



UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Geo,bio,cryo,hydro and Atmosphere

2627-2-E3304M013-E3304M013-1

Aims

The module provides the basic concepts of Earth System Science, focusing on the Earth as an integrated system composed of interacting geosphere, hydrosphere, biosphere, atmosphere, and cryosphere components. It introduces the fundamental processes governing these spheres and their interactions, highlighting how climate change affects each component of the Earth system and how these changes propagate through natural and human systems.

O1 – Knowledge and Understanding

Understand the Earth as a complex and interconnected system composed of the geosphere, hydrosphere, atmosphere, biosphere, and cryosphere.

Understand the hydrological cycle and the main processes controlling the occurrence, movement, and storage of water in surface water and groundwater systems and the role of glaciers and mountain water.

Understand the concepts of water balance, water resources availability, and water resource management and how climate change may affect them.

Learn the role of biogeochemical cycles in regulating the Earth's climate and environmental systems.

O2 – Ability to Apply Knowledge and Understanding

Apply Earth System Science concepts to analyze interactions among the different Earth system components.

Interpret the main hydrological processes occurring in surface water and groundwater systems, and evaluate the factors controlling water availability under present and future climate conditions.

Assess the impacts of climate change on the Earth system, with particular emphasis on water resources, droughts, and floods.

Evaluate the role of mountain glaciers and cryospheric processes in regional water supply.

Analyze the role of major biogeochemical cycles in regulating Earth system processes and climate.

O3 – Autonomy of Judgment

- Critically evaluate scientific information related to climate change, water resources, and Earth system interactions.
- Analyze water resource management systems at different spatial scales, from local to regional contexts.
- Assess the implications of human impacts on the different Earth system spheres and their interconnections.
- Form independent judgments on environmental management and climate adaptation strategies using a systems-

thinking approach.

O4 – Communication Skills

Use appropriate scientific terminology related to Earth System Science, hydrology, and climate change.

O5 – Learning Ability

Integrate information from different disciplines to address complex environmental and water-related challenges

Contents

The course introduces the fundamental concepts of Earth System Science, focusing on the Earth as a complex system composed of interconnected spheres whose interactions regulate environmental processes and climate. Particular emphasis is placed on the hydrosphere, including surface water and groundwater systems, water resources availability and management, and the effects of climate change on the hydrological cycle. The course also examines the role of the geosphere, biosphere, and cryosphere in the climate system, highlighting the impacts of environmental change on natural resources, ecosystems, human health, and infrastructure through an integrated Earth-system perspective.

Detailed program

- Introduction to Earth System Science: the Earth as a complex system; interactions among the geosphere, hydrosphere, atmosphere, biosphere, and cryosphere; climate feedback mechanisms.
- Geosphere: Earth's structure, rock cycle, weathering processes, soil formation, geological resources, and their links to climate.
- Biosphere and biogeochemical cycles: carbon, nitrogen, and other biogeochemical cycles; interactions between ecosystems and climate.
- Hydrosphere and water resources: hydrological cycle, river basins, surface water and groundwater systems, water balance, water quality, and water resources management.
- Cryosphere: glaciers, mountain environments, glacier retreat, and the role of mountains as water towers;
- Climate change and water resources: impacts on water availability, droughts, floods, water security, and adaptation strategies.
- Human-environment interactions: impacts of human activities on Earth system processes, risk and vulnerability to extreme events, climate change implications for human health, infrastructure, and environmental sustainability.
- Anthroposphere and human-environment interactions

Prerequisites

None

Teaching form

24 hours of lectures

Textbook and teaching resource

Lecture slides prepared by the instructors will be made available to students, together with additional open-access resources to support learning.

Some lectures will also draw on the following textbook:

E. Tziperman, *Global Warming Science: A Quantitative Introduction to Climate Change and Its Consequences*, Princeton University Press, ISBN 9780691228792.

Semester

First semester

Assessment method

There will be no interim assessment.

The final assessment will cover the topics addressed in both modules of the course.

The exam will consist of 12 multiple-choice questions and 6 open-ended questions covering the contents of both modules.

The duration of the exam will be two hours.

Office hours

Contact the instructors.

Sustainable Development Goals

CLEAN WATER AND SANITATION | CLIMATE ACTION
