Research Programme

38° cycle – Academic Years 2022/2023 – 2024/2025

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PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

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- The Urban-Water-Food-Energy NEXUS for resilience against global, and climate change

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- Assessing fresh water availability under climate change

- Global warming and natural disasters

- Mathematical modeling of green energy transition

- Role of the air-sea coupling and small-scale ocean processes on regional climate along coastal areas.

- Seasonal forecasts for climate impact assessment

- Coccolithophore growth rate and calcite production under high CO2 levels

- Impact of European open fire emissions to greenhouse and reactive gas atmospheric variability

- Hydropower generation in the Italian Alpine under a changing climate

- Monitoring of water quality of natural rivers exploiting image processing techniques

- Extreme events and associated atmospheric circulation patterns

- Advances in carbon accounting: circularity and responsibility in composite systems

- Knowledge, citizen awareness and policy of marine shallow-water biodiversity

- BIogeochemiCal fate of emerging Anthropogenic pollutants in the sedimentary Record

- MEDICHANGE – MEDIcanes risk in a climate CHANGE scenario

- Disaster risk reduction in coastal areas affected by climate change

- Quantum-chemical approaches to spectroscopy and reactivity for atmospheric chemistry

- Urbanization influence on climate change by remote sensing data

- Redesigning Deltas in a time of climate change

Curriculum 2. Socio-Economic Risk and Impacts

- Italian Inner Areas as Engine for Green Transition and Recovery

- Developing innovative approaches for cascading effects to improve flood risk management actions with a specific interest on the functional vulnerability of critical infrastructures.

- A systemic framework for climate risk assessment and management

- Sustainable mobility determinants in urban contexts: demand and supply analysis and policy design

- Climate Change Impact on Economic Systems and Policies for an Orderly Transition

- Irreconciliable sustainabilities? The critical macro financial side of green transition; a macro modelling perspective

- Innovative start-ups for a more innovative and sustainable economy

- Environmental policies and consumption choices for low carbon and circular transitions

- The Dark Side of Innovation: Predicting and Assessing Patent Toxicity

- Sustainable Tourism, impacts of the introduction of the eco-labels on family desitination choices

- Detecting SMEs' contribution to SDGs environmental challenges with big data

- The twin-transition geography: green & digital transitions across heterogeneous regions

- Food system and biodiversity loss: a transition to more sustainable behaviors

- Climate extremes and policy action. The role of social networks.

- Assessing droughts socio-economic impact combining social media and drought indexes

- Environmental awareness in the framework of sustainable development goals

- Transition towards more sustainable production and consumption in agri-food systems

- Water-in-food, conflicts, and migrations

- Sustainable mobility: models, methods and case studies.

- The role of Public Administration in the transition towards a sustainable and circular bioeconomy: policies, practices and assessment methods.

Curriculum 3. Technology and Territory

- Carbon reduction target: supporting the energy-environmental management studies (with a focus on consulting services)
- Ocean space utilization for energy harvesting purposes
- Development of nanostructured electrolytic materials for more sustainable batteries
- Highly emissive materials for energy-efficient devices, photovoltaic and photocatalytic systems
- Nonlinear technologies for green energy control
- Smart zero-carbon buildings and digital twins
- Assessing green infrastructures' mitigation effects by geo-data and simulation
- Photoelectrocatalytic conversion of CO_2 for sustainable and resilient energy management
- Biochar for Carbon Capture and Sequestration and accounting
- Sustainable manufacturing and smartness
- Circular economy as a driver for territorial development
- Innovative power cycles and working fluids for the energy transition
- Artificial Intelligence for Precision Livestock Farming: Supporting Sustainable Production and Improving Animal Welfare
- Decarbonisation of industry and cross-sectoral implications on the energy system
- ABEs for mitigating and contrasting climate change in buildings
- Innovative Catalysis for Sustainable Synthesis of Active Pharmaceutical Ingredient
- Impact of climate change on the renewable energy sector in Italy
- The impact of climate change on the future energy system
- Exploiting nonlinear dynamics for the design of innovative solutions of vibration energy harvesters
- Nature Based Solutions for the Sustainable Smart Cities of the Future
- Paradigm capsized: planning with tangible, manageable and measurable NbS
- Multi-criteria decarbonisation analysis for remote and rural areas
- Holistic stochastic approach for sustainable energy transition of alpine cities
- Flexible buildings as thermal storages for RES integration and smart cities/territories
- Simulation and optimisation of energy community energy flows by computational intelligence
- Implementation of local energy communities: hardware infrastructures and software logic
- Biocatalytic transformations in unconventional green solvents
- Sustainable Energy Communities
- Sustainable and Circular Manufacturing in the Digital Era
- Chemometric optimization of synthesis of materials for adsorption of pollutants

- Electro-nanocatalytic approaches for high added value products
- Sustainable integrated strategies for preservation and maintenance of urban art
- Urban resilience and participation for the territory safety from risks
- E-mobility and Smart-Grids
- Connecting online musicians and audiences to reduce travels and pollution

Curriculum 4. Theories, Institutions and Cultures

- Diachronic webfare: transgenerationality

- Institutions and governance of climate change

- Shaping sustainable identities through literature and art.

- The neuro-cognitive bases of sustainable decision-making

- Governing Sustainable Development and Climate Change: Theories and Regulation

- The Transformation of Work

- Synchronic Webfare and Sustainability

- Sustainability and resilience of cities in the face of climate change

- The regulation of sustainable finance and recent challenges: investor protection, technology and SMEs

- Food Safety and Criminal Compliance: Towards New Enforcement Models Against Individuals and Corporations

- Market regulation and sustainable investment policies: a comparative law perspective

- Climate Risks and the Media

- Sustainability in the Anthropocene: The Politics of Plant and Ecosystem Conservation

- The environment between philosophical conceptualisation and environmental aesthetics

- Epistemology, trust and philosophy of technology: towards a philosophy of sustainable choice

- Ethical, Political and Institutional Profiles of Sustainable Development and Climate Change

- The new trends in climate change litigation

- Hydrogen Strategy and Policy: Italy in Comparative Perspective

- Prosumagerism and Energy Communities: The Role of Local and Public Authorities. (P.E.C. Project)

- The Evaluation and Remediation of Climate Change Risks in Old and New Media

- Population health, sustainable development and climate change

Curriculum 5. Agriculture and Forestry

- Optimization of wet co-product ensiling techniques to maximize the nutritional quality and minimize greenhouse gas (Volatile organic compounds) emissions from silage.

- Modeling dairy farm management and nutrition facing climate impacts

- Genomic tools for DNA-informed breeding for fruit crops resilience

- Biodiversity and emerging technologies in agriculture for sustainable development

- Sustainability assessment of agri-food processes with the Water-Energy-Food Nexus approach towards a climate-neutral economy

- State and regional legislative power on agricultural energy in the perspective of the fight against the climate crisis

- Soil and plant-associated microbial communities for resilience to climate changes

- Soil functions for mitigating climate change

- Resilience strategies for the adaptation to abiotic stress of plants in altered climatic conditions.

- Impacts of climate change and its uncertainty on agriculture

- Insects as a source of novel feed for high-value aquatic and terrestrial animal rearing: a multidisciplinary approach

- Engineering Photosynthesis For Global Sustainable Supply Of Plants For Food Crops, Bioenergy And More

- Coupling sensors and modelling to support sustainable irrigation practice

- High Throughput Screening to select resilience dairy feeding systems

- Land planning for biodiversity conservation and food production

- Identify and preserve the unique microbial terroir in a changing alpine environment

- Integrated approaches for carbon, water, and energy ecosystem exchanges

- Exploring the role of data to support the ecological transition of European agriculture: barriers and opportunities from a user perspective

Curriculum 6. Health and Ecosystems

- Is human well-being enhanced by exposure to high biodiversity?

- Forecasting the consequences of glacier extinction for ecosystem functioning

- Pollution and health: exploiting geolocalized Emergency Medical Services data, ground monitoring and Earth observation

- Impact of atmospheric pollutant on human health: from mouth to lungs

- Conserving the evolutionary potential of endemic species under global changes

- Contaminants of Emerging Concerns in Marine Ecosystems: Evaluation of Presence and Ecotoxicological Effects

- Climate Change Impacts in Polar and Alpine permafrost areas

- Evaluation of global warming effects on pathogenesis of aquatic Mycobacterioses

- Use of microalgae for the sustainable treatment of dairy wastewater and as a renewable source of compounds for plant biostimulation and protection

- Climate sensitive diseases in a changing environment: a one-health approach

- Alternative protein sources for human nutrition

- Ecological, morphological and human safety impacts of hydropeaking mitigation measurements

- Biomolecules and biomaterials for ecosystems protection and human health (acronym: BREATH: BiomateRial for hEAITH)

- Tick-pathogen interactions: impact on ecology and transmission of tick-borne diseases

- Novel methodology for development of Safe and Sustainable by Design products using systems biology and bioinformatics methods.

