University of Zagreb Faculty of Agriculture
Svetošimunska cesta 25, 10000 Zagreb
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Environmental soil science (146036)

Course coordinator

Assoc. Prof. Vedran Rubinić, PhD

Course description

The course represents a comprehensive study of soil components and properties, which are responsible for chemical reactivity of soils. Students can learn and comprehend the fundamentals related to origin of soils; chemical, morphological and physical soil properties; and principles of soil classification and soil mapping. Students can also learn how to link theoretical concepts to environmental problems, soil pollution and remediation.

ECTS: **6.00**

English language: **L3**

Teaching hours: 60
Lectures: 39
Auditory exercises: 3
Laboratory exercises: 6
Practicum: 6
Seminar: 6

Lecturer

- Prof. Gabrijel Ondrašek, PhD
- Assoc. Prof. Vedran Rubinić, PhD

Associate teacher for exercises

- Prof. Gabrijel Ondrašek, PhD

Associate teacher for seminars

- Prof. Gabrijel Ondrašek, PhD

Grading

Sufficient (2): 60%
Good (3): 70%
Very good (4): 80%
Excellent (5): 90%

Conditions for obtaining signature

Attendance to exercises and seminars, and at least 80% of lectures.
Delivered (and presented) seminar papers.

Type of course

- Graduate studies / Environment, agriculture and resource management (Compulsory course, 1 semester, 1 year)

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General competencies

The course provides students with the broad general knowledge on soil genesis and classification, soil properties and processes, soil mapping and geostatistics.
The course trains students to fully understand and critically evaluate the importance of soil resources in certain sectors, as well as the implementation of environmental policies.
It also enables students to understand and explain the relationships between the soil and the environment in terms of agriculture, forestry, water management, as well as the impact of different land uses on the environment and the impact of environmental management on the soil.

Types of instruction

- Lectures
- Auditory Exercises
- Laboratory practice/exercises
- Field work
- Seminars

Learning outcomes

Learning outcome	Evaluation methods
IU1. To recognize and evaluate the roles of soil as a natural resource of a country, as well as the need for its protection	Partial test, Final exam
IU2. To identify, explain and compare the main characteristics of soil-forming factors and processes across different environmental settings	Partial test, Final exam
IU3. To identify, explain and predict the effects of physical, chemical and biological processes on soil properties across different environments	Partial test, Final exam
IU4. To list and explain the main principles of the leading soil classification systems in the world	Partial test, Final exam
IU5. To use the World Reference Base for Soil Resources (WRB) system for soil classification	Seminar
IU6. To list and explain the standards and the criteria for soil mapping	Partial test, Final exam
IU7. To conduct basic soil sampling and selected soil analyses, as well as to interpret the obtained results	Seminar – Laboratory report
IU8. To identify appropriate ways and methods for the sustainable soil use in connection with various activities	Partial test, Final exam
IU9. To define and apply different possibilities of using land resources and new technologies in agriculture, waste management and environmental protection	Partial test, Final exam
IU10. To determine causes and threats of soil degradation and environmental pollutions that occur in practice	Partial test, Final exam
IU11. To assess the degree of soil vulnerability to damage and to plan the land use in a permanently sustainable way	Partial test, Final exam

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Working methods

Teachers' obligations

- to give lectures, exercises and seminars as scheduled; to provide all necessary information and material concerning the Course; to control class attendance; to provide consultations; to evaluate seminar papers (laboratory reports) and their presentations; to organize, conduct and evaluate partial tests during the semester and final exam during the exam terms.

Students' obligations

- to attend lectures, exercises and seminars; to create and orally present seminar papers in due time.

