Universitat Autònoma de Barcelona

2023/2024

Soil Science

Code: 102803
ECTS Credits: 6

Degree	Type	Year	Semester
2501915 Environmental Sciences	OB	3	1

Contact

Name: Sara Marañon Jimenez

Email: sara.maranon@uab.cat

Teaching groups languages

You can check it through this link. To consult the language you will need to enter the CODE of the subject.
Please note that this information is provisional until 30 November 2023.

Teachers

Sara Marañon Jimenez

Xavier Domene Casadesús

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, ecology, physics, and chemistry.

Objectives and Contextualisation

The general objective of this subject is to provide a cross-disciplinary and interdisciplinary education that enables students to understand the environmental properties and functions of soils, the services they provide to society, their diversity, and the suitability of different types of soil for various uses, as well as the main causes and environmental problems that lead to their degradation, and the appropriate and viable corrective or rehabilitation measures.

Specific objectives:

- Learn to describe, sample, analyze, and interpret a soil in relation to the natural factors that influence its formation.
- Identify the main components of soil and interpret their properties.
- Understand the basis of soil classification to interpret its diversity and environmental value.
- Evaluate the soil's suitability for specific uses based on its properties.

- Identify, understand, and assess the most frequent problems of soil degradation (erosion, salinization, pollution, loss of organic matter, etc.) and apply this knowledge to propose viable solutions.
- Recognize the main environmental functions of soils to harness them in addressing current environmental issues.
- Critically select information from various sources on real soil degradation problems and integrate knowledge to propose feasible measures for prevention and conservation.
- Effectively and creatively communicate the importance of soils and their conservation using new communication and information technologies.
- Demonstrate initiative, versatility, and interest in both independent and teamwork.

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

CLASSES OF CONCEPTS, EXPERIENCES, AND CASE STUDIES

MODULE I: Soil as a Natural System

Topic 1: Soil Concept

- Importance of soil for humanity
- Functions of soil and ecosystem services

- The science that studies soil: Edaphology
- Soil as an interface of environmental compartments
- Soil as a natural resource
- Global stagnation of agricultural production increase
- Food security against climate change
- Soil degradation

Topic 2: Soil Formation and Morphological Description of Soil Profile

- How soil is formed: Forming factors and main edaphogenic processes
- Soil profile and pedon
- Genetic horizons and dominant edaphogenic processes
- Degree of soil development
- Naming of soil horizons
- Organic horizons (H and O)
- Organo-mineral horizons (A)
- Mineral horizons (E, B, and C)

MODULE II: Soil Components

Topic 3: Soil Mineral Constituents

- Main types of parent materials
- Physical and chemical alteration and determining factors
- Climatic alteration gradient
- Most abundant minerals in soil
- Crystalline silicates
- Phyllosilicates or main groups of clays and their properties
- Amorphous silicates
- Oxides, hydroxides, and oxyhydroxides: characteristics and significance in soil
- Carbonates
- Chlorates and sulfates
- Susceptibility to chemical alteration of primary minerals
- Main chemical alteration processes

Topic 4: Organic Matter and Biological Activity of Soil

- Composition of soil organic matter (SOM)
- Soil as a carbon (C) reservoir
- Expression and calculation of SOM and C stocks in soil
- Transformation of SOM
- Mechanisms of SOM stabilization
- Concept of carbon organic saturation (COS)
- Geographic distribution of SOM
- Distribution of SOM in the soil profile
- Ecosystem functions of SOM
- Effects of climate change and global factors on SOM

MODULE III: Physical Properties of Soil

Topic 5: Organization of Soil Components

- Soil architecture
- Color: its importance and determination
- Soil temperature and temperature regime
- Texture: its importance and determination
- Soil structure: formation processes, types, and ecosystem functions
- Structure stability and causes of degradation: crusting and compaction
- Measures for increasing or recovering structural stability
- Porosity and functions of pore space

- Bulk density and apparent density: determination methods

Topic 6: Soil as a Water Reservoir

- Forces acting on soil water: water retention in soil
- Quantitative measurement of soil moisture
- Qualitative measurement of soil moisture: water potential, water states, and CRAD
- Water fractions in soil
- Moisture characteristic curve
- Types of water movement in soil
- Hydraulic conductivity or permeability: measurement of infiltration and percolation
- Factors determining permeability
- Drainage and indicators of drainage degree
- Water balance and soil moisture regime
- Water conservation in soil and irrigation and drainage techniques

MODULE IV: Soil Physicochemical Properties

Topic 7: Soil Physicochemical Properties

- Type of interactions in the solid-liquid interface
- Soil colloids, ion exchange, and diffuse double layer
- Cation exchange capacity (CEC): determination and importance
- Anion exchange capacity (AEC)
- Relationship between CEC/AEC, acidity, and soil alteration degree
- Degree of base saturation (DBS)
- Importance and significance of soil pH
- Sources and effects of soil acidity. Soil buffering capacity
- Measurement of actual and potential pH
- pH corrections in acidic and alkaline soils
- Salinity: causes, effects, and measurement
- Sodicity and alkalinity: causes, effects, and measurement
- Treatment of saline and sodic soils

