Universitat Autònoma de Barcelona

2020/2021

Soil Science

Code: 102803
ECTS Credits: 6

Degree	Type	Year	Semester
2501915 Environmental Sciences	OB	3	1

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

Contact

Name: Josep Maria Alcañíz Baldellou
Email: JoseMaria.Alcaniz@uab.cat

Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: No
Some groups entirely in Spanish: No

Teachers

Andrea Vidal Durà

Xavier Domene Casadesus

Prerequisites

Although there are no prerequisites to take this course, the student should have:

1) Basic knowledge of Biology and Geology, Earth Sciences and the Environmental Sciences acquired during compulsory secondary education.

2) Knowledge of other disciplines such as biology, geology, physics, and chemistry.

Objectives and Contextualisation

The main aim of this course is to train the students in developing a basic understanding of the environmental functions of soils and the services that soil provides to society. Lectures will address the soil most relevant components and how they are organized in order to interpret their properties. The soil is shown as a complex natural system, resulting from the weathering processes that explain the diversity of soils. The main environmental problems affecting soils, such as pollution, erosion, salinization, among others are addressed in this course while providing knowledge on how to implement suitable and feasible corrective or rehabilitation measures. The role of soils in carbon sequestration and in the recycling of organic wastes will be also discussed. Furthermore, the legal framework promoting soil protection and other regulations aiming to achieve sustainable use of soils are considered.

Specific objectives:

Upon completion of the course, students will be able to

• Describe and interpret a soil profile in relation to natural environmental factors.

• Identify the soil main components and interpret their properties.

• Understand the basics of soil classification as a tool to describe soil diversity and its environmental value.

• Assess soil use capabilities according to their properties.

• Identify common soil degradation problems (erosion, salinization, pollution, etc.) and suggest solutions.

• Recognize the main environmental soil functions and apply this knowledge in solving current environmental problems.

Competences

- Adequately convey information verbally, written and graphic, including the use of new communication and information technologies.
- Analyze and use information critically.
- Demonstrate adequate knowledge and use the most relevant environmental tools and concepts of biology, geology, chemistry, physics and chemical engineering.
- Demonstrate concern for quality and praxis.
- Demonstrate initiative and adapt to new situations and problems.
- Learn and apply in practice the knowledge acquired and to solve problems.
- Quickly apply the knowledge and skills in the various fields involved in environmental issues, providing innovative proposals.
- Teaming developing personal values regarding social skills and teamwork.
- Work autonomously

Learning Outcomes

1. Adequately convey information verbally, written and graphic, including the use of new communication and information technologies.
2. Analyze and use information critically.
3. Define the basics of soil science.
4. Demonstrate concern for quality and praxis.
5. Demonstrate initiative and adapt to new situations and problems.
6. Describe, analyze and evaluate the environment.
7. Identify and interpret the diversity of organisms in the environment.
8. Identify organisms and biological processes in the surrounding environment and evaluate them properly and originally.
9. Learn and apply in practice the knowledge acquired and to solve problems.
10. Manage and conserve populations and ecosystems.
11. Participate in environmental assessments as to the biological environment.
12. Teaming developing personal values regarding social skills and teamwork.
13. Work autonomously

Content

THEORETICAL FORMATION (concepts and experiences)

1. The soil as a natural system

- The soil as a component and resource of the natural environment.
- Environmental functions and services provided to society.
- How is the soil formed? Factors and processes of soil formation.
- Soil organization. Soil profile and horizons.
- Main processes causing soil degradation.
- General regulations for soil protection.

2. Organization of soil components

- Particle size and texture.
- Soil architecture: aggregation of particles, structure, types, and stability.
- Bulk density and particle density. Porosity. Characteristics of porous space.

3. Mineral constituents of soil

- Soil mineral components. The weathering process.
- Clay minerals, main types, and properties.
- Oxy-hydroxides of iron and aluminum, specific characteristics and significance.
- Mineral constituents of arid and semi-arid zones: carbonates and evaporite minerals.

4. The organic matter, organic matter transformation, and the biological activity of the soil

- Soil organic matter within the global carbon cycle. Origin and functions.
- Soil as a carbon and nitrogen reservoir in the context of global change. C/N ratio.
- Mineralisation and humification processes. Carbon sequestration in soil. Biochar.
- Stabilization of organic matter in the soil. The clay-humic complexes.

- 5. Chemical properties of soil

- Surface interactions in the solid-liquid interface. Cation exchange capacity. The degree of base saturation.
- Soil pH: significance and measurement. Current and potential acidity. Buffer capacity. Sources of acidity in the soil. Correction of soil pH, liming.
- The soil solution. Anions and cations in solution. Salinity and sodicity. Management of saline and sodic soils.

6. The soil as a water reservoir

- Water retention in the soil. Water potential and its components. Water retention curves. Available water for plants.
- Water flow in the saturated and unsaturated zones. Infiltration and hydraulic conductivity. Drainage.
- Soil water balance. Soil moisture and temperature regimes. Water conservation in the soil and irrigation and drainage techniques.

