COURSES AY 2020/21

Syllabus and learning activities. Academic year 2020-2021

This edition will have a **new curriculum**, articulated in 11 courses corresponding to a total of **66 credits** (350 hours of lessons, lab activities with tools and software, design and presentation of individual/group projects). The 2020/2021 curriculum will be articulated into two streams:

1. **Climate Economics and Finance:** Decision theory, Climate-economy modelling, Applied environmental economics, Climate policies, Climate finance
2. **Climate Modelling and Impact Assessments:** Chemodynamics, Climate change and environmental quality, Ice Sheets and Glaciers in the Climate System, Risk Assessment and Decision Support System for Environmental Impacts of Climate Change, Adaptive Management of Natural Resources and Agricultural Systems, Climate Damage Modelling and Assessment

The first period includes a common curriculum and offers 6 basic courses.
Foundations: Mathematics, Statistics, Econometrics and Machine learning, Climate dynamics, Environmental and climate economics, Climate of the past.

Foundations

Introduction to R (Mistry)

Hands-on sessions with the R statistical software. Lectures will focus on imparting data handling and analysis skills utilizing various commonly used scientific data formats (e.g. netCDF, ascii etc). Students will also be introduced to geo-spatial mapping routines in R to facilitate rapid spatiotemporal aggregation and mapping of environmental and socio-economic data.

Mathematical Modelling and Programming (Pasut)

Understanding of dynamic systems and preliminary concepts such as linear algebra, eigenvalues, complex numbers. Introduction to mathematical instruments for dynamic systems and applications to environmental problems.
Lectures will focus on theory as well as on applications through hands-on sessions.

Statistics (Prosdocimi)

The course introduces the statistical methods useful to quantify changes in climate variables and the impacts of climate change on human activities. Students will learn how to specify, fit and interpret a variety of statistical models, and how to use them to answer scientific questions about the climate. The material is introduced using numerous case studies. Hands-on sessions with the R statistical software will be an integral part of the course.

Econometrics (Mammi)

Introduction to the theoretical and modelling elements of econometrics. Application of econometric methods (e.g. panel and cross-section data) for assessing climate impacts, with particular emphasis on pros and cons of different approaches will be central to the course. Lectures will also focus on hands-on econometric exercises in R.

Machine learning (Torsello)

Introduction to the principles and elements of machine learning. Application of commonly used neural networks and other machine learning approaches with focus on climate science will be a central theme of the course. Lectures will include hands-on machine learning algorithms using Python programming language. Students will get an overview and experience in data science, a hot topic having wide-ranging applications in environmental studies.

Introduction to Climate Dynamics (Zanchettin)

Introduction to climatology. Basic understanding of how Earth's climate operates and how it is investigated by contemporary and pioneering climate research, with focus on the physical components of climate. Students will become familiar with the main modern tools used for characterization, understanding and prediction of climate and learn fundamentals of anthropogenic climate change and natural climate variability. Lectures will be frontal.

Environmental and Climate Economics (De Cian)

Market failures and environmental externalities. The role of climate policy in the broader context of sustainable development and planetary boundaries. Climate-economy tools to simulate and evaluate climate policy instruments. Lectures will focus on theory and applications through hands-on sessions, group discussion, and students' presentations. Students will learn to compare costs and benefits of climate change, analyze, evaluate, and design climate policy solutions, conceive transformational pathways in the context of sustainable development.

Climate of the past (Barbante)

Introduction to paleo-climate, time scales of climate change, and climate in human history. Methods for detecting climate change, including proxies, ice cores, instrumental records, and time series analysis. Lectures will focus on the physical and chemical processes in climate, including primordial atmosphere, ozone chemistry, carbon and oxygen cycles, and heat and water budgets. Students will learn about the internal feedback mechanisms in earth's climate system, including ice, aerosols, water vapor, clouds, and ocean circulation.