- Plastics in marine Environment

- Active and Healthy Ageing for Sustainability

Curriculum: 1. Earth System and Environment

Chasing convective storm evolution with swarms of space-borne Ka-band radars

Reference Person: Battaglia Alessandro (alessandro_battaglia@polito.it)

Host University/Institute: Politecnico di Torino

Research Keywords: Radar remote sensing

Convection

Cloud resolving models

Reference ERCs: PE10_14 Earth observations from space/remote sensing

PE10_2 Meteorology, atmospheric physics and dynamics

PE10_3 Climatology and climate change

Reference SDGs: GOAL 13: Climate Action

Description of the research topic

Deep convection has a profound influence on Earth's climate system. Updraft plumes in deep convective clouds are in the tropics the principal pathway by which heat, moisture, mass and trace gases are transported into the upper atmosphere. Observations of the occurrence and magnitude of vertical transport in deep convection are simply not available over the tropical oceans and sparsely available over land. Monthly to seasonal prediction of weather is heavily influenced by the role of deep convection on important modes of variability, such as the Madden-Julian Oscillation, El Nino/Southern Oscillation, and tropical waves. Convection is therefore central to prediction of severe weather both at sub-seasonal and seasonal time scales. The sign and nature of changes to convective storms in a warming climate are also difficult to predict. While moisture convergence is expected to increase at about 7% per degree of warming following the Clausius-Clapeyron law, storms are likely to become deeper and narrower and to produce heavier precipitation at a rate which is still debated. It also remains unclear whether or not the increased transports will result in more moistening of the high troposphere and more cirrus clouds or will be compensated by heavier precipitation.

Ground-breaking novel observations of convective clouds are expected from the NASA's Earth Venture Program Investigation of Convective Updrafts (INCUS) mission (https://www.Nasa.Gov/press-release/nasa-selects-new-mission-to-study-storms-impacts-on-climate-models) with the launch (2027) in low Earth orbit of a constellation of satellites equipped with Ka-band (35 GHz) radars and microwave radiometers in close formation (Dt separation of the order of few minutes). This observing system will allow to

globally observe the explosive evolution of storms as never done before and should therefore provide new observables to test the realism of convection-permitting cloud resolving models. These models will represent the backbone of future operational weather forecast models, which are currently run at or near 5 km but will soon move to finer resolution capable of resolving convection.

Scope of the PhD is to perform ancillary studies in preparation of the mission with three main goals:

1) To simulate the radar and radiometer measurements by using fine temporal (sub-minute) and spatial (sub-km) resolution outputs from the WRF model. The study will capitalize on advanced radar and radiometer simulators (accounting for the viewing geometry, the radar sensitivity, the antenna pattern, the pulse compression schemes, etc) developed in the past ten years within the research team.

2) To investigate the sensitivity of the INCUS measurements to the different parametrizations and schemes of the WRF model). Stochastic schemes are capable to represent model uncertainty in ensemble simulations by applying a small perturbation at every time step to each member and very suitable for the convective clouds scale studies of this project

3) To refine algorithms for the derivation of convective-related quantities (updrafts, condensed mass vertical fluxes) based on the Dt measurements (collaboration with NASA INCUS PI, Prof. S. Van den Heever at Colorado State University).

Research team and environment

This project offers an excellent opportunity to develop and apply novel radar techniques to remote sensing of clouds and precipitation. The student will be trained in a wide range of topics including radar meteorology, cloud physics, radiative transfer and precipitation remote sensing. The PhD student will be supervised by Prof. A. Battaglia, who currently has a joint appointment at Politecnico of Turin and at the University of Leicester, UK. A. Battaglia is a world leader in spaceborne radars and forward modelling of space-borne microwave sensors with direct involvement in all international missions with cloud and precipitation microwave observing instruments. He was involved with the NASA INCUS team in the successful proposal to the NASA's Earth Venture Program led by Professor Susan van den Heever (PI) at Colorado State University.

The PhD student will be able to collaborate with the international INCUS team when refining the algorithms for the characterization of convection (specifically there will be weekly teleconferences with the INCUS PI and Prof. Kollias at Stony Brook, City College of New York).

The student will benefit from the collaboration with the CIMA foundation group led by Dr. A. Parodi who will provide consolidated experience in the execution of cloud-resolving numerical experiments at kilometric scale by combining different microphysics and radiative schemes as well by using stochastic parameterization schemes.

Suggested skills for this research topic

Applicants should have a science or engineering degree. Knowledge of meteorology would be beneficial. Programming skills in matlab/idl/Python/C/Java/C++ and knowledge of radar systems, signal processing and numerical modelling could also be beneficial. Team working attitude and excellent knowledge of spoken and written English are highly desirable.

Curriculum: 1. Earth System and Environment

Mechanisms and impacts of the Atlantic Multidecadal Variability

Reference Person: Bellomo Katinka (katinka.bellomo@polito.it)

Host University/Institute: Politecnico di Torino

Research Keywords:	Climate impacts
	Climate change
	Machine learning
Reference ERCs:	PE10_3
	PE10_2
	PE10_8
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

The Atlantic Multidecadal Variability (AMV) is the leading mode of climate variability over the North Atlantic on decadal and multidecadal timescales. Previous studies have shown that the AMV influences hurricanes, storm tracks, precipitation, and extreme events over the European and American continents, but despite its dramatic societal and economic effects, the mechanisms driving the AMV are still poorly understood. In this context, the role of ocean circulation is unclear because while in some models it seems to be strongly coupled with the sea surface temperatures, in others this coupling is weaker. In the models in which the ocean-atmosphere coupling is weaker, the atmospheric forcing from the North Atlantic Oscillation (NAO) prevails. In addition, from the industrial revolution, human emissions of aerosols and greenhouse gases have strongly contributed to the changes in sea surface temperature, further complicating the interplay between the ocean and the atmosphere in driving the AMV, and the attribution of the AMV's large-scale climate impacts to human emissions.

We plan to hire a Ph.D. Candidate to address some pressing research gaps regarding the mechanisms driving the AMV and its impacts on societies. More specifically the Ph.D. Candidate would examine the output of coupled global climate models archived in the Coupled Model Intercomparison Project phase 6 (CMIP6), which hosts at the moment ~40 models, and analyze the preindustrial and historical simulations to investigate the coupling of the ocean and the atmosphere in driving the AMV. While the preindustrial simulations are integrated without external forcing, thus entirely driven by internal variability, the historical simulations include the external forcings and can be used to attribute the residual variability
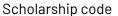
to human emissions when compared to the relative preindustrial simulation. In addition, the Ph.D. Candidate will analyze the Single Model Initial conditions Large Ensemble (SMILE), which is an archive of ~8 models that provided an ensemble of simulations integrated with the same external forcings boundary conditions but initialized from different initial conditions in the atmosphere. The SMILE models provide a unique dataset that, albeit exploiting a smaller sample of models, allows for accurate identification of the role of human and natural emissions from the internal variability.

Special attention will be given to climate impacts due to the AMV in the above set of model simulations and available observations. While some previous studies have found significant correlations of temperature and precipitation patterns due to the AMV in some single model studies and single observational datasets, there is a gap in understanding the impacts of the AMV on societies, especially over the European continent. In addition, since the ocean circulation (namely, the AMOC ocean current) and the AMV are believed to be strongly coupled and the AMOC is a tipping element of the climate system, it is plausible that abrupt changes in the AMOC could lead to drastic changes in the impacts of the AMV. Hence, the Ph.D. Candidate will be the first one to systematically investigate a very large archive of publicly shared data and observational datasets, with a special focus on societal impacts. For this purpose, we plan to leverage the machine learning and the big data expertise in our group and at Politecnico di Torino to build a novel approach for analyzing big datasets and extract meaningful information of AMV impacts to better prepare societies for future changes in the climate.

Research team and environment

The reference person (Katinka Bellomo) is a Marie Curie Individual Fellowship holder for 2021-2023 with a related project ('CliMOC: Climate Impacts of the Atlantic Meridional Overturning Circulation). Katinka holds a Ph.D. In Meteorology and Physical Oceanography from University of Miami and has previously worked as a postdoctoral scientist at Columbia University and the National Research Council of Italy (CNR). She has documented expertise in the proposed topic, including a publication that was published on Science. She has experience collaborating on projects and also supervising Ph.D. Students. In addition she maintains active collaborations with several research groups in Italy, Europe and the United States. Jost von Hardenberg, full professor at Politecnico di Torino would be the official supervisor to the Ph.D. Student, and there would be a group of close collaborators: Oliver Mehling who is a Ph.D. Student working at Politecnico and funded by the ITN Ph.D. Program ('Critical Earth'), and additional collaborators from the National Research Council-Institute of Atmospheric Science and Climate (CNR-ISAC) in Torino and Bologna (Paolo Davini, Virna Meccia and Susanna Corti) who are leading experts of climate variability and change. Additional funding that is related to this topic comes from H2020 project TiPES (Tipping Elements in the Climate System) and ROADMAP (The Role of ocean dynamics and Ocean-Atmosphere interactions in Driving cliMAte variations and future Projections of impact-relevant extreme events): both of these projects were funded to a consortium of international research centers and universities, with whom the Ph.D. Candidate would be able to collaborate during their Ph.D.

