PhD in Sustainable Development and Climate Change

Presentation

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1. Key Facts
Key Features

- 3 years of PhD programme in English
- 160+ hours of lectures
- 6 months of research abroad
- Network of 50+ universities
- 100+ professors and researchers

6 Curricula

- Inter-disciplinary
- Multi-disciplinary
- Trans-disciplinary
6 Curricula for 1 Research Topic

- PhD SDC EARTH SYSTEM AND ENVIRONMENT
- PhD SDC TECHNOLOGY AND TERRITORY
- PhD SDC AGRICULTURE AND FORESTRY
- PhD SDC SOCIO-ECONOMIC RISK AND IMPACTS
- PhD SDC THEORIES, INSTITUTIONS AND CULTURES
- PhD SDC HEALTH AND ECOSYSTEMS
2. Last Edition
600+ applications from around the world
# Research Topics by Curricula

<table>
<thead>
<tr>
<th>Curriculum</th>
<th>Topic</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CU1</td>
<td>Earth System and Environment</td>
<td>18</td>
</tr>
<tr>
<td>CU2</td>
<td>Socio-Economic Risk and Impacts</td>
<td>16</td>
</tr>
<tr>
<td>CU3</td>
<td>Technology and Territory</td>
<td>28</td>
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<tr>
<td>CU4</td>
<td>Theories, Institutions and Cultures</td>
<td>12</td>
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<tr>
<td>CU5</td>
<td>Agriculture and Forestry</td>
<td>13</td>
</tr>
<tr>
<td>CU6</td>
<td>Health and Ecosystems</td>
<td>13</td>
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</tbody>
</table>

**Total 100**
**Courses for All Students**

Access to more than **350 courses** provided by the universities of the network with **8,650 hours** to cover all curricula

<table>
<thead>
<tr>
<th>Curricula</th>
<th>N. of courses</th>
<th>Tot. hours</th>
<th>N. of Uni. involved</th>
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</thead>
<tbody>
<tr>
<td>CU 1 - Earth System and Environment:</td>
<td>60</td>
<td>2000</td>
<td>15</td>
</tr>
<tr>
<td>CU 2 - Socio-Economic Risk and Impacts:</td>
<td>80</td>
<td>2000</td>
<td>15</td>
</tr>
<tr>
<td>CU 3 - Technology and Territory:</td>
<td>100</td>
<td>2700</td>
<td>22</td>
</tr>
<tr>
<td>CU 4 - Theories, Institutions and Cultures:</td>
<td>50</td>
<td>650</td>
<td>12</td>
</tr>
<tr>
<td>CU 5 - Agriculture and Forestry:</td>
<td>30</td>
<td>650</td>
<td>15</td>
</tr>
<tr>
<td>CU 6 - Health and Ecosystems:</td>
<td>34</td>
<td>650</td>
<td>10</td>
</tr>
</tbody>
</table>

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3. The Network
A National PhD Programme

- Administration headquarters in Pavia
- 50+ affiliated universities from Italy
- Prestigious knowledge partners
Headquarters: IUSS Pavia

Scuola Universitaria Superiore IUSS Pavia is an Italian Public Institution devoted to research and higher education.

IUSS fulfills an advanced teaching and research model, which is also successfully implemented by the Scuola Normale Superiore and the Scuola Sant'Anna in Pisa.

IUSS offers a variety of educational and training paths based on a strong interdisciplinary approach.

+ more than 50 affiliated universities

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4. Education Programme
Structure of the PhD Programme

One core research topic and six curricula for a multi-, inter-, and trans-disciplinary research program to achieve the SDGs of the UN 2030 Agenda

Building on the two pillars of education and research in sustainable development and climate change
Educational Programme

Events:

Multi-Disciplinary (MD) events to expose all the PhD candidates to the complexity of Sustainability and Climate Change (48+ hours)

Curriculum (CU) events to train PhD candidates on tools and topics common to the specific curriculum (48+ hours)

Focused and Disciplinary (FD) selection of thematic and methodological courses suggested by the supervisors and offered by host universities (64+ hours)
5. Research Programme
From Research to SDGs

One core research topic and six curricula for a multi-, inter-, and trans-disciplinary research program to achieve the SDGs of the UN 2030 Agenda
6. Curricula
Curriculum 1

Earth system processes and new perspectives in environmental development

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Earth system processes and new perspectives in environmental development

Key topics:

- Climate and paleo-climate
- Environmental risks and impacts
- Physical and chemical processes
- Numerical modelling
- Greenhouse gas emissions
- Probability approaches and extremes

Description

The PhD candidates will study different biological, chemical, geological, physical, mathematical and environmental aspects of climate change and sustainability. The impacts and risks of climate change, including extreme events, will be investigated.

