnerability and increase their resilience;

independent or teamwork to develop sensitivity analyses and action plans for climate change adaptation at national and local levels.

Course content:

Theoretical teaching

The basics of climate change and adaptation to climate change. Hydrological and carbon cycle, greenhouse gases, climate sensitivity. Climate projections and scenarios.

Adaptation and mitigation. Vulnerability, resilience, and adaptability in ecological and social systems. Adaptation and equitable development.

Impact of climate change in different sectors and adaptation measures: water resources and water safety; public health; agriculture; forestry; energetics; biodiversity.

Climate impacts and vulnerability in urban systems. Urban vulnerability assessment and adaptation mechanisms. Planning for adaptation to climate change in urban areas.

Impact of climate change on water and aeolian erosion. Vulnerability assessment and adaptation measures. Managing the implementation of adaptation measures globally and nationally. National Framework for Climate Change and Disaster Risk Reduction. Financing and monitoring climate change adaptation.

Case Studies: EU Climate Change Adaptation Strategy; Climate change adaptation strategy for the Danube basin; Climate Change Adaptation Action Plan with Vulnerability Assessment for Belgrade; Climate Change Adaptation Action Plan for Kraljevo.

- Milutinović, S. (2018). Manual for planning adaptation to changed climate impacts in local communities in Serbia. Belgrade: Standing Conference of Cities and Municipalities (in Serbian)
- Government of the Republic of Serbia (2016). The first national plan for adaptation to changed climatic conditions. (in preparation). (in Serbian)
- UNDP (2015). Summary of the chapter on Climate Change, Affection, and Adaptation of the Second Report of the Republic of Serbia under the UN Framework Convention on Climate Change. Belgrade: UNDP. (in Serbian)
- Climate change adaptation action plan with vulnerability assessment for Belgrade. (2015). (in Serbian)

Number of teaching hours (per week)	**Theoretical classes: 2**	**Practical classes: 2**

Teaching methods: Lectures, auditory exercises, consultations

Evaluation of knowledge (maximum score 100)

Pre-exam obligations	points	**Final exam**	points
Activity during the lectures	**20**	oral exam	**40**
Activity during exercises	**20**		
colloquium	**20**		

Project number: 598403-EPP-1-2018-1-RS-EPPKA2-CBHE-JP (2018 – 2579 / 001 – 001)
"This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein"

Study program: Soil erosion and torrential flood prevention

Course title: Project management in natural resources protection

Teacher/teachers: Nada Dragović, Tijana Vulević

Course status: elective (1)

Number of ECTS credits: 4

Requirement(s): /

Course objective: Acquiring basic knowledge of methods for successful project management of soil and water resources. The course objective is to acquire the skills required for project management from the basic idea to their realization through the preparation, planning, and execution of works. The skills acquired through the program are related to the application of methods and techniques in the field of human resources management, project planning, and control, project management, contract management, quality and risk management.

Course outcome: Acquired knowledge of the approach, principles, and strategies for successful project management of soil protection against erosion and torrential floods. The skills acquired in the program relate to the application of methods and techniques in the field of human resource management, planning, and control of project implementation, contracting, quality, and risk management on the project.

Course content

Theoretical Teaching

Concept, tasks, and importance of project management; the Life cycle of natural resource conservation projects; Human resources management: forming a project team, participants in project implementation; Planning the realization of projects for the protection of natural resources: planning of time, resources (materials, labor, mechanization) and costs; Monitoring and control of project implementation; Project documentation and construction site documentation; Contract management (types and content of contract); Project risk management; Quality management; Safety and protection at work; Change management.

Practical Teaching

The solution of practical tasks in the field of Planning of realization of projects for the protection of natural resources (application of numerical, graphic and methods of network planning); Time and resource planning (identifying critical work and time reserves, calculation of resource number and costs); Application of methods for identification and analysis of project risks; Computer Project Management Software: MS Project, Primavera.