The Ph.D. Candidate would therefore be exposed to a large and vibrant research community through existing funded projects and networks from the supervisors, nationally and internationally.

Suggested skills for this research topic

- computation skills: python, matlab, ncl or similar language

- familiarity with shell scripting and unix environment

- background in physics, earth system science, meteorology, oceanography, engineering, math or similar

Curriculum: 1. Earth System and Environment

The Urban-Water-Food-Energy NEXUS for resilience against global, and climate change

Reference Person: Bocchiola Daniele (daniele.bocchiola@polimi.it)

Host University/Institute: Politecnico di Milano

Research Keywords:	Urban resilience to climate change
	Water food energy nexus.
	Nature Based Solutions
Reference ERCs:	PE10_17
	PE10_3
	PE10_14
Reference SDGs:	GOAL 2: Zero Hunger, GOAL 7: Affordable and Clean Energy, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

Cities worldwide experience unprecedented increasing urbanization, and despite the significance of cities and mega-cities in our societies, our ability to sustainably design urban systems is limited. The New Urban Agenda, adopted by the United Nations Conference on Housing and Sustainable Urban Development in 2016, acknowledged that cities "if well-planned and well-managed" can be a "powerful tool for sustainable development for both developing and developed countries", but there is a need, among others, for "nature-based innovations", i.E. For green based resilience measures, or nature based solutions NBSs.

Global and climate change affect livability of cities in several ways, i.E. I) extreme weather events and hardly manageable water cycle (floods, droughts), ii) thermal discomfort (Urban Heat Island UHI), and health risk (heat waves), iii) loss of food security and famine (e.G. Developing countries, cash-crops), and iv) energy shortage (e.G. For conditioning).

Sustainable development goals SDGs by UN, among others explicitly call for i) Sustainable Cities, and Communities (11), ii) Climate Action (13), iii) Zero Hunger (2), and iv) Affordable, and Clean Energy (7).

United Nations recently set forward the Water-Food-Energy WFE Nexus approach, considering the connection between these three resources, as a central tool for sustainable

development. At the urban scale, demand for these resources is increasing, more largely in cities, driven by rising population, rapid urbanization, changing diets, and economic growth.
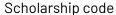
Objectives of the proposal are

1) Investigating the Urban-Water-Food-Energy UWFE potential to aid urban resilience in the face of ever increasing demand for water/food/energy, under global/climate changes.

2) Investigate 2-3 representative cities worldwide, and design UWFE based resilience plans in the face of global/climate change.

Research activity, and methods adopted will include

1) Assessment of present key literature, including i) urban scale impacts of global and climate change, physical reasons, and magnitude, ii) potential countermeasures adopted, iii) state of the art for notable case study towns worldwide.

2) Choice of at least 2-3 representative (mega)cities worldwide. Such cities will be both in Europe (e.G. Italy, Milan), and in developing countries (e.G. Asia-Singapore, Africa-Nairobi), to cover at least three continents, i.E. With different impacts at the urban scale, and a wide array of different socio-economic conditions.

3) Conceptual modeling of the interconnected processes of the UWFE Nexus. Physically based, spatially distributed modeling of the UWFE process, including e.G. I) urban thermal regimes, urban heat island UHI, ii) urban water cycle, precipitation, runoff (surface water depth), evapotranspiration (e.G. Using Poli-Hydro model, or others, daily scale), iii) Potential for urban agriculture, and yield, rain-fed, and with irrigation, and food supply thereby (e.G. Using Poli-Crop model, or others), iv) assessment of energy demand, price, and potential for energy supply, e.G. Peri-urban hydropower (run-of-river plants, using Poli-Power, Poli-Price models, or others).

4 Development of urban development scenarios, including climate/demographic/land use changes (scenarios from IPCC AR5/6, and other models, with proper local validation/downscaling), and subsequent depiction of the impact thereby upon the UWFE Nexus.

5) Assess countermeasures for urban resilience using NBS solutions under the UWFE approach.

Research team and environment

Politecnico di Milano is a public University, strongly oriented towards scientific and technological research, ranked as the 1st Italian Technical University, and one of the top technical universities in Europe. The team contributing to this project (POLIMI unit) the Department of Civil and Environmental Engineering DICA, and to the Water Science and Engineering (SIA) section. The department has 14 laboratories, including the "Gaudenzio Fantoli" hydraulic laboratory with several measuring, modeling and computational facilities and devices. The research activities of the Water Science and Engineering Groups (SIA

Section, 9 permanent staff, 10+ PhD students, 3+ Temporary Research Assistants) cover the study of climate change, hydrometeorology, design and construction of water structures, such as irrigation canals, river defenses, aqueducts and sewers, inland and maritime waterways, hydroelectric plants, reclamation and water management. With Daniele Bocchiola as the coordinator, Climate-LAB is the Interdepartmental Climate Change Laboratory of Politecnico. The C-Lab (https://www.Climatelab.Polimi.It) has a dedicated space within Politecnico, a staff of 10+ professors from four participating departments, 5 people (PhD students) dedicated to the management of the Lab, and has a reservoir of expertise in the field of water resources, climate change science, mitigation and adaptation strategies, IPCC data handling, and scenario making.

Suggested skills for this research topic

The candidate should have general skills in the field of

1) Basics of Mathematics, and Physics, Earth Sciences (geology, climate, hydrology), and Climate Change.

2) Basics of programming, and use of scientific soft-wares (e.G. Matlab, Excels, ARCGISs, Python, etc..)

3) Acceptable knowledge of English, spoken, written.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 1. Earth System and Environment

Arctic amplification and extreme events in the Mediterranean region

Reference Person:	Bordoni Simona (simona.bordoni@unitn.it)
Host University/Institute:	University of Trento

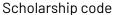|	
Research Keywords:	Climate change
	Extremes
	Polar amplification
Reference ERCs:	PE10_3
	PE10_2
	PE6_12
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

Over the past few decades, Arctic surface temperatures have increased at roughly twice the rate as the global mean surface temperature, through a phenomenon referred to as Arctic amplification. One of the most evident and dramatic manifestations of this accelerated warming in the Arctic is the loss of sea ice, which is causing a decrease in the planetary albedo with significant impacts on the Earths climate both at the local and global scales.

This research project will investigate mechanisms of both Arctic amplification and of its remote influences. More specifically, it will explore the possible impacts of high-latitude warming on the position, strength and waviness of the jet stream. It has in fact been hypothesized that a less intense jet stream, as a result of the weakened meridional pole-to-equator temperature gradient, might be more wavy, with potential significant impacts on the frequency and duration of extreme events, such as blocking, over Europe and the Mediterranean region. This is at however at odds with the future decline of blocking projected by climate models, and exact mechanisms remain debated.

The project will begin with a careful and systematic evaluation of blocking events in the ERA5 reanalysis and other observed data and their possible relation to Arctic temperatures and circulation patterns. Hypotheses emerging from this observational analysis will then be tested with numerical simulations in the model hierarchy. These will include simulations with

idealized and realistic atmospheric general circulation models, in which ice albedo effects will be parameterized in simple ways and in which sea surface temperature anomalies will be imposed in the Arctic region and/or elsewhere, as well as analysis of Earth System Model outputs in the CMIP6 archive and Large Ensemble simulations. This hierarchical approach will help shed light on the underlying processes behind future changes in blocking and reduce the associated uncertainty. It will also better quantify projected changes in the impacts of blocking, such as those related to temperature extremes, that have enormous societal relevance.

Research team and environment

The PhD candidate will work in the vibrant and diverse environment provided by the atmospheric physics group at the University of Trento, with skills and interests ranging from mountain meteorology to climate and largescale atmospheric dynamics. Unitn is the home of the recently established Masters of Science program in Environmental Meteorology joint with the University of Innsbruck, Austria, and offers a wide range of training and seminar activities. The projects supervisor has recently returned to Italy after twenty years in the United States, and is involved in several international collaborations and activities, including panels, workshops and summer schools. Worth of notice is her involvement in a European project aimed at developing and applying Storm-Resolving (that is, very high resolution) Earth System Models to the study of anthropogenic climate change. As they become available, these global simulations at unprecedented resolution will be leveraged as part of the research project. The PhD candidate will be fully immersed in and will greatly benefit from the very active, international and broad research program led by the supervisor.