MODULE V: Diversity, Mapping, and Soil Evaluation

Topic 8: Soil Classification

- Why do we need a soil classification system?
- Pedon as a classification unit
- Current classification systems
- Diagnostic elements
- Genetic horizons vs. diagnostic horizons
- Major diagnostic horizons
- The Soil Taxonomy system (USDA). Definition of major taxonomic groups
- Types of soils and their frequency in Catalonia

Topic 9: Soil Mapping and Evaluation

- Uses and applications of soil maps
- Classes of cartographic units
- Types of soil maps: objectives and scales
- Relationship between map scale and observation density
- Procedure for soil map creation
- Criteria for map quality
- Soil evaluation systems
- Classes of agrological capacity (USDA)
- Riquier-Bramao productivity index
- FAO land evaluation

MODULE VI: Soil Degradation Processes and Rehabilitation

Topic 10: Soil Degradation Processes

- Soil formation vs. soil degradation
- Soil degradation in Catalonia and globally
- Main factors, causes, and types of soil degradation
- Evaluation of soil quality and degradation status. Quality indicators
- Acceptable degradation rates and soil lifespan
- Costs of degradation and the relationship between soil degradation and poverty
- Sustainable soil use
- Existing organizations and policies for soil protection

Topic 11: Erosion as a Soil Degradation Problem

- Natural erosion vs. anthropogenic erosion
- Importance and soil loss due to water erosion globally and in Catalonia
- Factors, processes, and morphology of erosive processes
- Measurement and evaluation of water erosion. The (R)USLE equation
- Prevention and control of water erosion. Terraces and terraced fields

Topic 12: Contaminated Soils

- Importance of soil contamination and main sources
- Causes and effects of soil contamination
- Soil as a natural purification system
- Inorganic contaminants: Mobility and transformations in the soil
- Organic contaminants: Adsorption and factors affecting their fate
- Management of contaminated soils. Legal framework in Spain and Catalonia and its implementation
- Introduction to soil decontamination and bioremediation strategies

Topic 13: Organic Matter and Fertility Management

- Carbon sequestration potential in agricultural soils
- Good agricultural practices for increasing soil organic matter (SOM)
- Valorization (recycling) of organic waste. Application criteria to soil
- Regulations and management of organic waste and livestock manure
- Conservation, organic, and regenerative agriculture
- Nutrient availability, conservation, and fertilizer use efficiency
- Measures against over-fertilization. Good nitrogen fertilization practices

MODULE VII: Restoration of Degraded Soils

Topic 14: Introduction to Forest Soil Restoration

- Assessment of degradation and definition of restoration objectives
- Key methodological and technical aspects in soil restoration
- Indicators of restoration quality. Evaluation of restorations
- Restoration in extractive activities, slopes, and post-fire. Case studies

PRACTICAL TRAINING

Field Practices: Field Study of Soils: Morphology, Description, and Sampling

- Description of the soil formation environment
- Opening of a soil pit
- Elements of profile description
- Observation and morphological description of horizons and their interpretation
- Sampling and preservation for analytical purposes

Laboratory Practices: Soil Analysis

- Preparation of samples for analysis
- Determination of stoniness
- Determination of soil color in dry and wet conditions
- Determination of moisture content
- Determination of particle size distribution and texture
- Determination of real and potential pH
- Determination of carbonate content
- Determination of salinity
- Determination of oxidizable organic carbon and organic matter
- Integrated interpretation of analytical results from different soil types

Classroom Practices: Interpretation of Soil Analyses

- Interpretation of soil analyses
- Diagnosis of soil degradation problems through case studies
- Independent exercises interpreting soil analyses and profiles

Autonomous Collaborative Work (video) and Tutoring: Identification of Soil Degradation Problems and Proposal of Corrective Measures

- Identification of a real case of soil degradation or the degradation problems affecting an area
- Selection and compilation of information about the study area (physical and biotic environment, soil types) and its socio-economic context
- Interpretation of the territory regarding soil types, their uses, and the state of conservation ordegradation
- Analysisof the degradation problem(s) and explanation of their causes and soil processes
- Evaluation of the magnitude and importance of the degradation problem, its implications, and consequences
- Assessment of potential economic, environmental, and social conflicts caused by the degradation problem(s)
- Evaluation and proposal of viable preventive and conservation measures or practices
- Conclusion and synthesis of the main soil degradation problem in the area, its main causes and consequences, and the most feasible measures that could be implemented as a priority to prevent or address this problem.