The candidates will study key processes and scale interactions related to the atmosphere, oceans, the land surface and the sub-surface, and the cryosphere which determine the Earth's climate.

Multi-disciplinary approaches will be applied to understand the interplay between natural and human processes, and between greenhouse gases and ecosystems. Hierarchies of coupled models will be developed and used to understand the role of different processes in determining the Earth's climate and its evolution. Observations from conventional and satellite platforms will be leveraged to understand phenomena, and design and diagnose model performance. Observations and model simulations will be applied to disentangle the relative role of natural variability and human activities on the Earth's climate.

Modelling will be used to explore the interaction between global, large-scale, low-frequency phenomena and local, small-scale and high-frequency events (including extremes), and to assess the potential impacts of different adaptation and mitigation strategies. In particular, the socio-economic impacts of climate change will be investigated and quantified.

Changes detected over the last decades will be compared with changes that have occurred in the most recent and very distant past, including the paleo climate, to identify possible similarities and differences and to help to predict how the climate will evolve in the future. Changes in surface variables, such as temperature, wind and precipitation, in terms of both their average and their differences, will be studied. Particular emphasis will be placed on understanding past and future changes in the frequency and intensity of extreme events that populate the tails of the probability distribution functions. Sophisticated statistical techniques will be used to analyse available data and extract signals. Probability theory and stochastic calculus will be applied to improve the simulation and propagation of initial (e.g., linked to observations) and model uncertainties.

The impact of climate change on land surfaces and the sub-surface, on ecosystems and the energy, water and chemical (carbon, methane) cycles will be investigated. The impact of changes in the concentration of chemical species, in particular, of carbon and nitrogen compounds, on the ecosystems will be analysed. Greenhouse gas emissions will be monitored and quantified using observation and data assimilation systems, and numerical experiments will be designed and performed to investigate their propagation, from the local source area to the global region.

Combined analysis of past and present climates and application of multi-disciplinary approaches will allow estimation of future risks and identify the most effective adaptation and mitigation strategies.
Curriculum 2

Measuring the transition towards a decarbonised and sustainable economy

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Measuring the transition towards a decarbonised and sustainable economy

Key topics:

- Energy transition
- Physical and transition risks
- Circular economy and eco-innovations
- Responsible business, finance and consumption
- Sustainable mobility
- Predictive models and evaluation models
- Scenario analysis and policies for sustainability

Description

This curriculum focuses on analysis of the complex relationships between the phenomenon of climate change and the socio-economic system, defined based on market relationships and/or other types of interactions among economic actors (public and/or private companies, financial markets, international markets) and other stakeholders (institutions, civil society, workers, communities, consumers, etc.) included in these systems.

The curriculum is oriented to:

- predicting future scenarios regarding the relationship between climate change and socio-economic systems, with reference, also, to the development of environmental, quantitative (e.g., greenhouse gas emissions, flood scenarios) and qualitative (e.g., ESG rating) impact models;
- analysing and assessing the risks of climate change and energy transition on socio-economic systems and their actors, with reference also to distributional and social equity issues;
- investigating the socio-economic causes of the current climate crisis.

Through this research agenda, the curriculum aims to provide economic policy and managerial practice recommendations to prevent and enable mitigation of environmental and climate risks on territories and an orderly transition towards a fair, circular and low-carbon economy, in line with the UN 2030 Sustainable Development Goals agenda.

The curriculum aims, also, to promote more responsible and sustainable production and consumption models in terms of: resources use (e.g., through the promotion of advanced circular economy models and green innovation); business strategy (e.g., through the adoption of corporate social responsibility principles in production processes, operations and stakeholder management); organization of the financial system (e.g., green fintech, investor activism in the ESG field); technological advances (e.g., favouring the development of sustainable artificial intelligence applications) and in terms of consumption patterns (e.g., energy communities, purchasing groups, cooperatives, collaborative consumption).