Methods of grading

Evaluation elements	Maximum points or Share in evaluation	Grade rating scale	Grade	Direct teaching hours	Total number of average student workload	ECTS
Partial test No 1	50%	Insufficient (1): 0-60% Sufficient (2): 61-70% Good (3): 71-80% Very good (4): 81-90% Excellent (5): 91-100%	Insufficient (1) Sufficient (2) Good (3) Very good (4) Excellent (5)	44	110	3
Partial test No 2	40%	Insufficient (1): 0-60% Sufficient (2): 61-70% Good (3): 71-80% Very good (4): 81-90% Excellent (5): 91-100%	Insufficient (1) Sufficient (2) Good (3) Very good (4) Excellent (5)	16	50	2
Final written exam (to be taken if the student does not pass both partial tests)	90%	Insufficient (1): 0-60% Sufficient (2): 61-70% Good (3): 71-80% Very good (4): 81-90% Excellent (5): 91-100%	Insufficient (1) Sufficient (2) Good (3) Very good (4) Excellent (5)	54	160	5
Seminars	10% (of which 50% goes for the quality of the written report, while 50% goes for the quality of the oral presentation - where applicable)			6	20	1

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Evaluation elements	Maximum points or Share in evaluation	Grade rating scale	Grade	Direct teaching hours	Total number of average student workload	ECTS
Total	100%	1-5		60	180	6

Evaluation elements	Description	Deadline	Recoupment
Partial test No 1	About 15 open-type questions (listing, describing, defining, calculating, etc.) dealing with the topics covered during the first 8 weeks of the semester.	Around the middle of the semester	None
Partial test No 2	About 15 open-type questions (listing, describing, defining, calculating, etc.) dealing with the topics covered during the last 7 weeks of the semester.	By the end of the semester	None
Final written exam (to be taken if the student does not pass both partial tests)	About 20 open-type questions (listing, describing, defining, calculating, etc.) dealing with all the topics covered during the semester.	Regular exam terms after the end of the semester	Regular exam terms

Weekly class schedule

1. Soils as natural resources (L) - Soil and land definitions and roles in the environment, pedosphere as a part of geosphere, importance of soil; Soil development.
2. Relations of soils and environment (L) - Soil-forming factors (parent material, climate, organisms and land-use, relief, time of soil formation), horizonation and haploidization soil-forming processes.
3. General composition of soil (L); Soil morphology and horizon designations, soil sampling principles (E) – Introduction to soil phases (solid, liquid, gaseous); Soil morphological characteristics and their determination, soil horizon designation (FAO, 2006), basic soil sampling methods and equipment.
4. Soil-forming factors and processes, soil morphology and sampling Field soil survey, examples of soil development across varying environmental conditions, soil sampling (E); Basic principles of soil survey, soil mapping, and soil/land information systems (L)
5. Soil solid phase (L) – Importance of soil solid phase; Soil texture and structure, soil density and porosity, relationships among different physical properties; Relations among soil solids and liquids/gases.
6. Soil liquid phase (L); Soil gas phase – the basics (L) - Soil water regime and balance, hydropedological constants, energy state of water in soil, water flow in saturated and unsaturated soil, measurements of soil water content and water flow; Composition and movement of soil air, soil respiration, measurements of soil aeration.
7. Soil thermal regime – the basics (L); Basic soil physical analyses (E) - Atmospheric energy balance, solar radiation, thermal soil properties, measurement of soil temperature; Laboratory determination of soil particle size distribution, water retention, density, porosity, air capacity.
8. Forms and classification of soil organic matter (L); Humus composition and properties (L) - Living biomass in soils, soil organic detritus, humus, factors influencing soil organic matter transformation, mineralization and humification; Humic substances (humic acid, fulvic acid,