Suggested skills for this research topic

The PhD candidate is expected to have a background in physics, math, earth and environmental sciences or related disciplines, as well as experience in the analysis of observational data and/or numerical simulations. Previous training in meteorology, atmospheric physics, oceanography and/or climate dynamics will be considered a plus.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Curriculum: 1. Earth System and Environment

Multi-risk assessment and sustainable adaptation of marine coastal environments

Reference Person:　　　　Critto Andrea (critto@unive.it)

Host University/Institute:　University Ca' Foscari Venice

Research Keywords:	Multi-risk assessment
	Marine coastal environments
	Machine and learning
Reference ERCs:	PE10_3 Climatology and climate change
	PE6_11 Machine learning, statistical data processing and applications using signal processing (e.G. Speech, image, video)
	PE4_18 Environment chemistry
Reference SDGs:	GOAL 6: Clean Water and Sanitation, GOAL 13: Climate Action, GOAL 14: Life Below Water

Description of the research topic

Marine Coastal Ecosystems (MCEs) worldwide, their services and the societal goods and benefits they provide, play a central role in the achievement of Sustainable Development Goals and biodiversity targets.

However, located at the land-sea interface, they result to be highly threatened by the complex interplay between human-induced (e.G., e increasing populations and coastal development, exploitation and use of marine space and resources) and climate change pressures (e.G., rising sea temperature, coastal extreme events). All these pressures lead in concert to severe multi-risk scenarios affecting MCEs ecological status and resilience and their capacity to deliver services for human well-being. In this setting, Nature-based solutions have gained increase attention as a tool for sustainable climate adaptation and mitigation that can rise biodiversity while providing benefits to people. They play a pivotal role in facing physical impacts affecting coastal areas (e.G., shoreline erosion), mitigate water quality degradation of seas, while reducing disaster risks arising from extreme events through the enhancement of the ecosystems' adaptive capacity and resilience.

Despite the recognized importance of MCEs as contributors to human well-being, little is known about their potential in mitigating climate-related risks, and very few nature-based solutions have been implemented so far in the marine environment. This is mainly due to the complexity and limited access to MCEs and the lack of empirical approaches able to frame

and model spatio-temporal dynamics of MCEs response to climate change, and the mid and long-term effects of such adaptation measures to face with them.

Progress in understanding and predicting these dynamics represents a priority for coastal and marine researchers to design and up-scale ecosystem-based management and conservation strategies for MCEs to face climate change and human-made pressures. In recent years, the exponential growth in digital data released by multiple sources and sensors for environmental applications and monitoring (e.G., earth observations, drones, social media), has boosted the research community to test machine and deep learning algorithms, leveraging the potential of big data to model MCEs response to climate change and provide support to sustainable climate adaptation and mitigation.

The here proposed research topic addresses the challenge of multi-risk assessment and adaptation planning in marine coastal areas, trying to unravel and model most relevant ecosystem processes under an integrated appraisal framework embracing physical, environmental and human aspects. Particularly, we will try to connect climate hazards and ecosystem-based management of MCEs with data science and machine/deep learning technologies, to provide effective decision-making tools for management and planning bodies.

Particular attention will be paid to machine learning-based models (e.G., Artificial Neural Network, Graph Neural Networks) and innovative digital technologies (e.G., big data applications, geospatial visualization tools) unlocking new opportunities for a significant transformative change in the way we assess, and then adapt, to climate-related risks, safeguarding MCEs while transforming society.

Research team and environment

We will make available to the PhD candidates the laboratories, tools and infrastructures of the CMCC@Ca'Foscari. CMCC@Ca'Foscari is the research centre on climate change of Ca'Foscari University of Venice, the result of a strategic partnership with the CMCC Foundation'Euro-Mediterranean Center on Climate Change (CMCC). CMCC@Ca'Foscari is today the most important climate research centre developed by an Italian university. Its multidisciplinary task force includes climatologists, economists, chemists, and statisticians, conducting national and international research on the interaction between the climate, the environment, the economy, and society. The Fellow will benefit from CMCC's computational modelling infrastructure, including one of the most powerful supercomputers in Europe, dedicated to the climatic modelling and forecasting and to the assessment of the economic repercussions of climate change. The Fellow will be provided with a workstation with his own desk (fully equipped with PC, printer, Wi-Fi access, etc.); full access to the infrastructures, services, equipment, libraries and laboratories to carry out the project; Free access to various academic courses; access to University and Council Libraries; a personal e-mail; profile on Ca'Foscari and CMCC website; access to online scientific journals, and access to international and EU professional databases. Ca'Foscari provides classrooms, boardrooms, and main halls for meetings seminars, lectures, conferences, and exhibitions. The efficient

research management will be comprised of administrative and financial execution of projects, personal assistance, and support for the organization of meetings, and implementation of dissemination, communication, and outreach activities. Ca'Foscari and CMCC observes high-level health, safety, and security standards at the workplace, in conformity with national legislation. The beneficiary will be offered with an international and multi-disciplinary environment that is non-discriminatory and transparent in its recruitment and professional advancement. Furthermore, professional supervision and career mentorship, a periodic research review and evaluation, and a stimulating research and training atmosphere are all guaranteed for the Fellow's career advancement.

For this scholarship a period of internship is planned at *Fondazione Centro Euro-Mediterraneo sui Cambiamenti Climatici – CMCC, Venezia*

Suggested skills for this research topic

- Knowledge of the impacts of climate change and extreme events on marine coastal areas;

- Knowledge of environmental risk assessment frameworks and methodological approaches;

- Experience in data compilation and handling;

- Experience in the development and validation of Machine Learning models (e.G. Neural Networks) for the spatio-temporal analysis of environmental systems dynamics and detection of environmental patterns in marine coastal areas;

- Programming skills in R and Python;

- Good knowledge of GIS tools.

- Excellent communication and writing skills in English.

Type of scholarship and obligations

The type of this scholarship is: Transizioni Digitali ed Ambientali (Digital and Environmental Transitions). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 1. Earth System and Environment

Assessing fresh water availability under climate change

Reference Person: Deidda Roberto (rdeidda@unica.it)

Host University/Institute: Università di Cagliari

Research Keywords:	Stochastic and hydrological modelling
	Droughts and climate change
	Water management
Reference ERCs:	PE10_3 Climatology and climate change
	PE10_17 Hydrology, hydrogeology, engineering and environmental geology, water and soil pollution
	SH7_6 Environmental and climate change, societal impact and policy
Reference SDGs:	GOAL 1: No Poverty, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

Climate change is heavily affecting several meteo-hydrological processes, and primary rainfall and temperature regimes, with consequent impacts on the future availability of fresh water.

In such context, this PhD research project will focus on the reconstruction (in the past) and the projection (in the future) of the hydrological balances in the major catchments in Sardinia (Italy). Sardinia is an island in the centre of the Mediterranean Sea, which was affected in the past by prolonged drought periods, that are expected to exacerbate in frequency and severity under climate change.

Specifically, the research will be aimed at a better understanding of the meteo-hydrological dynamics and at a characterization of the intra- and inter-annual variability of the main hydrological fluxes. While the projected temperature increase will be one of the main causes for the increase of rainfall extremes rainfall, according to Clausius-Clapeyron equation, the occurrence of rainfall events will be more intermittent and annual rainfall amounts are expected to decrease. Moreover, the increase of evapotranspiration, driven by changes in temperature, will alter the soil moisture dynamic, with impact in the agriculture and the availability of fresh water.

The PhD candidate will develop and apply different and complementary approaches to characterize the dynamics of water partitioning and the statistical properties of the main hydrological flux components impacting frequency and severity of droughts. Such methods include e.G. Statistical analyses of available meteo-hydrological time series, exploitation of remote sensing observations, stochastic and hydrological modelling.

Results from this PhD research will contribute to the assessment of the future availability of fresh water in Sardinia and will provide the knowledge base to regional water agencies and policy makers. Outputs are expected to be employed for planning and designing new water reservoirs and new infrastructures (e.G. Water pipelines and interconnections among reservoirs to cope with local water deficits), and to help decision makers in implementing policies of water exploitation, that can effectively cope with drought risks.

Research team and environment

The research team will involve researchers of the Hydrology Group at the Department of Civil and Environmental Engineering and Architecture (DICAAR) at the University of Cagliari (Italy). Further cooperation is foreseen with other research bodies and universities, in Italy and abroad (e.G., Arizona State University, University of Reading, University of Patras, University of Quebec, the Center for Advanced Studies, Research and Development in Sardinia, among others; as well as water management authorities and civil protection agencies). The research activities include hydraulic and hydrologic modelling, statistical hydrology, climate change impacts and are supported by several national and international grants.

