UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Extreme Events

2627-1-F7503Q033-F7503Q03302

Aims

The overall goal of the teaching module "Extreme Events" is to provide the cultural bases for understanding the climate drivers of extreme events and their impacts on natural and anthropic systems, as well as possible adaptations, through frontal lessons, practical sessions, and dedicated lab activities.

EXPECTED LEARNING OUTCOMES

1. Knowledge and understanding
   Describe and contextualize the global climate system, the mechanisms of meteo-climatic variability, future scenarios, and the definition of an extreme event.
   Illustrate in depth the core concepts of vulnerability, risk, adaptation strategies, and impact (both single and multiple) on natural and anthropic systems.
   Frame historically and methodologically scientific climate research within the context of international climate change negotiations and agreements.
   Distinguish and classify the different methods of representing meteo-climatic variables, including time series, periodicities, and probability distributions.

2. Applying knowledge and understanding
   Apply descriptive statistics tools to analyze meteo-climatic datasets and quantify the spatio-temporal variability of extreme events.
   Extract, interpret, and analyze quantitative data and risk scenarios derived directly from IPCC reports and official technical documents.
   Manipulate, and integrate point climate data and digital elevation models within a GIS software environment.
   Utilize the fundamentals of Terrain Analysis to model, simulate, and assess the physical and environmental impacts generated by extreme events on the territory.

3. Making judgments, Communication skills, Learning skills
   Critically evaluate different climate risk scenarios and the effectiveness of related adaptation strategies

across diverse territorial contexts, formulating independent assessments based on the integration of objective data (IPCC, GIS, historical series).
Present, argue, and communicate the results of statistical and territorial analyses with scientific rigor, clarity of exposition, and appropriate technical vocabulary, effectively interfacing with both specialist and non-expert audiences.
Independently source, interpret, and assimilate relevant scientific literature, future international technical reports, and new meteo-climatic and territorial datasets made available by monitoring platforms.

Contents

The discussion will focus on the following themes:
• Definition and features of extreme events (meteorological and climatological aspects)
• Analytical methods for extreme events and their variability
• Analysis of extreme events in the past and future evolution (past-to-future)
• Analysis of the impacts of extreme events on several natural and anthropic systems
• Adaptation to extreme events
• Handling and analysis of data for spatial models

Detailed program

The teaching module “Extreme Events” is formally composed by a section of frontal lessons, a section of practical session, as well as two lab sessions focused on climate and terrain data, respectively.

The frontal classes will be organized in two main sections:
• An introduction, aiming at providing a general picture of the climate system and climate and meteorological variability (including a definition of extreme events), and contextualizing the role and methods of scientific research on climate within the international debate and treaties on climate change
• A section focused on key aspects of the module, including the scientific bases of climate change, climatic drivers of extreme events and their impacts, and the concepts of vulnerability, risk, adaptation, future scenarios, and climate impacts at the regional scale

The practical sessions will focus on the analysis of climatic drivers of extreme events and their impacts (past, emerging, possible/future), the associated risks and possible adaptation strategies, with focus on different types of impacts, different sectors and landscape / environmental contexts, including the analysis of compound impacts. The practical sessions will be mostly based on the IPCC reports and selected technical documents.

The “climate data” lab aims at:
• Learning the main methods to display and analyze meteo-climatic data (time series, periodicities, probability distributions) at different levels of time resolution, and apply the main tools of descriptive statistics (including measures of dispersion of the data)
• Clarifying different definitions of extreme events, based on the statistical methods previously recalled, applied to meteo-climatic data
• Solving simple problems that show the variability of extreme events on relation to climate change

The “terrain data” lab will show the use climate data and digital models within an integrated GIS environment, with the goal of:
• Understanding, organizing and digitizing climate data (e.g. from a meteorological station)
• Learning the bases of Terrain Analysis with the objective to understand the possible effects of extreme events on

the territory

Prerequisites

Bases of digital cartography and physical geography

Teaching form

8 two-hour lectures of delivered didactics, in person (2 ECTS ; Prof. Albani)
4 two-hours practical classes of delivered didactics, in person + 1 two-hours practical class (LiBaaS) of interactive teaching, in person (1 ECTS ; Prof. Albani)
5 two-hours laboratory (LiBaaS) sessions of interactive teaching, in person (1 ECTS ; Prof. Albani) - compulsory presence to at least 75% of the hours
5 four-hours laboratory (LiBaaS) sessions with interactive teaching, in person (2 ECTS ; Dr. Bosino) - compulsory presence to at least 75% of the hours

Textbook and teaching resource

Teachers' slides, scientific and technical documents (see list below), further in-depth reading (links to relevant scientific publications, documents, web pages).

General parts (bases of climatology)
• Atmospheric science : an introductory survey, J.M. Wallace and P.V. Hobbs, Elsevier, 2006.
• Global Physical Climatology, D.L. Hartmann, Academic Press, 1994 (eBook).
• A Climate Modelling Primer. Kendal McGuffie; Ann Henderson-Sellers. Edition: 3rd ed. Chichester, West Sussex : Wiley. 2005. eBook.

Specific parts (climate change, extreme events, impacts, adaptation)
• IPCC Assessment Report 6, Working Group 1. Technical Summary : https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_TS.pdf
• IPCC Assessment Report 6, Working Group 2. Technical Summary : https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_TechnicalSummary.pdf
• Summary documents in Italian available through the IPCC Focal Point for Italy : https://ipccitalia.cmcc.it/
• Additional specific documents will be made available during the course.

Semester

Frontal lessons (SECOND semester ; Prof. Albani)
Practical (SECOND semester ; Prof. Albani)
“Climate Data” Lab (SECOND semester ; Prof. Albani) - compulsory presence to at least 75% of the hours
“Terrain Data” Lab (SECOND semester ; Dr. Bosino) - compulsory presence to at least 75% of the hours

Assessment method

The part of the module under the responsibility of Prof. Albani (frontal classes + practical sessions + climate data lab) will be evaluated through a unique oral exam on the topics of all the different activities.

The part of the module under the responsibility of Dr. Bosino (terrain data lab) will be evaluated in all cases through a dedicated practical activity.

The final score for module “Extreme Events”, on a scale of 30 points, will result from the weighted average of the scores of the evaluation from Prof. Albani (4) and the evaluation from Dr. Bosino (2).

As per the University rules, presence limited to less than 75% of the hours dedicated to each of the two lab units (climate and terrain data labs) precludes the access to the final exam.

The final score will be registered after enrolling to the entire course "Sustainable Management of the Territory", resulting from the average of the scores of the two modules "Environmental Geology and Territorial Management" and "Extreme Events".

Office hours

By appointment

Sustainable Development Goals

CLIMATE ACTION