Literature:

Jovanović, P. (2008): Project Management. Eighth Edition, College of Project Management, Belgrade (In Serbian)

Ivković, B., Popović, J. (2005): Project Management in Construction, Measurement Book, Belgrade (In Serbian)

(2010): Project Management Knowledge Corps Guide (PMBOK® Guide), IMP (Project Management Institute), translators Bojan L. et al. Faculty of Technical Sciences, Novi Sad (In Serbian)

Number of teaching hours (per week)	**Theoretical classes: 2**	**Practical classes: 2**

Teaching Methods: Lectures with an introduction to the literature in this discipline. Students gain practical knowledge in the application of planning methods in this field, and through the development of seminar paper show a personal initiative in solving the problems of project management for the protection of natural resources.

Pre-exam obligations	points	**Final exam**	points
Activity during the lectures	**10**	Written exam	**-**
practical teaching	**10**	oral exam	**45**
Colloquium	**15**		
seminar paper	**20**		

Study program: Soil erosion and torrential flood prevention

Course title: Sustainable land management

Teacher/teachers: Mariana Kapović Solomon, Miodrag Zlatić, Mirjana Todosijević, Katarina Lazarević

Course status: elective (1)

Number of ECTS credits: 4

Requirement(s): /

Course goal: Introducing students to the methods of research on sustainable land management, with a focus on problems, approaches, and techniques.

Course outcome: Students' ability to choose adequate models of sustainable land management under specific conditions of the study area.

Course content

Theoretical teaching:

Levels of intervention and activity in a multi-stakeholder approach to sustainable land management; Natural Resources Management in the local community; Collaborative management; Ecosystem approach; WEHAB approach; International legal and institutional frameworks for land; The UNCCD Convention; The role of the political and legal framework in SLM; Land-relevant initiatives (Forest Principles; International Covenant on Environment and Development; Selected Legal and Institutional Elements for Disadvantaged People); Modern techniques and approaches to sustainable land management (WOCAT methodology); Management procedures for sustainable land use; The role of education in sustainable land use;

Case study of sustainable land management in a specific area: (1) Sociological principle: meeting the needs of the population with specific product lines (surveys, interviews); (2) economic principle: achieving profitability and long-term economic effects (benefit-cost analyzes); (3) environmental principle: established production or land use is sustainable if land losses are below tolerable limits.

Practical teaching: developing a model of sustainable land management in a specific area.

Literature:

- Grazia Borrini-Feyerabend, M. Taghi Farvar, Jean Claude Nguinguiri and Vincent Awa Ndangang (2007): *Co-management of Natural Resources*, Kasparek Verlag, Heidelberg
- Ilić, B., Mihajlović, D. (2017): Management of natural resources, sustainability and protection, Megabiznis 1/1. (in Serbian)
- World Bank (2008): *Sustainable Land Management* – Source book, Agriculture and Rural Development
- Editor: Zlatic, M. (2010): *Global Change - Challenges for Soil Management*, Advances in Geoecology, Volume 41, Catena Verlag, Reiskirchen.
- 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.
- Editors: Zlatic, M. and Kostadinov, S. (2018): *Soil and water resources protection in the changing environment*, Catena, Soil Science, Advanced in GeoEcology 45, ISBN 978-3-510-65418-5, US-ISBN 1-5932
- 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 Herzegovina https://qcat.wocat.net/en/wocat/technologies/view/technologies_4367
- Kapović Solomun, M., Barger, N., Keesstra, S., Cerda, A., Marković, M. (2018): *Assessing land condition as a first step to achieving Land Degradation Neutrality*, Environmental Science & Policy 90 (2018):19-27

Number of teaching hours (per week)	**Theoretical classes: 2**	**Practical classes: 2**

Teaching methods: Lectures, consultations and exercises

Evaluation of knowledge (maximum score 100)

Pre-exam obligations	points	**Final exam**	points
Activity during the lectures	**5**	Written exam	**20**
practical teaching	**5**	oral exam	**50**
Colloquium	**20**		

Project number: 598403-EPP-1-2018-1-RS-EPPKA2-CBHE-JP (2018 – 2579 / 001 – 001)
"This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein"

Study program: Soil erosion and torrential flood prevention

Course title: Biomeliorations of barren lands

Teacher/teachers: Jugoslav Brujić, Branislav Cvjetković

Course status: elective (1)

Number of ECTS credits: 4

Requirement(s): /

Course objective: During the semester, students get the necessary knowledge about the phenomenon of barren land in forestry. Students should become familiar with the appropriate sources of starting material - seed and planting material and the parameters of their quality. Furthermore, students are introduced to the techniques of preparing the terrain for afforestation by forest tree species and shrubs, afforestation, and the maintenance of planted vegetation in the above-mentioned areas.