For this scholarship a period of internship is planned at *Ente Acque della Sardegna*

Suggested skills for this research topic

Background on global and local water cycle and hydrological processes.

Background on statistics and probability: experience in the treatment and analysis of meteo-climatic and hydrological data will be positively evaluated.

Familiarity with programming languages such as MATLAB, R, Python, etc.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Curriculum: 1. Earth System and Environment

Global warming and natural disasters

Reference Person: Di Carlo Piero (piero.dicarlo@unich.it)

Host University/Institute: University 'G. D'Annunzio' of Chiti-Pescara

Research Keywords:	Climate change
	Atmospheric events
	Climate scenarios
Reference ERCs:	PE10_3
	PE10_1
	SH1_1
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

The proposed research is focused on the analysis of the impact of global warming and changes of the precipitation regimes on severe meteorological events such as tornados, flooding and drought, in the last decades. The analyses will range from the regional to the European scale and will be completed with future projections under different scenarios. The socio-economic consequences will be a further research activity.

Research team and environment

The research team includs a full professor of atmospheric physics, a full professor of business administration and climate, 2 assistant professors and a post doc.

For this scholarship a period of internship is planned at *EURAC, Bolzano.*

Suggested skills for this research topic

Candidates with good skills in programming and data analysis are appreciated. Background in physics, engineering, environmental science, chemistry is desirable.
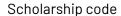
Type of scholarship and obligations

The type of this scholarship is: Pubblica Amministrazione (Public Administration). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of

University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Curriculum: 1. Earth System and Environment

Mathematical modeling of green energy transition

Reference Person: Flandoli Franco (franco.flandoli@sns.it)

Host University/Institute: Scuola Normale Superiore

Research Keywords:	Interacting agent models
	Stochastic models and methods
	Mathematical study of Extreme events
Reference ERCs:	PE1_13 Probability
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

The PhD candidate will be addressed to investigate modeling of a community of agents (like people or companies) which respond to a variety of inputs related to the green energy transition: moral issues, governmental rules, subsidies and taxes, reciprocal influences and people-companies feedbacks. The tools will include agent based models, mean field models, games and mean field games, stochastic dynamics, differential equations and Markov chains. This is a very interdisciplinary research direction with existing collaboration between the group of Scuola Normale Superiore and members of other Curricula of the PhD program, in particular "Theory, Institution and Cultures". Among the mathematical and conceptual challenges, We shall investigate the link between the agent-based dynamics described above and concepts like tipping points and extreme events, other topics in climate dynamics which are under investigation by the research group of Scuola Normale Superiore.

Research team and environment

The team is composed by the PI (Franco Flandoli), two structured researchers (Giulia Livieri and Alessandra Caraceni), three post doc (Ruojun Huang, Milo Viviani, Leonardo De Salvo), 7 PhD candidates (Umberto Pappalettera, Andrea Papini, Alessandro Bondi, Eliseo Luongo, Silvia Morlacchi, Tommaso Cortopassi and Gianmarco Del Sarto). The environement, namely the Scuola Normale Superiore is extremely rich of opportunities. The project will profit of the collaboration with Scuola Sant'Anna of Pisa and IUSS of Pavia

Suggested skills for this research topic

Good background on probability, stochastic analysis, differential equations; some background on numerical computations, mathematical statistics, mathematical physics.

Type of scholarship and obligations

The type of this scholarship is: Transizioni Digitali ed Ambientali (Digital and Environmental Transitions). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 1. Earth System and Environment

Role of the air-sea coupling and small-scale ocean processes on regional climate along coastal areas.

Reference Person: Fosser Giorgia (giorgia.fosser@iusspavia.it)

Host University/Institute: IUSS Pavia

Research Keywords:	Sea-atmospheric interaction
	Ocean and atmospheric modelling
	Coastal areas
Reference ERCs:	PE10_21 Earth system modelling and interactions
	PE10_2 Meteorology, atmospheric physics and dynamics
	PE10_3 Climatology and climate change
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

The relevance of air-sea interactions on climate variability and climate change at large scale is widely documented; however, little is known on the impact those interactions on the regional climate, especially over coastal areas.

Convection-permitting models (CPMs) are km-scale atmospheric model that explicitly represent deep convection without the need for a convective parameterization, which is a known source of model error and uncertainties in regional climate models (RCMs). It has been showed that CPMs provide a more realistic representation of local processes thus improving, among the others, the inland advection of showers coming from the sea and the sub-daily precipitation statistics and extremes. This leads to a greater confidence in their projections of future changes. However, CPMs are often not coupled with the ocean models and use sea surface temperature (SST) as boundary conditions at much lower spatial resolutions than the RCMs or CPMs grid mesh.

The Mediterranean Sea is often referred to as an ocean in miniature due to the variety of processes occurring therein. These include strong air-sea interactions, active mesoscale and sub-mesoscale dynamics and a permanent thermohaline overturning circulation. Moreover, this area is very well covered by both observational network of meteorological stations and regular oceanographic campaigns providing observations of the ocean-atmosphere coupled system. Ocean mesoscale in the Mediterranean Sea is characterized by a Rossby deformation radius of 5-10 km. In consequence, the SST often shows narrow and

sharp fronts with associated strong temperature gradients that can significantly modify the air-sea interaction and affect the climate evolution. Ocean mesoscale also plays a crucial role in the main mechanism of heat uptake by the ocean, namely dense water formation, which modelling requires both atmospheric and oceanic high spatial resolution.

This research aims to investigate the added-values of a more realistic air-sea interaction on the regional climate especially along the coastal areas of the Mediterranean Sea at sub-daily scale. Particular emphasis will be pose at the impact of the resolution of the ocean and atmospheric component in the coupled model. Comparison can be done with uncoupled model and validated with observational dataset.

The study will be conducted in collaboration with the Climate Modelling Laboratory of ENEA, that already developed and uses the regional couple model WRF-NEMO. The selected candidate will need to increase the resolution of the atmospheric component of the coupled model to reach to convection-permitting scale and test the ocean-atmosphere coupling strength with sensitivity tests. The selected PhD student will be based in Rome but expected to travel to Pavia when required.

Research team and environment

The selected candidate will join the research centre on Climate change impAct studies for RISk MAnagement (CARISMA) within IUSS, Pavia. The CARISMA team is composed by STEM and Social scientists working in the prism of climate change on: data analysis and modelling of Earth system and economic system processes; impact assessment of extreme natural events and anthropogenic activities on human and natural environments; risk management of natural and anthropogenic hazards; formulation and proposal of new economic, political and legal models of sustainable development.

The research activity will be based at the Climate Modelling and Impact Laboratory of the National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA) at the Casaccia Research Centre (Rome). The primary mission of the Laboratory is to study and model the climate system for projecting the impacts of climate variability and future scenarios on society and natural resources at spatial scales most relevant to humans, ecosystems and the national productively system. The numerical models developed and applied in the Laboratory are of different complexity and realism spanning from global models to high resolution regional climate models mainly focused on the Euro-Mediterranean area. The Laboratory promotes the development of Climate Services at both national and international level, implementing climate information transfer protocols and products for the energy, water and coastal region management, food emergency, tourism and agriculture. The laboratory is actively involved in international and national research initiatives on climate, energy and environment.

Suggested skills for this research topic

The ideal candidate should have experience with the FORTRAN language and be familiar with atmospheric or/and ocean modelling. Knowledge of the climate physics, statistical analysis, large climate dataset will be beneficial.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Curriculum: 1. Earth System and Environment

Seasonal forecasts for climate impact assessment

Reference Person: Gaetani Marco (marco.gaetani@iusspavia.it)

Host University/Institute: IUSS Pavia

Research Keywords:	Climate variability
	Climate modelling
	Climate predictions
Reference ERCs:	PE10_2
	PE10_3
	PE10_21
Reference SDGs:	GOAL 2: Zero Hunger, GOAL 7: Affordable and Clean Energy, GOAL 12: Responsible Consumption and Production

Description of the research topic

Effective policies for the adaptation to weather and climate related impacts rely on the availability of skilful predictions at diverse timescales. Weather forecasts and climate predictions are nowadays widely used in impact studies, and an increasing focus is being placed on forecasts at seasonal (i.E. Out to several months) forecasts. The seasonal time scale is in fact crucial in the activity planning of several key socio-economic sectors, such as energy, agriculture, and health, among others. Over the last decades the seasonal prediction skill has considerably improved, and it is now considered useful for societal applications. However, seasonal forecasts need to be better exploited/improved further and their economic value need to be quantified properly (depending on the region, season and/or sectoral application).