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humin) and their functional groups, charge development on soil organics, types of humus, benefits of organic matter for physical, chemical and biological soil properties.
9. Basic soil chemical analyses (E); Soil solution chemistry I (L) - Humus content and quality, content of soil carbonates, soil pH; Soil solution concentration and composition; soil acidity, alkalinity, salinity, and sodicity – causes and implications on the environment; soil redox potential.
10. Soil classification – the international WRB system (L); WRB soil classification system (S) - Principles and types of soil classification systems, Soil Taxonomy classification system, World Reference Base for Soil Resources (WRB) classification system; Soil classification according to the WRB system and the FAO (2006) Guidelines.
11. Exchange reaction in soils (L), Soil solution chemistry and exchange reactions (S+L) - Ion exchange selectivity, The exchange process
12. Thermodynamic expressions: Empirical or Semi-Theorethical Expressions, Beckett – Q/I relationship, Derivation of the Ca-Mg exchange function; Quantitative description of soil solution- colloid interface; Adsorption, common sorption isotherms types; Sorption of inorganics on soil surface; Adsorption of organics on soil surface (L).
13. Assessment and management of contaminated sites (L), Geochemical behaviour of trace metals (L), bioavailability and ecotoxicology (L) - Theoretical background of the issue - the nature of contaminated land, characterisation of soil pollution, including its impact on water resources and other parts of the environment; Factors and processes controlling metal solubility and bioavailability; Models / concepts of phytoavailability (BLM, free ion activity model); methods of assessment.
14. Remediation and risk assessment (L), Ecological risk assessment - case studies (E) Geochemical methods for assessment of soil contamination by trace metals (L) - Approaches of risk assessment of polluted soils and ash land fills; pathways of risk and endpoints; Treatments and solutions to show complexity of the issue, pH and metal fluxes, use of novel techniques (DGT); site-specific risk assessment. Treatments and solutions to show complexity of the issue, pH and metal fluxes, use of novel techniques (DGT); site-specific risk assessment; Factors controlling trace metals behaviour in soils; environmental soil functions; trace metals characteristics and soil properties; methods of bioavailability assessment.
15. Contribution of soil studies to geochemical mapping (L), Soil spatial variation (E) - Merging classification with geostatistics; soil-oriented geochemical mapping; baseline; identification of the pedogeochemical contents of selected heavy metals as a function of sediment provenance, soil maturity and land use; Statistical aspects of spatial variation; basics of spatial interpolation methods, sampling design, basic GIS visualization. Soil spatial variation - Statistical aspects of spatial variation; basics of spatial interpolation methods, sampling design, basic GIS visualization.

Obligatory literature

1. Castrignano A. 2011. Introduction to spatial data processing. CRA - SCA, Bari, Italija
2. Zovko M., Romić M. 2011. Soil contamination by trace metals: Geochemical behaviour as an element of risk assessment (poglavlje u knjizi: Earth and Environmental Sciences). Ahmad Dar, Imran (ur.). Rijeka, InTech, p. 437-456
3. Lectures / Powerpoint presentations
4. IUSS Working Group WRB, 2022. World reference base for soil resources. International soil classification system for naming soils and creating legends for soil maps. 4th ed. IUSS, Vienna

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Recommended literature

1. Kim H.T: (1994): Environmental soil science. Marcel Dekker, INC, New Yiork
2. Brady C.N., Weil R.R. (2002): The Nature and Properties of Soils, 13th Edition, Prentice Hall, New Jersey
3. Buol, S.W., Hole, F.D., McCracken, R.J., Southard, R.J. (1997): Soil genesis and classification. Fourth Edition, Iowa state University Press/Ames, Iowa
4. Bohn H.L., McNeal B.L:, O´Connor G. (2001): Soil Chemistry, 3rd Edition, John Wiley & Sons, Inc.
5. Jury W.A., Horton R. (2004): Soil Physics, 6th Edition, John Wiley & Sons, Inc.
6. Environmental Chemistry of Soils, Murray B. McBride, Oxford University Press, 1994.
7. FAO, 2006. Guidelines for soil description, fourth ed. FAO, Rome.

Similar course at related universities

- Soil in the Environment (BOKU – University of Natural Resources and Life Sciences, Vienna)
- General Soil Science (College of Agricultural and Life Sciences, University of Wisconsin-Madison)