Course outcome: Students will get knowledge of an adequate environmentally-friendly selection of starting materials that will meet all aspects of quality: genetic, physiological, and morphometric. Also, students will gain knowledge on the preparation sites for aforestation, methods, and techniques of afforestation and maintenance of newly established planted forests.

Course contents

Theoretical teaching

Introduction. Biomelioration - concept, and classifications. A barren land - concept and classifications. Degradation of forests. The ecological classification of barren lands. B. l. on silicate substrates. B. l. on ophiolites. Biomeliorative species. Sources of starting material. Target seedlings production. Quality of planting material. Anti-erosion species. Soil covers. Serpentinophytes. Recultivation species. Types of phytoremediation. Types of syndinamic progressions. Afforestation techniques. Site preparation and planting techniques. Maintenance of planted areas. Protective functions. Special Purposes.

Practical teaching

Introduction and objectives of afforestation. Choosing species for afforestation. Ecology of barren lands. Site preparation for afforestation. Planting. Maintenance of newly established planted forests. The timetable of implementation. Costs calculation.

Literature:

Đorović, M., Isajev, V., Kadović, R. (2003): Anti-erosion and afforestation systems. Faculty of Forestry Banja Luka. (in Serbian)

Isajev V., Čomić R., Mančić A., Marić LJ.(1999): Manual for the production of forest container seedlings. Faculty of Forestry Banja Luka, Belgrade-Banja Luka 1-160 (in Serbian)

Španjol, Ž (2005): Karst melioration. (in Bosnian)

Moffat, A. (1994): Reclaiming disturbed land for forestry

Number of teaching hours (per week)	**Theoretical classes: 2**	**Practical classes: 2**

Teaching methods: Lectures. Practical classes. Consultations. Seminar paper and presentation. **Evaluation of knowledge (maximum score 100)**

Pre-exam obligations	points	**Final exam**	points
activities during the class	**20**	oral exam	**60**
seminar paper	**10**		
presentation of project	**10**		

Study program: Soil erosion and torrential flood prevention

Course title: Natural disaster risk management

Teacher/teachers: Slobodan Milutinović, Snežana Živković

Course status: elective (2)

Number of ECTS credits: 4

Requirement(s): /

Course objective: Acquiring knowledge and skills about the concept, causes, and possible consequences of natural disasters, as well as their types and ways of eventual anticipation and mitigation, with an emphasis on disaster preparedness, response, and recovery.

Course outcome:
Students' ability to:

understand the underlying processes leading to natural disasters and basic concepts in risk analysis, and propose measures and procedures to reduce the risk associated with natural disasters;

successfully participate in the organization of specialized teams and the development of operational procedures for emergency response;

contribute to the planning and implementation of appropriate analyzes, measures, and activities to prevent and mitigate the effects of natural disasters.

Introduction to Natural Disaster Risk Management; Understanding the concepts and definitions of disaster, danger, vulnerability, risk, capacity; Global trends in natural disasters; Natural disasters and development; Types, causes, consequences, and control of natural disasters; Geological disasters (earthquakes, landslides, tsunamis,…); Hydrometeorological disasters (floods, cyclones, thunderstorms, hail, avalanches, droughts, cold and heat waves); Biological disasters (epidemics, pest attacks, forest fire); Cycle and management framework for natural disasters: 10 principles of the Yokohama Strategy for a Safer World; Sendai framework; Risk assessment and analysis, risk mapping, disaster prevention, and mitigation, early warning system; Preparedness, capacity development; Evacuation; natural disaster communication; search and rescue; command system; Management in the Post-Disaster Period; Damage and need assessment; Restoration of critical infrastructure; Early recovery;

Designing a natural disaster risk management project; or seminar paper in the field of natural disaster risk management (student's choice).

