Universitat Autònoma de Barcelona

2018/2019

Soil Science

Code: 102803
ECTS Credits: 6

Degree	Type	Year	Semester
2501915 Environmental Sciences	OB	3	1

Contact

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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 a sustainable use of soils are considered.

Specific objectives:

Upon completion of the course, students will be able to

• Describe and interpret a soil under field conditions 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.

Skills

- Adequately convey information verbally, written and graphic, including the use of new communication and information technologies.
- Analyze and use information critically.
- Collect, analyze and represent data and observations, both qualitative and quantitative, using secure adequate classroom, field and laboratory techniques
- 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. Diagnose and solve environmental problems concerning the biological 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. Observe, recognize, analyze, measure and properly and safely represent organisms and biological processes.
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 a soil formed? Factors and processed 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 carbon and nitrogen reservoir in the context of global change. C/N ratio.
- Mineralisation and humification processes. Humus composition and formation. Humic substances.
- Stabilization of organic matter in the soil. The clay-humic complexes. Carbon sequestration in soil. Biochar.

5. 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.

6. 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.

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. Environmental management of contaminated sites. Introduction to the remediation strategies of contaminated soils. Study of cases.

11. Management of soil organic matter and carbon sequestration. Recycling of organic wastes and criteria of their application 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 (one-day field trip): morphological description and soil sampling (One-day field practice: 5h guided work + 4 supervised work)

- 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 (laboratory, 12h)

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

Soil analysis interpretation (practical activity in class following the laboratory practices, 3h guided work and 10h of autonomous work):

- Interpretation of the results of soil analysis, diagnosis of problems by case study (3 hours, attendance hours)
- Autonomous exercises for interpretation of soil analysis.

Environmental evaluation of a soil (collaborative work, 25h)

- 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, technical and economic 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 and will be carried out in the classroom 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.

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.

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. They will help the students to interpret the results obtained in the laboratory.

5) **Collaborative work (team-work).** Environmental diagnosis of soils and rehabilitation proposal for degraded soils. The work will consist of the preparation of a scientific poster about the degradation problems of the soils of an area along with a proposal of rehabilitation activities that will include the scientific, technical and economic aspects. This will be an assessed activity. Alternatively, it is also possible to do the environmental diagnosis in a single soil degradation problem for a given location, although a more detailed description of the solutions will be required. The professors may also give suggestions on possible cases of study.

Activities

Title	Hours	ECTS	Learning outcomes
Type: Directed			
Classroom practices	3	0.12	9, 7, 10
Field work	5	0.2	3, 4, 6, 8, 11
Lab work	12	0.48	2, 9, 3, 6, 10, 11, 12
Lectures	30	1.2	9, 3, 4, 6, 7, 8, 11
Type: Supervised			
Field work	3	0.12	3, 6, 8, 11, 12
Type: Autonomous			
Case studies and problems	10	0.4	2, 9, 11, 13
Environmental evaluation of soils (poster)	25	1	2, 3, 6, 8, 10, 11, 1, 12
Study	56	2.24	9, 3, 4, 6, 7, 8, 11, 13

Evaluation

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

1. **Midterm exam**. It consists of questions and/or short answer exercises about the main concepts and competences of the subject explained before the test.

2. **Final 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 field and laboratory practices.** The report will include the field description, a table with the laboratory results, and the interpretation and discussion of these results. The quality of interpretation 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.

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. 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 professors will set a date for the revision of exams and other assessed activities. No appointments for marking revision will be accepted outside the times scheduled.

The lack of attendance to 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.

Evaluation activities

Title	Weighting	Hours	ECTS	Learning outcomes
Environmental diagnosis of soils (poster)	20%	1	0.04	2, 3, 5, 4, 6, 7, 8, 10, 11, 1, 12
First midterm test	30%	2	0.08	3, 4, 6, 8, 1, 13
Second midterm test	40%	2	0.08	2, 3, 4, 7, 11
Soil description and evaluation	10%	1	0.04	2, 9, 3, 4, 6, 7, 8, 10, 11, 13

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.

- Schoeneberger, P. J.; D. A. Wysocki, E. C. Benham & W. D. Broderson. 1998. Libro de campaña para descripción y muestreo de suelos (Field book for describing and sampling soils). National Soil Survey Center - Natural Resources Conservation Service - USDA. Nebraska.

- 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. Technical References: http://soils.usda.gov/technical/

- USDA - Natural Resources Conservation Service. Soil Education. http://soils.usda.gov/education/

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

- National Aeronautics and Space Administration (NASA). We Study Soil Because It's A(n)... http://soil.gsfc.nasa.gov/pvg/1-1why.htm

- National Aeronautics and Space Administration (NASA). Soil Science Education Homepage. http://soil.gsfc.nasa.gov/

- 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

- Institut d'Estudis Catalans. Protecció de sòls, mapa de sòls de Catalunya. http://www.iecat.net/mapasols/index.html

- Mapes de Sòls de Catalunya: http://www.icgc.cat/Administracio-i-empresa/Descarregues/Cartografia-geologica-i-geotematica/Cartografia-de-so