Universitat Autònoma de Barcelona

**2017/2018**

# Soil Science

Code: 102803
ECTS Credits: 6

| Degree | Type | Year | Semester |
|---|---|---|---|
| 2501915 Environmental Sciences | OB | 3 | 1 |

## 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

Xavier Domene Casadesus

## Prerequisites

Although there are no prerequisites, it is recommended the student to be skilled in:

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

2) Knwoledge on other disciplines such as biology, geology, physics and chemistry.

## Objectives and Contextualisation

The main aim of this course is providing training in terms of the understanding of the environmental functions of soils and the services that it 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, while providing knowledge on how implementing suitable and feasible corrective or rehabilitation measures, as well as the importance of soil for carbon sequestration and for the recycling of organic wastes . Furthermore, the legal framework ensuring soil protection and other instruments aiming to achieve a sustainable soil use are considered.

Specific objectives:

• Describe and interpret a soil under field conditions regarding 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.

• Evaluate soil use capabilities according to their properties.

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

• Recognize the main environmental soil functions in order to use them in order to solve 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

**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 a soil is formed: forming factors and main processes.
- Soil organization. Soil profile and horizons.
- Main processes causing soil degradation.
- General regulations for soil protection.

**Organization of soil components**

- Particle size and texture.

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

**Mineral constituents of soil**

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

**The organic matter 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.
- Humus composition and formation. Humic substances.
- Stabilization of organic matter in the soil. The clay-humic complexes. Carbon sequestration in soil. Biochar.

**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 saturated and unsaturated medium. Infiltration and hydraulic conductivity. Drainage.
- Soil water balance. Soil moisture and temperature regimes. Water conservation in the soil and techniques of irrigation and drainage.

**Chemical properties of soil**

- Surface interactions in the solid-liquid interface. Cation exchange capacity. Degree of base saturation.
- Soil pH: significance and measure. 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.

**Soil diversity, mapping and evaluation**

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

**Soil degradation processes and their correction**

- Erosion as a soil degradation problem. Water erosion: rainfall erosivity and soil erodibility. Erosion models: the (R)USLE. Prevention measures and erosion control techniques, terraces and benches.
- Contaminated soils. Causes and characteristics of soil contamination. Current legal framework and its application. Generic levels of reference and their interpretation. Environmental management of contaminated sites. Introduction to the remediation strategies of contaminated soils. Study of cases.
- Management of soil organic matter and carbon sequestration. Recycling of organic wastes and soil application criteria. Composting and other valorisation ways of organic matter through soil. Regulations.
- Management of agricultural soils fertility and environmental protection. Fertilization and biogeochemical cycles. Fertilization and nutrient-use efficiency. Best agricultural practices regarding nitrogen fertilization.

PRACTICAL PART

**Field description of soils (one-day field trip): morphological description and soil sampling** (One-day field practice: 5h guided + 4 supervised work)

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

**How to analyze a soil** (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 classroom activity following the laboratory practices, 3h guided and 10h of autonomous work):

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

**Environmental evaluation of a soi**l (collaborative work, 25h)

- Preparation of a poster identifying soil degradation problems of an area and proposing rehabilitation activities. It must include recommendations of suitable soil uses, including scientific, technical and economic aspects.

## Methodology

Several teaching-learning strategies will be combined to achieve the objectives of the subject.

1) **Lectures.** The expository sessions are the main activity that will be done in the classroom, since they allow the transference of basic concepts to students in a short time. The lectures will be accompanied by notes and other teaching materials that will be provided to students through the virtual campus. The contents and their assimilation by students requires the student's autonomous work for their assimilation. As a guidance, it is estimated that each hour of master class requires two hours of personal study.

2) **Field practice.** It is essential for the student comprehension on how is a natural and to learn how to describe it in a representative sampling. The practice will consist of a one-day compulsory trip, that will include and initial explanation of the professors followed by the students autonomous work in small groups to describe the forming factors for a given soil, excavate a ditch, describe the different horizons that comprise it, and wtake samples for analytical purposes.

3) **Laboratory practices**. These sessions intend the students to learn the most common international soil analytical procedures, but in turn obtaining reliable and representative results of the samples obtained in the field. They will be organized in three sessions of four hours in which the students, keeping the same groups used in the field, will analyse the collected samples. A brief report will be hand out after the practices by each group containing the soil description, the analytical results and its 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 in the laboratory. These activities will consist of the interpretation of analysis of varied soils and in the resolution of complementary problems. They will help to interpret the results obtained in the lab.

5) Environmental diagnosis of soils and rehabilitation proposals (**collaborative work**). The work will consist in the preparation of a poster evaluating degradation problems of the soils of an area together with a proposal of rehabilitation activities, including the scientific, technical and economic aspects. Alternatively, it is also possible to do the diagnosis in a single soil degradation problem for a given location, although a more detailed description of the solutions will be required.

## 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 | 4 | 0.16 | 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 | 55 | 2.2 | 9, 3, 4, 6, 7, 8, 11, 13 |

## Evaluation

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

1. **Midterm exam**. It consists of questions and/or short answer exercises about the main concepts 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. **Presentation of a short report of the laboratory practices** that will include the field description, a table with the laboratory results and their interpretation (maximum three A4 sheets). The quality of interpretation will be assessed.

4. **Poster summarizing the environmental diagnosis / rehabilitation of the degraded soils** of an area or a particular site. A digital copy (pdf) equivalent to A1 (594 x 840 mm) will be handout by each group of students. Guidance will be given on the items to be included.

The student will pass the theoretical part of the subject if the weighted average of the midterm and final exam is equal to or higher than 5. Otherwise, the student reaching a minimum mark of 3.5 in any of the individual exams is obligated to do a reassessment test, consisting of an global exam including all the topics of the subject, obtaining a maximum mark of 5.

A student will be considered as 'non-evaluable' if not attending to any of the evaluation activities. The lack of attendance to any of the evaluation activities will score a mark of 0.

## Evaluation activities

| Title | Weighting | Hours | ECTS | Learning outcomes |
|---|---|---|---|---|
| Environmental diagnosis of soils (poster) | 25 | 0 | 0 | 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 | 35 | 2 | 0.08 | 2, 3, 4, 7, 11 |

| | | | | |
|---|---|---|---|---|
| Soil description and evaluation | 10 | 2 | 0.08 | 2, 9, 3, 4, 6, 7, 8, 10, 11, 13 |

## Bibliography

### 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