- Birkmann, J. (ed.) (2013): *Measuring vulnerability to natural hazards: Towards disaster resilient societies*. Part I: Basic principles and theoretical basis. Tokyo: United Nations University Press. 7 – 106. https://collections.unu.edu/eserv/UNU:2880/n9789280812022_text.pdf
- van Niekerk, D. (2011). *Introduction to disaster risk reduction*. USAID Disaster Risk Reduction Training Course for Southern Africa. https://www.preventionweb.net/publications/view/26081
- United Nations Human Settlements Programme (UN-HABITAT) (2010): *Land and Natural Disasters: Guidance for Practitioners*. Nairobi, Kenya: Nairobi 00100, Kenya. : https://postconflict.unep.ch/humanitarianaction/documents/02_03-04_03-02.pdf
- Đorđević, A., V. Stevanović (2020). Environmental risk. Niš: Faculty of Occupational Safety in Niš (in Serbian)

Number of teaching hours (per week)	**Theoretical classes: 2**	**Practical classes: 2**

Teaching methods: Teacher presentations; Case study analysis.

Evaluation of knowledge (maximum score 100)

Pre-exam obligations	points	**Final exam**	points
Activity during the lectures	**10**	Written exam	
practical classes	**10**	oral exam	**40**
making a project or seminar paper	**40**		

Project number: 598403-EPP-1-2018-1-RS-EPPKA2-CBHE-JP (2018 – 2579 / 001 – 001)
"This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein"

Study program: Soil erosion and torrential flood prevention

Course title: Land degradation and ecosystem services

The teacher/teachers: Mirjana Todosijević, Marijana Kapović Solomun, Katarina Lazarević

Course status: elective (2)

Number of ECTS credits: 4

Requirement(s): /

Course objective: The course strives to acquaint students with the concept of land degradation, explain the factors and trends of degradation in the context of ecosystem services and synergies with sustainable management of natural resources, and to expand knowledge about measures to resist various types of land degradation.

Course outcome: The student's ability to recognize the type of land degradation and plan adequate measures, approaches whose implementation will contribute to the prevention, conservation, and sustainability of ecosystems.

Course content: Global trends and land degradation; International conventions and agreements; State of land resources of the region; The most important factors of land degradation in the region; Assessment of land degradation using Land PKS software; Possibility to prevent land degradation; Neutrality of land degradation. Science and policy in the field of land degradation; Basic concepts of ecosystem and ecosystem services; Assessment of soil ecosystem services; Ecosystem services mapping process; Ecosystem services evaluation methodology: TEV (Total Ecosystem Valuation), InVEST.

Literature:

- Ilić B, Mihajlović D. (2017): Natural Resources Management, Sustainability and Protection, Megabusiness 1/1. (in Serbian)
- Chotte J.L, Aynekulu E., Cowie A., Campbell, E. Vlek P., Lal R.**,** Kapović Solomun M., von Maltitz G.,. Kust G, Barger N, Vargas R. and Gastrow S. (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.
- Masiero M., Pettenella D, Boscolo M., Kanti Barua S., Animon I. and Matta R. (2019): *Valuing ecosystem services,* A training manual for planners and project developers, FAO
- European Communities (2008): *The economics of ecosystems&biodiversity*, An interrim report ISBN-13 978-92-79-08960-2, *Printed by Welzel+Hardt, Wesseling, Germany.*
- Burkhard Benjamin & Maes Joachim (2017): *Mapping Ecosystem Service*s, Pensoft Publishers, Sofia, 374 pp

Number of teaching hours (per week)	**Theoretical classes: 2**	**Practical classes: 2**	
Teaching methods: Lectures, auditory exercises, consultations			
Evaluation of knowledge (maximum score 100)			
Pre-exam obligations	points	**Final exam**	points
Activity during the lectures	**5**	Written exam	**20**
practical classes	**5**	oral exam	**50**
Colloquium	**20**		

Study program: Soil erosion and torrential flood prevention

Course tittle: Torrent monitoring and early warning system

Teacher/teachers: Muhamed Bajrić, Dejan Vasović, Siniša Polovina, Ranka Erić

Course status: elective (2)

Number of ECTS credits: 4

Requirement(s): /

Course objective: Acquiring knowledge on the organization of torrential flood monitoring systems and early warning systems, as well as the application of reporting methods, to preserve the functions of torrential aquatic ecosystems and provide the necessary level of protection of people, natural and created values from the adverse effects of torrential floods.