The objective of this research programme is to determine the usability and value of seasonal forecasts for climate impact assessment in specific socio-economic sectors. Available forecast products, possibly combined and optimized from multi-model ensembles, will be analysed to compute the skill for essential climate variables like precipitation and temperature, circulation patterns and related metrics in targeted regions and seasons. The analysis and evaluation of the seasonal forecast skill need proper observational datasets and high-resolution reanalysis products for comparison. For applications as in agriculture or renewable energy sectors the analysis of climate variables and related metrics will be extended to the related climate impact indicators (e.G. Renewable energy potentials and drought indices).

Research team and environment

The activities will be carried out in the CARISMA group at IUSS Pavia, in close collaboration with the CNR-ISAC in Bologna.

The CARISMA team is composed by STEM and Social scientists working in the prism of climate change on: data analysis and modelling of Earth system and economic system processes; impact assessment of extreme natural events and anthropogenic activities on human and natural environments; risk management of natural and anthropogenic hazards; formulation and proposal of new economic, political and legal models of sustainable development.

The Institute of Atmospheric Science and Climate of the National Research Council of Italy (CNR-ISAC) aims at the understanding of the atmosphere, climate and Earth system sciences in a multidisciplinary approach. One of its main research areas, CAMEO (climate and meteorology, modelling and earth observations) combines theoretical, experimental and numerical applications for climate variability and predictability/predictions, from sub-seasonal to multi-annual timescale, on diverse spatial scales (from global large-scale to individual meteorological events).

IUSS and ISAC-CNR are actively committed towards internationalisation, inclusion and diversity.

Suggested skills for this research topic

The ideal candidate should have a strong background in data analysis and statistics (analysis of probability distribution functions, uncertainties, etc.) and be familiar with the management of large datasets. He/she should have basic knowledge of climate dynamics, climate change and the associated impacts. Some knowledge and preliminary understanding of numerical modelling can be an added value.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 1. Earth System and Environment

Coccolithophore growth rate and calcite production under high CO2 levels

Reference Person: Lupi Claudia (claudia.lupi@unipv.it)

Host University/Institute: University of Pavia

Research Keywords: Coccolithophores

CaCO3 production

Cellular physiology

Reference ERCs: PE10_3 Climatology and climate change

PE10_6

PE10_9

Reference SDGs: GOAL 13: Climate Action, GOAL 14: Life Below Water

Description of the research topic

Coccolithophore, unicellular calcifying microalgae, significantly impact the atmosphere–ocean CO2 exchanges and the carbon cycle since geological time (Monteiro et al., 2016). Despite being only 1% of the Earth photosynthetic biomass, they store as much carbon as terrestrial plants thanks to their fast renovation time (Falkowski, 2012), assessing up to 10% of the global C fixation (Poulton et al., 2013).

Among the 200 living species of coccolithophores, this project focuses on *Helicosphaera carteri* a species considered resistant to many environmental stressors (Šupraha et al., 2015) including highly polluted waters (Dimiza et al., 2014). Through a pilot study, we observed that *H. carteri* cultivated under high CO2 level (700 ppm) reaches faster growth rates showing better preserved and bigger coccospheres than experiments at lower CO2. Thus, the CaCO3 production, the C uptake and storage, increase with increased CO2 levels. It has been demonstrated that small alterations of growth rate can affect the calcite production up to 50% (Sheward et al., 2017) with significant differences in the geometry and number of coccoliths on the coccosphere. As growth rate and cell size are the main drivers of calcite production, it is very important to understand which environmental parameter mainly affects them, and thus the cellular physiology. Being CO2 the main climate variable attracting the scientific and public interest, in this research we will deepen the CO2 effects on coccolithophore physiology exploring coccolithophores potential towards CO2 biofixation and biomass production under controlled CO2 conditions, studying the impact of climate change on future scenarios for the calcite production and export.

To do so, we will reconstruct the morphological, and thus physiological, variations of *H. carteri* induced by different levels of CO2. The experiments on cultures will be carried out at the National Center for Oceanography and Experimental Geophysics (OGS) in Trieste and in the context of international collaborations. A 3D reconstruction of the coccosphere and its coccoliths would allow to identify different cellular development under low to high CO2 scenarios. We will also deepen on past and future climate/environmental drivers studying the geochemical information extracted from cultured *H. carteri*. Geochemical analyzes of the trace elements will be performed on coccoliths in collaboration with Elettra synchrotron of Trieste (proposal already approved). The acquisition of the element maps will provide new evidences on the specific-element distribution on the coccolith which is still poorly known, shedding light on both the physiological processes involved in the elements' incorporation and the relationships with the surrounding environmental and climate conditions.

By knowing in depth the repercussions of environmental parameters on physiology will it be possible to understand the impact of future climate change for the production and export of calcite and the role of coccolithophores in the global carbon cycle.

Research team and environment

The selected candidate will be employed for three years at the University of Pavia (Italy) in a young and dynamic team. The PhD candidate will have access to facilities concerning the study of deep marine sediments in the coccolith content at both optical and electronic microscope. Moreover, he/she is expected to collaborate with national and international outstanding institutions such as the National Institute of Oceanography and Applied Geophysics (OGS) of Trieste, the Elettra synchrotron of Trieste or the Tongji University of Shanghai.

Suggested skills for this research topic

Successful candidates are expected to have a background in geology, marine biology or ocean chemistry with interest in biogeochemistry and climate changes. Previous research experience with coccolithophores will be a plus. We are looking for a candidate who knows how to work both in a team and independently, and he/she is willing to test him/herself with pioneering and transdisciplinary researches. The research is in collaboration with the National Center for Oceanography and Experimental Geophysics (OGS) of Trieste.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research).This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and

Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 1. Earth System and Environment

Impact of European open fire emissions to greenhouse and reactive gas atmospheric variability

Reference Person: Maione Michela (michela.maione@uniurb.it)

Host University/Institute: University of Urbino Carlo Bo

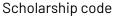|	
Research Keywords:	Changes in Atmospheric Composition
	Impact on climate
	Impact on health
Reference ERCs:	PE4_18
	PE10_1
	PE10_2
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

Open fires (both uncontrolled or prescribed burning of forests and crops) are a global phenomenon mostly related to human practices with a large spectrum of impacts ranging from environment to society and economy and affecting ecosystems as well as human health and property. In the last years, the exceptional wildfires in the Amazon and in the Arctic have raised the public attention and awareness over this phenomenon that affects and consumes large amounts of vegetation across wide regions and modifies Earth surface characteristics.

Although globally, the dominant biomass burning regions are sub-Saharan Africa, South America, and equatorial Asia, an average of approximately 4500 km2 is burn every year in the Mediterranean region. Due to the project increase of average temperatures and more frequent dry conditions, the Mediterranean region is expected to be affected by significant increases in the burned areas under different scenarios of global warming. Some studies indicated that activity of fire suppression and preventive management reduced or stabilized fire occurrence but did not affect the incidence of large (>500 ha) fires, which are less responsive to fire control efforts.

Wildfires emit a large number of greenhouse gases (CO_2, CH_4, N_2O) and reactive gases (e.G. NM-VOC, NOx) which are precursors of aerosols and ozone. At global scale, some studies indicated an average total annual greenhouse gas emissions of 7.3 $PgCO_2$, 16 $TgCH_4$, and 0.9 TgN_2O which, using a 100-year time horizon and based on global warming potentials of 34 for

CH4 and 298 for N2O, translates in 8.1 PgCO2 equivalent annually, or 23% of global fossil fuel CO2 emissions .

The main goal of this research project is to investigate the impact of open fires to the atmospheric variability of some of these key-species, finally providing an estimate of GHG and NM-VOCs emissions related to these events. The focus will be the European domain and fires occurring in this region, with a special emphasis on the Mediterranean basin. The project will base on the integration of in-situ observations (like those performed in the framework of atmospheric RIs ICOS and ACTRIS) with atmospheric transport simulations and gridded dataset (like GFED or GFES fire emission inventory).

Since a correct knowledge of the data creation process and of the related physical uncertainties are the prerequisite for a correct utilization of a dataset, during the PhD work, the student will gain confidence with the principal techniques for the observations of greenhouse gas and reactive gases (special emphasis on NM-VOCs). The student will treat massive amount of data provided by European reference networks for the atmospheric observations of these chemical species (like ICOS-RI and ACTRIS-RI), atmospheric transport-chemistry models and gridded dataset. Thus, it is pivotal that the student will gain confidence on advanced tools for the statistical analysis of data. A period (minimum 6 months) of study abroad is advised to one leading laboratory in Europe devoted to the use of atmospheric observations to derive GHG and reactive gas emissions (e.G. LSCE in France, MPI in Gemany or NILU in Norway).