Methodologically, the curriculum will employ mainly quantitative measurement and evaluation methods, although not to the exclusion of qualitative approaches. Finally, the research will be conducted at different levels of analysis – micro and/or macro – to be defined depending on the research project objective(s).
Curriculum 3

Technologies, systems, and approaches for the sustainable transition of communities, territories, and production processes
Technologies, systems and approaches for the sustainable transition of communities, territories and production processes

Key topics:

- Sustainable mobility
- Energy transition
- Innovative materials and advanced technological processes
- Regeneration of cities, communities and infrastructures
- Governance of the territory and networks
- System and process monitoring
- Sustainable catalytic processes

Description

The doctoral research related to this curriculum will be focused on resilience, sustainable development paradigms, circularity and actions against climate change to be implemented in territories, communities and production processes and in the consumption of resources and energy.

The goals will be ambitious and involve a range of technological and sectoral challenges, such as:

- development and sustainability of the built environment in relation to structures and infrastructures and their impact on territory, survey and monitoring of the territory, and the natural and built environment;
- systemic design and innovation in transport systems and sustainable mobility solutions, with particular reference to the development of pedestrian, bicycle and electric transport;
- enhancement of cultural heritage and the landscape, and urban and territorial regeneration;
- study of traditional and advanced smart technologies for sustainable production system conversion to ensure resilience of production and territorial systems;
- management of the entire raw materials life cycle with particular attention to domestic resources and reduction and management of waste;
- new technologies for the production, transport, storage and use of energy, with particular reference to the development of renewable sources, efficient and resilient energy systems, methodologies for their management and establishment of energy communities;
- chemical technologies and methodologies to enable development of new industrial processes, understanding of chemical synthesis, mechanisms and reactivity, study of materials and their properties, and sustainable catalytic processes;
- development of new materials, conversion systems and technologies necessary for progressive electrification of transport and production systems.

This urgent and complex transition will require the development of new multi-transdisciplinary approaches and integrated objectives, including:

- reducing climate-altering emissions, transition to renewable energy sources, closure of the carbon cycle;
- design of the built environment, plants and infrastructures based on the concepts of resilience and integration with the natural environment;
- new models of territorial organization and use of city spaces;
- extended application of the concepts of systemic design, circular economy, reduced use of natural resources, environmental impact, ‘smart cities’ and the Industry 4.0 paradigm and the notion of sustainability to economic and production systems, and management of public services, energy networks and transport;

The PhD candidates will be encouraged to interact in their training activities in relation to different components and transversal dimensions of the research, such as:

- the technical knowledge framework used to measure, evaluate and monitor territorial vulnerabilities and exploit in experiments related to innovative methods and actions and projects oriented to resilience;
- metrics to assess the sustainability and resilience of territories, local communities, manufacturing organizations and production and consumption processes;
- territorial governance models to support the transition of institutions and communities, integrating mitigation, adaptation and transition objectives into plans, projects and strategies, in order to implement the multi-scale and inter-sectoral perspectives of resilience, sustainability and circularity.
Curriculum 4

Theories, institutions, and cultures of the ecological transition
Theories, institutions, and cultures of the ecological transition

Key topics:
- Theories of justice
- Ecological transition
- Regulatory policies
- Ecological humanities
- Health and climate
- Transgenerationality
- Governance and sustainable finance

Description

This curriculum promotes education and research activities related to the theories, institutions and cultures of sustainability and climate change, and favours a transdisciplinary methodological perspective based on different humanities and social science approaches, in particular from philosophy, literary studies, law and sociology. Particular attention will be devoted to issues related to ontology and ethics; national, European and international juridical regulations; climate, environmental and intergenerational justice; global politics; asymmetries and inequalities in distribution criteria; the ecological humanities and ecocriticism; environmental semiotics and aesthetics; and the interactions between the environment and living beings, including non-human beings.

The overall education and research objective is to develop theoretical and practical tools to enable future researchers to manage the cognitive and practical challenges posed by sustainability and climate change, with specific reference to the intergenerational solidarity pact and the ecological transition, whose importance can no longer be neglected.

The research activities involved in the curriculum are indicated in the descriptions of the scholarships. They range from representations of (un)sustainable societies in narrative, poetry, theatre and media, and in social and collective dynamics and practices capable of generating ecological thinking and promoting empowerment and agency in both individuals and communities, to the ethical, theoretical-political and social implications of the promotion of innovative models of social and economic development. This is done from the perspective of environmental and post-subjectivist aesthetics related to the Anthropocene era, as well as the legal issues and the regulatory policies linked to the transition to new forms of sustainability, sustainable finance and management of climate change in a law, comparative law and economic analysis of law context.
Curriculum 5

Innovative models for resilient and sustainable agri-food and forestry systems

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Innovative models for resilient and sustainable agri-food and forestry systems