Course outcome: Students' competence and skills to work independently with the control and management of the torrential flow monitoring system, as well as early warning systems regarding the occurrence and adverse effect of torrential floods.

Course content

Theoretical teaching

1. Torrent monitoring: goals of torrential streams monitoring, elements of a monitoring system, spatial-temporal organization of the system, types of monitoring, structuring and design of the system of monitoring of torrential flows in the watershed area, analytical and conceptual frameworks for processing the obtained data, advanced models of visualization of the obtained data 2. Assessment of hazard levels: determination of flood zones, endangered sections, and profiles; prediction of the consequences of torrential floods, impact parameters 3. Early warning systems: early warning system elements positioning; types of data transfer in real-time; responsible institutions for data reception and processing; hazard level determination; types of public warning (ministries, municipalities, headquarters for emergencies, media) 4. Providing the required/desired level of protection: early warning system efficiency evaluation; system results implementation in Operational plans for protection from torrential floods; activities on torrential floods prevention and local population inclusion.

Practical teaching

Computational exercises and seminar paper - project assignment in the field of designing a torrent monitoring system in a specific watershed area and designing an early warning system for a particular region. Monitoring methodology for selected parameters (precipitation, discharge), selection of representative measuring locations, system work control.

Literature:

- Schanze, J.; Zeman, E.; Marsalek, J. (2006): *Flood risk management: hazards, vulnerability and mitigation measures*, Dordrecht 331 ISBN 10: 1402045964 Springer
- Mukolwe, M. M. (2016): *Flood Hazard Mapping: Uncertainty and its Value in the Decision-making Process*, ISBN 9781138032866 - CRC Press/ Balkema
- Sene, K. (2010): *Flood Warning, Forecasting and Emergency Response*, 1st Edition. Springer, ISBN 10: 3642096654
- Committee on FEMA Flood Maps, Mapping Science Committee, Board on Earth Sciences and Resources, Water Science and Technology Board, Division on Earth and Life Studies, National Research Council (2009): Mapping the Zone: Improving Flood Map Accuracy, National Academies Press, ISBN 13: 9780309130578
- Kostadinov, S. (2008): Torrential floods and erosion. Faculty of Forestry, Belgrade. (in Serbian)
- Ristić, R.; Malošević, D. (2011). Hydrology of torrential streams. Faculty of Forestry, Belgrade. (in Serbian)
- Birkmann, J. (ed.) (2013): *Measuring vulnerability to natural hazards: Towards disaster resilient societies*. Part I: Basic principles and theoretical basis. Tokyo: United Nations University Press. 7 – 106.
- Toolkit. A (2015): *Flood Forecasting and Early Warning in Transboundary River Basins*: Bangkok: United Nations Economic and Social Commissionfor Asia and the Pacific (UNESCAP)

Number of teaching hours (per week)	**Theoretical classes: 2**	**Practical classes: 2**

Teaching methods: Lectures, auditory exercises, consultations

Evaluation of knowledge (maximum score 100)

Pre-exam obligations	points	**Final exam**	points
Activity during the lectures	**5**	Written exam	**20**
Activity during exercises	**5**	oral exam	**20**
Colloquium 1 / Colloquium 2	**15/15**		
seminar paper	**20**		

Project number: 598403-EPP-1-2018-1-RS-EPPKA2-CBHE-JP (2018 – 2579 / 001 – 001)
"This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein"