Research team and environment

The training will take place at the University of Urbino Carlo Bo under the supervision of Prof. Michela Maione and Prof. Umberto Giostra from the departments of Pure and Applied Sciences, in strict collaboration the Institute of Atmospheric Sciences and Climate (CNR-ISAC). Research activities carried out at UNIURB that are relevant for the proposal are: chemical and physical basis of climate change, analytical methods for measuring atmospheric composition changes and atmospheric modelling. Michela Maione is professor of environmental chemistry. Her research is in the field of atmospheric composition change in relation to air quality and climate change. She is responsible for the long-term programme for observations of climate altering and ozone depleting substances and of volatile organic compounds at the GAW-WMO station of Monte Cimone. This activity is carried out within international networks, such as AGAGE and ACTRIS. She has authored more than 100 publications and is Lead Author in the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Umberto Giostra is professor of climatology. His main activity concerns theoretical, numerical and experimental studies on atmospheric turbulence structure, on meso-scale motions (meandering and gravity waves) and on dispersion modelling. He has authored more than 60 publications in peer-reviewed journals. Has been involved as PI or WP leader in more than 20 research projects. Has supervised more than 30 Master's Degree theses (Physics and Environmental Sciences), more than 20 PhD

theses. He has tutored more than 20 post-doc and CNR (Italian Research Council) research fellows.

Suggested skills for this research topic

Knowledge about atmospheric chemistry and physics

The capability of performing data analyses

Knowledge about analytical techniques for atmospheric trace gases

Curriculum: 1. Earth System and Environment

Hydropower generation in the Italian Alpine under a changing climate

Reference Person: Majone Bruno (bruno.majone@unitn.it)

Host University/Institute: University of Trento

Research Keywords:	Hydropower generation
	Water resources management and optimization
	Hydrological and human systems interactions
Reference ERCs:	PE10_17 Hydrology, hydrogeology, engineering and environmental geology, water and soil pollution
	PE10_21 Earth system modelling and interactions
	PE6_12 Scientific computing, simulation and modelling tools
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 13: Climate Action

Description of the research topic

Water resources are under threat by the combined effect of climate change and overexploitation for agricultural, industrial and human consumption. To gain knowledge and better inform future directions in the water sectors this research topic aims at developing a suite of models, organized as digital twins of the intertwined natural and technological systems, for simulating the complex interplay between water needs and stresses caused by climate change and the uneven distribution of water demand.

In particular, the objective of this research project is to analyse the impact of climate change and the energy market on hydropower production of the Italian Alpine Region (GAR). The analysis will be conducted by means of the multi-scale hydrological model HYPERstreamHS recently developed by the Hydrology group of the University of Trento. The model will simulate the hydropower production and the associated streamflow alterations by modelling explicitly the functioning of relevant hydraulic infrastructures. The main research lines are the following:

-Implementation of a model of hydropower production able to simulate the operation of the hydropower plants according to the modelled water availability (the model will also simulate the altered streamflow downstream of the hydropower plants). This model will be prodromal to the development of a twin digital model of hydropower production.

- Scenario analyses of climate change impact on hydropower production in the Italian Alpine region including assessment of the vulnerability of the main hydropower systems. In addition, the role of reservoirs as energy storage systems complementing other renewable energy sources, namely solar and wind energy, will be investigated also in relation to climate change scenarios. Transition to pumped-storage solutions will be also considered to exploit the transfer of large water volumes in hours of relatively low electricity prices.

- Effect on hydropower production of the evolution of the electricity market as fostered by the development of new storage technologies and projected changes in wind and solar energy production.

- Development of tools for the analysis of the water conflicts and related mitigation strategies for enhancing the resilience of the energy-water nexus.
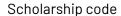
Research team and environment

The prospective candidate will work in the active and stimulating environment provided by the Hydrology group at the Department of Civil, Environmental and Mechanical Engineering of the University of Trento. The candidate will collaborate with post-docs and temporary researchers hired in the context of several funded national and international projects. In this respect, the candidate will benefit from the active, international and broad research program led by the supervisor.

Suggested skills for this research topic

The candidate is expected to have a background in civil/environmental engineering, earth and environmental sciences or related disciplines. Furthermore, the candidate is expected to have a strong mathematical background, strong programming skills (e.g. C++, FORTRAN, Python, MATLAB) and a desire to perform modelling work within the context of the climate-water-energy nexus. Fluent spoken and written English, as well as good communication skills, are also required.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Curriculum: 1. Earth System and Environment

Monitoring of water quality of natural rivers exploiting image processing techniques

Reference Person: Manfreda Salvatore (salvatore.manfreda@unina.it)

Host University/Institute: University of Naples Federico II

Research Keywords:	Image velocimetry
	Image processing
	River monitoring
Reference ERCs:	PE8_11
	PE10_17
Reference SDGs:	GOAL 6: Clean Water and Sanitation, GOAL 9: Industry, Innovation and Infrastructure, GOAL 13: Climate Action

Description of the research topic

In the coming years, water management will face critical challenges due to the concomitant impact of global warming, population growth, and pollution. There is therefore an urgent need to identify new strategies for river monitoring to support water budget and quality assessment. The main goal of this project is to develop a new generation of monitoring systems based on RGB, multispectral and thermal cameras combining image processing, Earth Observations (EO), and Artificial Intelligence (AI). The research will build on current knowledge in image-based hydrological monitoring to explore novel advancements in unsupervised computer vision techniques for river monitoring. Camera systems on fixed stations, onboard of drones, and on smartphones will be exploited to collect streamflow observations that will be used to train existing and ad-hoc developed models for the estimation of discharge, solid transport and surface pollutants.

The study will be carried out exploiting camera systems combined with satellite observations to interpret the expected impact of climate and land use changes on the hydrological processes and water quality. Satellite and camera observations along with traditional measurements will be used to develop algorithms based on Artificial Intelligence (AI) which will help the description of river hydrological response and water quality parameters.

The proposed methodologies will be tested a heavily polluted Italian river, which is also a complex environment to install monitoring networks. Our study site will be the Sarno River, which is considered the most polluted river in Europe and one of the ten most polluted rivers in the world.

Research team and environment

HydroLAB coordinated by Prof. Salvatore Manfreda is operating in the department DICEA of the University of Naples Federico II which is a leading institute in hydraulic construction and hydrological studies particularly devoted in the optimization of water management systems. HydroLAB is developing new innovative technologies for environmental monitoring using remote sensing and camera systems. The environment is a stimulating and challenging one with a strong and significant international dimension.

For this scholarship a period of internship is planned at *Consorzio di Bonifica Integrale, Comprensorio Sarno, Nocera Inferiore (SA)*

Suggested skills for this research topic

Hydraulic engineering, image processing, programming, remote sensing and data processing

Type of scholarship and obligations

The type of this scholarship is: Transizioni Digitali ed Ambientali (Digital and Environmental Transitions). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 1. Earth System and Environment

Extreme events and associated atmospheric circulation patterns

Reference Person: Martina Mario (mario.martina@iusspavia.it)

Host University/Institute: IUSS Pavia

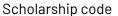|	
Research Keywords:	Atmospheric circulation patterns
	Extreme events
	Climate change impact
Reference ERCs:	PE10_3
	PE10_2
	PE8_3
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

Weather-related extreme events may have a strong societal and economic impact on human activities. In the context of the accelerating global warming, the frequency and intensity of extreme events is increasing and projected to further rise in the future. Reliable predictions are then crucial to implement effective actions for impact assessment and mitigation. However, reanalysis products and global climate models still struggle in correctly represent extreme events, because of the intrinsic difficulty in simulating physical processes characterised by low probability . Nonetheless, most of weather-related extreme events are associated with large-scale atmospheric circulation patterns which are generally well represented in climate models, and can be then used to characterise and predict the occurrence of these events.

This research programme will focus on the characterisation of weather-related extreme events through the analysis of the associated circulation patterns. The analysis may target: heat waves, dry spells, atmospheric rivers, heavy precipitation, wind storms, storm surges, and natural and anthropogenic aerosol outbreaks. The scientific objectives are: 1) to identify the atmospheric circulation patterns associated with the occurrence of extreme events; 2) to use them as predictors to reconstruct the event occurrence in the past and project it in the future. To this aim, data from surface observational datasets (E-OBS, CRU), atmospheric reanalysis products (ERA5, CAMS) and climate models (CORDEX, CMIP6) will be analysed. The results of this research are expected to provide useful insights for the assessment and mitigation of climate change impacts.

Research team and environment

IUSS mission is to provide advanced education to undergraduate and graduate students, as well as fundamental and applied research in the fields of Science, Technology, Engineering and Mathematics (STEM), and Human, Social and Life Sciences. At IUSS, PhD candidates will find an open multidisciplinary environment offering real opportunities for developing academic and professional tools for facing the challenges arising from increasing complexity and fast changes in the society and the environment. IUSS is always and actively committed towards internationalisation, inclusion and diversity. The selected candidate will join the research centre on Climate change impAct studies for RISk MAnagement (CARISMA). The CARISMA team is composed by STEM and Social scientists working in the prism of climate change on: data analysis and modelling of Earth system and economic system processes; impact assessment of extreme natural events and anthropogenic activities on human and natural environments; risk management of natural and anthropogenic hazards; formulation and proposal of new economic, political and legal models of sustainable development.