7. Soil diversity, mapping, and assessment

- Soil classification. The Soil Taxonomy system. The pedon and diagnostic horizons. Definition of the main taxonomic groups. Examples of the soils of Catalonia.
- Soil maps and their interpretation. Availability and environmental applications.
- Assessment of soil capability for different land uses. General and specific systems. Applications. Land use planning based on soil aptitudes.

8. Soil degradation processes and their correction. principal soil degradation processes. Soil quality indicators. Acceptable rates of degradation and sustainable management of soils.

9. Erosion as a soil degradation problem. Water erosion: rainfall erosivity and soil erodibility. study of erosion models: the (R)USLE. Preventive and erosion control techniques, terraces and benches.

10. Contaminated soils. Causes and characteristics of soil pollution. Current legal framework and its application. Generic levels of reference, their setting, and their interpretation. Introduction to the remediation strategies of contaminated soils. Study of cases.

11. Management of soil organic matter. Recycling of organic wastes. Criteria of the application of organic wastes to soils. Composting and other organic matter valorisation alternatives through the soil. Regulations.

12. Management of agricultural soils fertility and environmental protection. Fertilization and biogeochemical cycles. Fertilization and nutrient-use efficiency. Best agricultural practices regarding nitrogen fertilization.

13. Environmental restoration and rehabilitation of degraded soils. Restoration ecology. Restoration of mining activities and slopes. Technosols.

PRACTICAL PART

Field description of soils: soil morphology, soil description, and soil sampling:

- Description of the soil-forming environment. General attributes of the soil profile. Soil pits and bore-holes.
- Observation and morphological description of the horizons.
- Sampling for analytical purposes. Sample preparation for laboratory analysis.

How to analyze soil samples

- Analysis of the soils collected in the field practice or others: particle-size, water retention, pH, organic matter, carbonates, and salinity.

Soil analysis interpretation

- Interpretation of the results of soil analysis, diagnosis of problems by case study
- Autonomous exercises for interpretation of soil analysis.

Environmental evaluation of a soil

- Preparation of a scientific poster focused on the identification of soil degradation problems in an area and the proposal of a set of rehabilitation activities. It must include recommendations of suitable soil uses, including scientific and technical aspects. This activity will be assessed.

Methodology

Several teaching-learning strategies will be combined in order to achieve the objectives of the course.

1) Lectures and professor experiences. The expository sessions will be the main type of activity since basic concepts are transferred to students in a short time. The lectures will be accompanied by handouts and other educational materials that will be delivered to the students through the virtual campus. The learning contents and concepts explained during the lectures require student's autonomous work in order to assimilate them. As a guidance, it is estimated that every hour of master class requires two hours of self-study.

2) Field practice. The field practicals are essential for the student understanding of how soil is found in nature and how to describe a soil profile in a representative sampling. The practice will consist of a one-day trip to which assistance is mandatory, that will include an initial explanation by the professors followed by the students' autonomous work in small groups. They will describe the soil-forming factors for a given soil, excavate a pit, describe the different horizons, and take samples for analytical purposes. (5h guided work + 4h supervised work). If the field trip cannot be held as scheduled due to events of force majeure, it will be substituted by alternative activities.

3) Laboratory practices. These sessions intend for the students to learn the most common international soil analytical procedures using the samples obtained in the field by themselves, so they will obtain reliable and representative results for interpretation. The laboratory practicals will be organized in three sessions of four hours in which the students, keeping the field groups, will analyse the samples collected in the field. A brief report will be submitted by each group after the practical sessions. The report will contain the soil description, the analytical results, and their discussion and interpretation (12 h guided work). If the laboratory practices cannot be held as scheduled due to events of force majeure, the sessions will be substituted by case studies and/or practical exercises.

4) Classroom practices for the interpretation of soil analysis. Case-based learning is a particularly useful tool since it enables the student to apply the knowledge acquired in lectures and also in the laboratory. These activities will consist of the interpretation of the analysis of diverse soils and the resolution of complementary problems. (3h of guided work and 10h of autonomous work). If these sessions cannot be held as scheduled due to events of force majeure, the sessions will be online.

5) Collaborative work (team-work). Environmental diagnosis and assessment of soils of a given location, their uses and their state of conservation, in order to be able to make proposals for corrective measures. The work will consist of an estimate of the soil loss due to erosion processes, an assessment of the agrological capacity of the soils of the study area, and the localization of the potential pollutant activities. The work will include at least the following parts: 1) Location and description of the study area, 2) Distribution of land uses, 3) A list of the detected soil degradation problems, their causes, surface and degree of impact, 4) Possible corrective measures, 5) Global assessment of the state of conservation of the soils in the area as a conclusion. The work will be done by groups of 4 or 5 students and will be presented as a poster. There will be a follow-up in voluntary tutorials where teachers will guide the process of the work (Collaborative group work, 25h).