Study program: Soil erosion and torrential flood prevention			
Course title: Decision-making in soil erosion and torrent control			
Teacher/teachers: Tijana Vulević, Boško Blagojević			
Course status: elective (2)			
Number of ECTS credits: 4			
Requirement(s): /			
Course objective: The course aims to contribute to the students´ understanding of Multi-Criteria Decision Analysis (MCDA) and how to apply it step-by-step by using decision-making problems from soil erosion and torrent control management. The participants will learn how to structure complex decision problems and break them down into manageable parts. An important aim is to learn how to elicit subjective preferences from decision-makers and how to use computer-based tools for MCDA.			
Course outcome: Upon completion of this course, the student will be able to: structure multi-criteria decision-making problems (goal or objective of decision making, criteria, sub-criteria, and alternatives), understand basic cognitive and motivational biases and learn how to minimize them during multi-criteria decision making, explain the basics of commonly used MCDA methods and learn how to apply them, discuss philosophies and pros and cons of different methods, reflect upon which method(s) can be appropriate for a different type of decision-making problems.			
Introduction to MCDA; Problem structuring methods; Linear programming; Goal, aspiration or reference level methods (Goal programming, Compromise programming, TOPSIS); Outranking methods (PROMETHEE method); Value measurement methods (Analytic Hierarchy Process (AHP) and Multi-Attribute Value Theory (MAVT)); Group Decision Making; Cognitive and motivational biases in decision making; Application of MCDA in soil erosion and torrent control.			
- Ishizaka A., Nemery P. (2013): *Multi-criteria decision analysis: methods and software*. John Wiley & Sons - Kangas A., Kurttila M., Hujala T., Eyvindson K., Kangas J.(2015): *Decision support for forest management*, second edition, Springer Berlin, 307 p. URL: https://link.springer.com/book/10.1007%2F978-3-319-23522-6 - Montibeller G., Winterfeldt D. (2015): *Cognitive and motivational biases in decision and risk analysis*. Risk Analysis 35(7): 1230–1251. https://doi.org/10.1111/risa.12360 - Kostadinov S. (2008): Torrents and erosion. Faculty of Forestry, Belgrade. (In Serbian)			
Number of teaching hours (per week)	**Theoretical classes: 2**	**Practical classes: 2**	
Teaching methods: Lectures, consultations and exercises			
Evaluation of knowledge (maximum score 100)			
Pre-exam obligations	points	**Final exam**	points
Activity during the lectures	**10**	Written exam	**40**
practical teaching	**10**	oral exam	**40**

Study program: Soil erosion and torrential flood prevention

Course title : Modelling of land and water degradation

Teacher/teachers: Mirjana Todosijević, Atila Bezdan, Katarina Lazarević, Ranka Erić

Course status: elective (2)

Number of ECTS credits: 4

Requirement(s): /

Course objective: Mastering knowledge in the field of soil and water degradation models as modern tools for assessing natural and anthropogenic impacts on soil and water degradation processes, for predicting the impact of land use and climate change on erosion and sediment transport.

Course outcome: Students gain basic knowledge of modeling soil and water degradation processes; definition and description of basic processes and components within the model (erosion, hydrological, chemical, etc.). Ability to apply analysis to address and select systems for the sustainable use and protection of soil and water resources.

Course content

Theoretical teaching: Models are based on physical laws and are based on the laws of conservation of mass and energy. Most models use the differential equation (the continuity equation), which expresses the conservation of matter, its movement through space and time.

Modeling of erosion, production, and transport of sediment; Model types; Models based on physical laws USLE, RUSLE, WEPP (Water Erosion Prediction Project): approach; basic concept; model component; soil erosion calculation; application of the model.

Application of GIS and remote detection methods in data collection for modeling of soil degradation (interpolation of meteorological parameters for determination of rain erosion power factors, determination of topographic factors by digital terrain model analysis, vegetation cover analysis, and land use methods by remote detection methods).

Water quality parameters. The most common sources of water pollution (concentrated and bulk pollutants). Modeling of water quality. Historical overview of the development of water quality models.Water quality model divisions. QUAL2K model of pollution propagation and transformation in watercourses.

Practical classes: Focuses on the application of selected models to analyze individual components of the model and work in a computer lab. Attention has been given to the description and prediction of soil and water degradation processes, primarily under the influence of water and eolian erosion, as a basis for designing a soil and water protection system.

Literature:

- Summer Wolfgang and Walling E. Desmond, editors (2002): *Modelling erosion, sediment transport and sediment yield*, IHP-VI Technical Documents in Hydrology No. 60 UNESCO, Paris,
- Morgan R. P. C., Quinton1 J. N., Smith R. E., Govers G., Poesen J. W. A, Auerswald K., Chisci G., Torri D. and Styczen M. E. (1998): *The European soil erosion model (EUROSEM): a dynamic approach for predicting sediment transport from fields and small catchments*, Earth Surface Processes and Landforms Earth Surf. Process. Landforms 23, 527–544
- Morgan, R.P.C. (2009): *Soil Erosion and Conservation*. Blackwell Publishing,
- Kadam, A.K., Umrikar, B.N. and Sankhua, R.N.(20189: *Assessment of soil loss using revised universal soil loss equation (RUSLE): a remote sensing and GIS approach.* Remote Sens Land, 2(1), pp.65-75.
- Kamaludin H., Lihan T., Ali Rahman Z., Mustapha M.A., Idris W.M.R. and Rahim S.A. (2013): *Integration of remote sensing, RUSLE and GIS to model potential soil loss and sediment yield (SY)*. Hydrology and Earth System Sciences Discussions, 10(4), pp.4567-4596.
- Kirkby Mike, e GobinAnn and Irvine Brian: *Pan-european soil erosion risk assessment, deliverable 05: Pesera model strategy, Land use and vegetation growth*, (1 apr ’00 – 30 sept '03)
- Botterweg Peter, Leek Rodney, Romstad Eirik, Vatn Arild: *The EUROSEM-GRIDSEM modeling system for erosion analyses under different natural and economic conditions*, http://dx.doi.org/10.1016/S0304-3800(98)00023-4,
- Chapra, S.C., Pelletier, G.J. and Tao, H. 2012. QUAL2K: *A Modeling Framework for Simulating River and Stream Water Quality*, Version 2.12: Documentation and Users Manual. Civil and Environmental Engineering Dept., Tufts University, Medford, MA, Steven.Chapra@tufts.edu

Number of teaching hours (per week)	**Theoretical classes: 2**	**Practical classes: 2**

Teaching methods: Lectures, auditory exercises, consultations

Evaluation of knowledge (maximum score 100)

Pre-exam obligations	points	**Final exam**	points
Activity during the lectures	**5**	written exam	**20**
practical teaching	**5**	oral exam	**50**
colloquium	**20**		

Project number: 598403-EPP-1-2018-1-RS-EPPKA2-CBHE-JP (2018 – 2579 / 001 – 001)
"This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein"

Study program: Soil erosion and torrential flood prevention			
Course title: Melioration of degraded forests			
Teacher/teachers: Ćemal Višnjić			
Course status: elective (2)			
Number of ECTS credits: 4			
Requirement(s): /			
Course objective: The course objective is to enable students to independently analyze and valorize habitat conditions and characteristics of degraded forests, and to propose breeding and meliorative interventions based on the analysis to preserve and improve forest stability, as well as optimal use of habitat production opportunities.			
Course outcome: After successfully mastering the class, the student should: - independently and in a team analyze the habitat conditions and stand characteristics of degraded forests; - categorize degraded forests based on the degree of habitat degradation, forest conditions and structural development of degraded stands, and based on the performed categorization optimize breeding interventions for individual categories; - independently and in a team, on a scientific basis applied in practice, coordinate and lead the team that participates in the development of the detailed design for the melioration of degraded forests.			
Course content: Basic terms, low forest, coppice forest, stump, thicket shrub formation, land reclamation, degradation, devastation, conversion. Classification of degraded forests, division according to belonging to the primary community, division according to the degree of degradation. Characteristics of degraded forests, age, stump generation, number of stump shoots, presence of shrubs, trees of seed origin. Planning of breeding interventions in degraded forests, meliorative categorization concerning breeding needs, purpose, and goal to be achieved, breeding measures to be applied. Melioration categorization according to the priority of works. Plan for the implementation of breeding measures, where and when to start with breeding interventions, how much to capture.			
Literature: - Višnjić et al (2010): Ecological breeding characteristics of beech stumps in Bosnia and Herzegovina (in Bosnian) - Višnjić et al. (2016): Meliorative categorization of coppice beech forests in the Sarajevo Canton (in Bosnian) - Krstić et al. (2006): Forest cultivation-conversion, land reclamation, and artificial regeneration (in Serbian)			
Number of teaching hours (per week)	**Theoretical classes: 2**	**Practical classes: 2**	
Teaching methods: Teaching is carried out in lectures, exercises (development project for the melioration of a specific degraded forest unit), and field exercises where students are introduced to specific examples and collect data for the implementation project.			
Evaluation of knowledge (maximum score 100)			
Pre-exam obligations	points	**Final exam**	points
Activity during the lectures	**5**	written exam	**85**
practical teaching	**10**	oral exam	