Stream 1: Climate Economics and Finance Stream

Decision Theory and Multi-criteria Analysis (Giove)

Methodological basis of Decision Theory under uncertainty, Utility Theory, Decision Tree, Group Decision, Weighted Averaging, Ordered Weighted Averaging. Methods for optimization problems, in particular Linear Programming approach and some extensions.
Lectures will focus on methods as well as hands-on exercises in R. Students will learn how to understand, specify, describe some problems in this field, and to implement a resolution strategy.

CGE and integrated assessment modelling of climate change impacts and policies

Overview of macroeconomic approaches used to study the socio-economic impacts of climate change and the adaptation responses. Four topics related to different modelling aspects: discounting, impacts assessment, mitigation and adaptation policy assessments. Focus on Computable General Equilibrium (CGE) models. Lectures will focus on theory as well as applications with hands-on sessions. Students will learn the theoretical foundations of those models and learn how to apply them for the analysis of the socio-economic impacts of climate change.

Applied Environmental Economics and Policy Evaluation (Vona)

The objective of the course is to introduce students to the use of econometric methods to evaluate historical environmental and climate policies, with an empirical focus on their impacts on innovation and employment.

Domestic and International Climate Policies (Carraro)

Recent history of international negotiations on climate change to identify the main factors that prevent countries to achieve a widespread and effective agreement. Lectures will focus on the economic theory of climate negotiations using a quantitative approach based on game theory. The course will also review the main climate policy instruments with particular emphasis on the design of emission permits schemes both nationally and internationally.

Climate finance (Battiston)

Climate risk differs from other sources of risk traditionally analysed in finance. The course focuses on the new scientific approaches required to describe and manage climate-related risk, a topic of increasing interest for practitioners of both public and private financial institutions. Student will learn: i) the main theoretical notions of climate financial risk (in class) and ii) practical know-how for the computation of metrics of climate financial risk on empirical data (hand-on sessions).

Stream 2: Climate Modelling and Impact Assessments

Chemodynamics, climate change and environmental quality (Marcomini)

Basic concepts of environmental chemistry and thermodynamics. Climate system under a chemical and thermodynamic perspective. Impacts of climate change on environmental chemical pollution. Environmental risk assessment by exposure to chemicals. Lectures will focus on the behavior of environmental pollutants having different lifespans, with emphasis of the feedback cycle under climate change. Students will learn of the overall framework of contaminants' management, and to estimate and manage climate change risk.

Ice Sheets and Glaciers in the Climate System (Lucchi/Colleoni)

Basis of the processes related to past ice sheet dynamics through the use of ice-sheet related or ocean-related proxies in geological archive or by using geophysical methods to depict the past dynamics, and through the study of the polar high latitude atmospheric and oceanic dynamical processes affecting and interacting with the ice sheets and glaciers based on numerical modeling and or the direct comparison/integration of past and current observation in numerical models. Lectures will be organized in two blocs. Students will learn

Risk Assessment and Decision Support System for Environmental Impacts of Climate Change (Critto)

Tools, methods and skills required for assessing environmental hazards, vulnerability and risks posed by climate change in the context of global environmental changes. Decision Support System for climate change risk assessment and management. Lectures will focus on theory as well as on applications through hands-on sessions, students' presentations, and group discussion. Students will learn to define and implement environmental risk analysis, impacts and vulnerability assessment, and use related specific decision support systems.

Adaptive Management of Natural Resources and Agricultural Systems (Giupponi)

Introduction to the principles of natural resources management. Lectures will focus on the interactions between natural and human elements of socio-ecosystems and agro-ecosystems in particular. Sustainability and sustainable development will be central themes of the course. System dynamics will be the most widely used approach. Spatial and temporal dynamics are explored with concrete examples and case studies. Students will be involved in individual and group case-studies and learn methods and tools for problem-solving approaches.

Climate Damage Modelling and Assessment (Mysiak)

Theoretical and practical understanding of the methods and tools to assess climate change risk and the economic benefits of climate adaptation. Analysis of climate policies and management of risks deriving from climate change and variability.

Lecture will focus on methods as well as applications in R and QGIS. Students will learn to estimate and manage climate change risk utilizing current geospatial modelling tools and practices.