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Classroom practices (in person or online classes)	3	0.12	
Field work or alternative activities	5	0.2	
Lab work or alternative activities	12	0.48	
Lectures	30	1.2	
Type: Supervised			
Field work or alternative activities	3	0.12	
Type: Autonomous			
Case studies and problems	10	0.4	
Environmental evaluation of soils (poster)	25	1	
Study	56	2.24	

Assessment

The evaluation of this subject is continuous and is based on the following elements:

1. First midterm test. It consists of questions and/or short answer exercises and/or a multiple choice test about the main concepts and competences of the subject explained before the test.

2. Second midterm test. It consists of questions and/or brief exercises that will be formulated in relation to any topic of the subject, and especially those corresponding to the thematic block of soil degradation processes and their correction.

3. Submission of a short report of the laboratory practices. The report will present the analytic results obtained by the working team or the responses for the practical problems, including an interpretation and discussion of the results. The quality of the interpretation of the results will be assessed. There is no resit of this activity.

4. The scientific poster summarizing the environmental diagnosis/rehabilitation proposal of the degraded soils of an area or a particular site. A digital copy (pdf) equivalent to A1 (594 x 840 mm) of the poster will be submitted by each group of students. Guidance will be given on the items to be included. There is no resit of this activity. There will be a first submission of the poster which will be worth 45% of the final mark of this course work. After this, the students will receive feedback from the responsible professor. Between this

response to the first submission and the final submission, there will be at least two weeks, so the students will have time to make any changes and corrections needed. The final work submitted will worth 55% of the mark.

To pass the course, it is necessary to obtain a global average mark equal to or higher than 4,9. However, the students that do not reach this score and have been assessed of 2/3 of the overall assessed items, will be able to take an exam resit (it will assess the course materials included in the first and final exams). According to the current UAB assessment regulations, having an average score equal to or greater than 3,5 will be a sine qua non (i.e. 3.5 is the minimum required mark) to be eligible for the exam resit. The lack of attendance to or no submission of any of the evaluation activities will score a mark of 0. A student will be considered as 'non-evaluable' only if not attending to any of the evaluation activities. The professors will set a date for the revision of exams and other assessed activities and will inform the students via online communication. No appointments for marking revision will be accepted outside the times scheduled.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Environmental diagnosis of soils (poster)	25%	1	0.04	2, 3, 5, 4, 6, 8, 7, 11, 1, 12
First midterm test	30%	2	0.08	3, 4, 6, 8, 1, 13
Second midterm test	35%	2	0.08	2, 3, 4, 10, 11
Soil description and evaluation	10%	1	0.04	2, 9, 3, 5, 4, 6, 8, 7, 11, 13, 12

Bibliography

Further web links and learning materials will be posted by the professors on the Campus Virtual during the course development.

Basic bibliography

- Brady N. C. & R. R. Weil. 2008. The nature and properties of soils (14th ed.). Prentice Hall Upper Saddle River, New Jersey. 975 p. http://wps.prenhall.com/chet_brady_natureandp_13

- Lal, R.; W.H.Blum, C. Valentine, B.A. Stewart (1998) Methods for assessement of Soil Degradation, Advances in Soil Science, CRC press, New York, 558 p.

- Porta, J. 1986. Técnicas y experimentos en edafología. Col·legi Oficial d'Enginyers Agrònoms de Catalunya.

- Porta, J., M. Lopez-Acevedo y C. Roquero. 2003. Edafología para la agricultura y el medio ambiente, Ed Mundi-Prensa, Madrid.

- Porta, J.; López-Acevedo, M. 2005. Agenda de campo de suelos. Información de suelos para la agricultura y el medio ambiente. Ed. Mundi-Prensa, Madrid, 541p., ISBN 84-8476-231-9

- Porta, J., M. López-Acevedo & R. M. Poch. 2014. Edafología: uso y protección de suelos, 3ª ed. Mundi-Prensa. Madrid.

- Tan, K. H. 1994. Environmental soil science. Marcel Dekker. New York.

- USDA - NRCS. 2006. Claves para la Taxonomía de Suelos.

- Van Reeuwijk, L. P. 2002. Procedures for soil analysis. ISRIC - FAO. [2847]

Web links:

-USDA - Natural Resources Conservation Service: https://www.nrcs.usda.gov/wps/portal/nrcs/site/soils/home/

- FAO Soils Portal: http://www.fao.org/soils-portal/en/

- Universidad de Granada. Departamento de Edafología y Química Agrícola: http://edafologia.ugr.es/index.htm

- Institut d'Estudis Catalans. Protecció de sòls, mapa de sòls de Catalunya: http://www.iec.cat/mapasols/

- Institut Cartogràfic i Geològic de Catalunya: https://www.icgc.cat/

- Sociedad Española de Ciencias del suelo: https://www.secs.com.es

- The nature Education Knowledge Project, Soil, Agriculture and Agricultural Biotechnology: https://www.nature.com/scitable/knowledge/soil-agriculture-and-agricultural-biotechnology-84826767/

- Soil-net. Welcome to Soil-net.com. http://www.soil-net.com/

- International Union of Soil Sciences. Soil science education. http://www.iuss.org/popup/education.htm

- European Society for Soil Conservation http://www.soilconservation.eu/