UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

# COURSE SYLLABUS

# Quality and Sustainability of Soils

**2526-1-F7503Q007**

## Aims

The course provides the knowledge necessary to understand and assess soil quality and degradation dynamics, with a focus on the sustainable management of soil resources. It presents tools and indicators for monitoring soil conditions and techniques for soil conservation, also in relation to environmental and climate goals. The course also introduces concepts of soil functionality and ecosystem services, adopting an integrated approach that encompasses physical, chemical, biological, and ecological aspects.

At the end of the course the student will be able to:

- assess soil quality using physical, chemical, and biological indicators, recognizing signs of degradation and loss of functionality;
- estimate the risk of water erosion and propose appropriate mitigation measures and soil conservation techniques adapted to the context;
- calculate simplified budgets of soil organic matter and nitrogen, also in relation to land use changes and sustainable management practices;
- critically read, interpret, and use soil maps and soil databases for agronomic, environmental, and territorial assessments;
- apply methods for land and soil evaluation relevant to sustainable planning and environmental protection.

After completing the final exam, the student will have acquired adequate autonomy judgment for:

- critically and practically address key issues related to the sustainable management of soils in different land use contexts (agricultural, forest, urban, natural);
- integrate pedological knowledge into the assessment of environmental impacts and in the development of strategies for soil protection and related ecosystem services.

## Contents

- Soil quality and functionality; physical, chemical, and biological indicators.
- Soil degradation: erosion, organic matter loss, compaction, salinization, contamination, sealing.
- Soil conservation techniques and sustainable soil management.
- Soil ecosystem services and role in climate change mitigation.
- Methods for soil and land evaluation: categorical, parametric, and integrated approaches.
- Soil survey, soil mapping, and the use of databases for sustainable land planning.

## Detailed program

1. Soil quality, functionality and health

- Definitions of soil quality, functionality and health: comparison of approaches.
- Soil functions and ecosystem services.
- Quality indicators: physical, chemical and biological properties.
- Standards and thresholds for soil quality assessment.
- Laboratory analytical techniques and interpretation of results.

2. Soil degradation and resource conservation

- Water erosion: simplified models (USLE, RUSLE), tolerable soil loss, erosion control techniques.
- Loss of organic matter and reduction of organic carbon storage capacity.
- Chemical degradation: acidification, salinization, contamination from diffuse source.
- Physical degradation: compaction, loss of structure, waterlogging.
- Soil sealing and land take.
- Management techniques and practices for the conservation and restoration of degraded soils.

3. Assessment of soil quality and sustainable land use

- Methods for soil assessment: categorical, parametric and integrated approaches.
- Soil capability and suitability (Land Capability Classification and Land Suitability).
- Agronomic evaluations (Fertility Capability Classification).
- Environmental evaluations: soil protective function and water vulnerability.
- Soil in land use and environmental planning contexts.

4. Soil survey and tools for sustainability

- Soil survey methods and mapping scales.
- Soil–landscape relationships and predictive models.
- Interpretation and application of soil maps and derived thematic maps.
- Soil databases and their use in agronomic, environmental and urban contexts.
- Integration with geographic information systems and remote sensing data.

Practical exercises

- Study and classification of soil profiles (WRB taxonomy).
- Assessment of erosion risk and conservation techniques.
- Simplified budgeting of organic matter and nitrogen; estimation of organic carbon storage potential.
- Critical analysis of soil maps and derived thematic maps.
- Integrated evaluation of soil quality using indicator sets.

Field activities

- Field excursion for the description of natural soils, analysis of soil–landscape relationships and discussion of degradation and conservation processes. The excursion may include sites with paleosols or areas of pedo-environmental interest.

## Prerequisites

- Prerequisites: basic knowledge of the soil (description; physical, chemical and biological characteristics; genesis; horizons; main taxonomies).

## Teaching form

- 18 two-hour lectures, in person, Delivered Didactics, 4.5 CFU
- 5 two-hour practical classes, in person, Interactive Teaching, 1 CFU
- 1 five-hour field activities, in person, Interactive Teaching, 0.5 CFU

## Textbook and teaching resource

Educational material distributed:

- Slides projected during the lessons: made available on the e-learning website.
- Work schemes and materials for exercises: made available on the e-learning website.
- Material for field activities: made available on the e-learning website.

Recommended texts for further information:

- Alexander E.B. (2004). Soils in Natural Landscapes. CRC Press, Boca Raton, FL, USA.
- Blanco H., Lal R. (2008). Principles of Soil Conservation and Management, Springer, Berlin (available at the Bicocca Library of Sciences).
- Giordano A. (2002). Forest pedology and soil conservation. UTET, Turin (available at the Bicocca Library of Sciences).
- Hillel D. (2008). Soil in the Environment. Crucible of Terrestrial Life. Elsevier, Amsterdam (available at the Bicocca Library of Sciences).
- IUSS Working Group WRB (2022). World Reference Base for Soil Resources. International Union of Soil Sciences
  (IUSS), Vienna, Austria (available online).
- Morgan R.P.C. (2005). Soil Erosion and Conservation. Longman, London (available at the Bicocca Library of Sciences).
- Shepherd G. (2000). Visual Soil Assessment - Landcare Research, Palmerston North, NZ (available online).
- Weil R.R., Brady N.C. (2017). The Nature and Properties of Soils. Pearson, Harlow, England.

## Semester

Second semester

## Assessment method

Written exam with optional oral exam.
The written exam includes open-ended questions (very short essays or analysis of problems) and closed answer questions (multiple choice answers), related to all the topics covered in the course (lectures, laboratories, field activities); the text is evaluated in thirtieths (24/30 in total for open-ended questions; 6/30 in total for closed answer questions). Upon request of the student or teacher, the written exam can be supplemented by an oral exam (related to all the topics covered in the course), carried out by means of verification questions. The outcome of the oral exam can lead to an increase or decrease of maximum 4 points of the grade of the written exam (therefore, it is possible to be admitted to the oral exam when the grade of the written exam is at least equal to 14/30). There are no intermediate tests.

## Office hours

On appointment

## Sustainable Development Goals

ZERO HUNGER | SUSTAINABLE CITIES AND COMMUNITIES | CLIMATE ACTION | LIFE ON LAND