Key topics:
- Resource use efficiency
- Transformative adaptation
- Rural development
- Precision farming, biotechnologies and eco innovation
- Food security/safety and farm productivity
- Ecosystem services
- Smart and digital agriculture

Description

The agriculture and forestry curriculum focuses on environmental, economic and social sustainability and climate change in key areas (agriculture, livestock and forestry), from both a life cycle and supply chain perspective with a particular focus on Mediterranean agricultural and forestry systems. The Mediterranean region is a mosaic of agricultural and forestry system hotspots that are threatened by the impact of climate change. The course aims to provide a solid, up-to-date and interdisciplinary cultural and scientific base and a deep understanding of the systemic implications of human activities and awareness of the importance of relationships with business, administrations and civil society in an international contest. The ultimate objective is to implement a transformative process of sustainable agriculture and forestry, within a climate change context, rooted in analysis and evaluation of new sustainable development models with a sound scientific, technical and technological base. The curriculum themes are consistent with the 2030 sustainable development goals related to food security, ending of extreme poverty, sustainable management of water resources, good quality education, combating drought, land degradation, desertification, hydro-geomorphic hazards, and enabling mitigation of and adaptation to climate change.

The PhD students will develop new tools and explore new options to tackle agriculture and forestry challenges posed by climate change. They will include: more efficient use of natural resources in agro-ecosystems; sustainable production of food and biomass; reduced dependence on non-renewable resources; conservation of biodiversity; more resilient agro-forestry systems; better animal welfare; reduced use of antibiotics and agrochemicals in food production; improved food quality, security and safety; investment in adaptation to and mitigation of climate change; reduced waste and increased recycling within a circular bio-economy; enhancing and promoting ecosystem services related to agriculture, livestock and urban greenery and forestry; preventing soil degradation and desertification; and safeguarding water resources.

Linked to the other interdisciplinary curricula and use and integration of a wide range of emerging technologies, this will contribute to the achievement of sustainable and profitable agri-food and forestry production that complies with conservation of environmental resources and landscapes and the values of equity and social solidarity. Life sciences, information technologies, crop modelling, robotics, digital agriculture technologies, renewable energies will all be exploited. An analytical perspective on agricultural and forestry socio-ecosystems is important and includes integration of research on the quantitative assessment of the impacts of climate change with semi-quantitative and participatory research on strengthening the adaptive capacity of rural communities. Climate change will require major transformative adaptations to ensure sustainable management of natural resources and support economic and cultural development of rural areas.
Curriculum 6

Climate, global changes, and health – from ecosystems to humans

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Climate, global changes, and health – from ecosystems to humans

Key topics:

• Ecosystem health
• Human health
• Chemical and biological risks
• Biodiversity and biotechnology
• Anthropogenic threats
• Safe and sustainable design
• Advanced modelling

Description

This curriculum tackles research questions regarding the impacts of climate and global change on ecosystems and humans, and adaptation to and mitigation of climate change, to identify novel sustainable development models and understand the interactions between the environment and health.

The curriculum has two objectives:

• to study the impacts of climate change on the structure, function and health of the biotic and abiotic components of ecosystems at different spatio-temporal scales, in various environmental contexts;
• to study the human health risks associated with the synergies between environmental change (including various types and sources of pollution) and/or climate and global change, and a focus on current and future social and economic dynamics in the context of sustainable development.

Research activities include:

• implementation of protocols for measuring and monitoring climate change and its impacts on ecosystems, including use of modelling approaches;
• identification and evaluation of possible climate change adaptation and mitigation strategies, including ecological restoration and biotechnological means of curbing of greenhouse gas levels;
• analysis of vulnerability and adaptation to climate change of structural, functional and compositional traits characterizing biota and ecosystem processes (including biogeochemical cycles);
• study of the impacts of climate and global change on the ecosystems of extreme environments;
• analysis of the determinants of environmental pressures that produce real or potential impacts on biodiversity and ecosystem functions that are vulnerable to climate change;
• identification of ATC (Anthropogenic Threat Complexes) and their real or potential impact on ecosystem alterations induced by climate change in different environmental contexts;
• analysis of the impact of climate change and related adaptation and/or mitigation policies on human health via its associated ecosystem effects, based on modelling diffusion of viral, bacterial and parasitic infections, including zoonoses, and their influence on related control and prevention policies;
• study of the risks to animal and human health (related to the pathology predispositions of individuals), associated with chemical and environmental pollution in the context of climate and global change, with particular attention to current and future social and economic dynamics in the context of sustainable development;
• development of safe and sustainable solutions using non-toxic materials and products.
CONTACTS

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