Methodology

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

1) Lectures of concepts, experiences and cases study. 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 practices. 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 + 3h 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 discussionand 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) Autonomous collaborative work (video). It consists on the production of a video-documentary about a process of soil degradation or about the processes of soil degradation that affect a specific area. The video will include an explanation of the soil degradation process (s), the mechanisms involved, their relevance and implications, as well as the corrective measures that could be carried out and their potential viability. The video may include interviews, visits to the field or affected areas, visits to centers (eg: waste treatment, treatment plants, etc). As an assessable previous activity, a script will be delivered with the contents of the video, the target audience and communication objectives (eg: educational and training, informative, informative, awareness, etc). The maximum length of the video will be 15 min. The video will be made in groups of 3-5 people. There will be follow-up sessions (assistance will be voluntary) in which the professors will guide the progression of the work and a collective presentation session of some of the works.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Lectures of concepts, experiences and cases study	30	1.2	2, 9, 3, 5, 4, 6, 10, 8, 7, 13, 12
Classroom practices	3	0.12	2, 9, 5, 6, 10, 8, 11, 13, 12
Field practices	5	0.2	2, 9, 3, 4, 6, 8, 7, 1
Laboratory practices	12	0.48	2, 9, 3, 5, 4, 6, 8, 1, 13, 12
Type: Supervised			
Field work	3	0.12	2, 9, 3, 5, 4, 6, 8, 7, 1, 13, 12
Type: Autonomous			
Autonomous collaborative work (video)	25	1	9, 3, 5, 4, 6, 10, 8, 7, 11, 1, 13, 12
Case studies and problems	10	0.4	2, 9, 5, 4, 6, 10, 8, 11, 13, 12
Personal study	56	2.24	2, 9, 3, 6, 10, 8, 7, 13, 12

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. Final exam. 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. Brief report of practices. It consists of the presentation, for each group of practices, of the description of the soil profile carried out during the field practices, the interpretation of those involved in the formation of the soil and the results of the laboratory analyzes of each group of practices, with a justification or interpretation of these. The correct interpretation and critical evaluations will be valued. This activity is not recoverable.

4. Video-documentary about soil degradation processes. A first evaluation consists of the presentation of a video script, made in a group, about a process or processes of degradation of an area, the mechanisms involved, their relevance and implications, as well as the corrective measures that could be carried out and their potential viability. Thirty days before the delivery of the video, it will be delivered a video script, which will represent the 33% of the final qualification mark of the video. After this delivery, the students will have feedback from the responsible teacher and will have to make the pertinent modifications. The final video will have 66% of the weight final qualification mark of the video. The projection of some of the videos will take place in a joint session at the end of the course. 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, thestudentsthat 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. 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.

The student obtains the qualification of "Not Evaluable" when the evaluation activities carried out have a weighting of less than 67% in the final qualification. Attendance at practical sessions or field trips is mandatory. The student body obtains the qualification of "Not Evaluable" when their absence is greater than 20% of the scheduled compulsory sessions.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Brief report of practices	10%	1	0.04	2, 9, 3, 5, 4, 6, 8, 7, 11, 13, 12
Final exam	35%	2	0.08	2, 3, 4, 10, 11
First midterm test	30%	2	0.08	3, 4, 6, 8, 1, 13
Video-documentary about soil degradation processes	25%	1	0.04	2, 3, 5, 4, 6, 8, 7, 11, 1, 12

Bibliography

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

Main books:

-Brady N. C. & R. R. Weil. 2017. The nature and properties of soils (15th ed.). Prentice Hall Upper Saddle River, New Jersey. 975 p.
https://cataleg.uab.cat/iii/encore/record/C__Rb2007847__SBrady__Orightresult__U__X4;jsessionid=233CFE7E45

-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.
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-Magdoff, F. & H. van Es. 2009. Building Soils for Better Crops. Sustainable Agriculture Network (SAN) - USDA
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-Porta, J., M. López-Acevedo & R. M. Poch. 2014. Edafología: uso y protección de suelos, 3ª ed, Mundi-Prensa.
https://cataleg.uab.cat/iii/encore/record/C__Rb1795204__SL%C3%B3pez-Acevedo__Orightresult__U__X4?lang=

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-Tan, K. H. 2009. Environmental soil science. Marcel Dekker. New York.
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-TRAGSA (1998). Restauración hidrológico forestal de cuencas y control de la erosión. Ed. Mundi Prensa.
https://cataleg.uab.cat/iii/encore/record/C__Rb1450709__SRestauraci%C3%B3n%20hidrol%C3%B3gico%20fore

- USDA - NRCS. 2006. Claves para la Taxonomía de Suelos. Keys to Soil Taxonomy | NRCS Soils (usda.gov)

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 KnowledgeProject, 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/

Software

Common use software such as Microsoft Office will be used. Also common use GIS software.

Several internet browsers.

Free software for video editing (iMovie, Biteable, Shotcut, OpenShot, VideoPad, Lightworks, WeVideo, etc.)