For this scholarship a period of internship is planned at *CRIF SpA, Bologna*

Suggested skills for this research topic

The ideal candidate should be skilled in the fields of Physical and Mathematical Sciences, Earth and Environmental Sciences or Civil Engineering, with a strong background in statistics. Specific skills in the field of climate science will be considered a plus. Moreover, the candidate should be strongly motivated to work in a pluralist and multi-disciplinary environment, collaborating with the STEM and social scientists of the CARISMA research centre.

Type of scholarship and obligations

The type of this scholarship is: Dottorati Innovativi (Innovative PhD courses). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Curriculum: 1. Earth System and Environment

Advances in carbon accounting: circularity and responsibility in composite systems

Reference Person: Pulselli Federico Maria (federico.pulselli@unisi.it)

Host University/Institute: University of Siena

Research Keywords:	GHG accounting
	Life Cycle Thinking
	Composite processes
Reference ERCs:	SH7_6 Environmental and climate change, societal impact and policy
	SH7_5 Sustainability sciences, environment and resources
	PE10_3 Climatology and climate change
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

Systematic monitoring and accounting process are fundamental tools for the control and the mitigation of the greenhouse gas (GHG) emission into the atmosphere. The IPCC provides a well-known method for GHG accounting by means of the 2006 guidelines and 2019 refinement. Its long-standing and widespread adoption for monitoring the emission at national or subnational level (relevant the case of the province of Siena, that reached the Carbon Neutrality already in 2011, also thanks to a systematic monitoring procedure - see Bastianoni et al., 2014), helps identify and quantify, via bottom-up approach, the emission sources that contribute to the anthropogenic greenhouse effect. The progressive adoption and application of these physics-based methods of environmental accounting may help integrate the information more commonly used for policy-making, related and limited to economic growth, financial stability, employment results. Different systems for GHG emission accounting exist and the adoption of each one brings about that, in turn, may generate different implications, solutions and policies at different levels. In fact, the wide debate on how to assign the responsibility of GHG emission plays an important role in the research fields of mitigation of, and adaptation to climate change. The main efforts that have been done so far are focused on the macrosystem (especially country) level, investigating, for instance, how to discriminate between producer and consumer countries, importer from exporter ones, also including phenomena like decentralization, delocalization, or decoupling.

The proposal here presented adapts the responsibility approach to the micro- or the meso-system, introducing significant research perspectives to the use of the traditional methods of GHG accounting. Special attention will be paid to the adoption of the Life Cycle Thinking approach to GHG estimation and accounting, and responsibility assignment, respectively. Specifically, the accounting can be extended to include the indirect emissions (or process emissions), in order to calculate the effects of the production and consumption of goods and services in terms of the so-called Carbon Footprint (namely, accounting the GHG emission throughout the life cycle of the products or flows analyzed) in a system in which a set of subjects (production units, companies) are involved in a composite process made of phases that can be connected with each other. The main aim of the research is to find ways to highlight, measure and increase the mutuality, the cooperation, and the circularity of the whole system and mitigate the impact on the environment (in terms of emission reduction). The investigation will focus on production sectors or macro-sectors in order to highlight (if any) or encourage circularity aspects, measured based on the results deriving from the application of the above-mentioned accounting methods. The approach, first refined theoretically, will be applied to different systems. Examples of great interest are the use, re-use and recycle of agriproducts and agricultural residues, integration of agriculture and rearing activities, the use of timber as material for building to replace concrete, circle closure in industrial districts, and waste management strategies.

Research team and environment

The University of Siena considers sustainability as a strategic task and hosts the UN-SDSN hub for the Mediterranean Area. The PhD candidate will work in the Department of Physical Sciences, Earth and Environment in which many research groups operate in the Environmental and Earth System Science fields. The PhD candidate will work within the Ecodynamics Group, a multidisciplinary research team that has been dealing with sustainability and climate change for three decades. The group has extensive experience in compiling GHG inventories at territorial level, certification tools, Life Cycle Assessment and Carbon Footprint, applied in multiple contexts and to various systems (territorial, productive, etc.). Other projects of the group are based on sustainability assessment of systems and processes, GHG emission responsibility assessment; environmental accounting system development; dissemination and education. The Ecodynamics Group is currently made of 2 full professors, 2 associate professors, 1 technical-administrative staff, 3 technologists, 2 scholarship holders, and 3 PhD students. The Ecodynamics Group has also relevant international collaborations such as Manfred Lenzen from the University of Sydney, Marianne Thomsen from Copenhagen University (DK), Steven J. Davis from the University of California Irvine, Ken Caldeira from Stanford University (USA), Enrico Benetto from the Luxembourg Institute of Science and Technology (LUX), Mathis Wackernagel from the Global Footprint Network (USA).

Suggested skills for this research topic

The PhD candidate is expected to have a background in environmental science, sustainability foundations, assessment and indicators.

The candidate must have proficient English and familiarity with the most common software for data computing. Knowledge of GHG accounting method, Life Cycle Assessment and other environmental accounting methods is seen as a significant merit.

The candidate should be motivated and open-minded, available to develop and share his/her experience in a transdisciplinary environment. He/she must be available to stay in Siena and also travel for both education and research purposes.

Curriculum: 1. Earth System and Environment

Knowledge, citizen awareness and policy of marine shallow-water biodiversity

Reference Person: Rosso Antonietta (rosso@unict.it)

Host University/Institute: University of Catania

Research Keywords: Biodiversity and changes in species occurrence and ranges in relation to global warming and the diffusion of Non-Indigenous Species in Sicily

Communication of science to the public and policy makers

Production of seachable dataset and GIS maps for management

Reference ERCs: LS8_2 Biodiversity

LS8_3 Conservation biology

LS8_13 Marine biology and ecology

Reference SDGs: GOAL 4: Quality Education, GOAL 13: Climate Action, GOAL 14: Life Below Water

Description of the research topic

Global change, often associated to and exasperated by particular human activities, is increasingly and dramatically affecting life in the seas with effects that are more relevant and apparent in shallow waters.

In the Mediterranean basin, the global increase in temperature and the persistence of high temperature values for longer and longer time spans during the so-called heat wave events, as well as the increasing frequency of such events has been documented mostly in northern sectors, in the last two decades. The most striking effect is the mass mortality of the most stenothermic and vulnerable species with consequent impoverishment of the local biodiversity and degradation of habitats. Further consequences include the northward shift of the distribution range of thermophilic taxa, with several examples from the north Adriatic and the Ligurian and Proveçal seas, and the successful naturalisation of species entering mostly through the Suez Canal from the Indo-Pacific region. In an already compromised state, this flux (often anthropogenically mediated and exasperated) of non-indigenous species (NIS) contribute to banalise habitats that are also and contemporarily subject to further natural/anthropogenic stresses including super exploitation, pollution, perturbation in deposition rate, and so on , …).

In this context, and owing to the scantiness of data still available for Sicily (that are mostly dispersed in literature including grey literature), it would be relevant to produce a large

dataset and a GIS map of the occurrence of marine benthic and nektonic species, using historical information and new data to evaluate the entity of expected shift in species distribution and the NIS arrival. This could be achieved through special surveys and the involvement of local population (citizen science) contemporaneously promoting awareness of topics related with biodiversity in the public. Whenever possible, historical meteo-marine data will be collated in order to investigate possible relationships with biological information. Molecular analyses could be used to define the state of particular species. The expected output could serve to policy makers as a tool to decide about the opportunity or not to undertake measures to safeguard and maintain biodiversity.

Research team and environment

The research project will be carried out in collaboration with:

Università degli Studi di Catania (UniCT), at the Paleoecological Laboratory of the Dipartimento di Scienze Biologiche, Geologiche e Ambientali where a team of researchers has been engaged for years in studies aboutpresent-day Mediterranean biodiversity, especially focusing on selected benthic groups.

Università degli Studi di Catania (UniCT), at the Paleontological Museum: this structure I manage, could represent one of the sites for exhibitions and events to disseminate achievements to the public.

Agenzia Regionale per la Protezione dell'Ambiente (ARPA Sicilia) e più dettagliatamente con l'Unità Ambiente Marino Costiero: this instituton could provide historical data and collaboration in field activities, in data storage and management.

Stazione Zoologica Anton Dohrn di Napoli which could provide collaboration for taxonomy of particular groups and molecular analysis of selected specimens.

Suggested skills for this research topic

Knowledge in marine animal and plant taxonomy

Knowledge on benthic habitats and environmental factors

Skills in processing large amount of data

Skills in communication of science

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Curriculum: 1. Earth System and Environment

BIogeochemiCal fate of emerging Anthropogenic pollutants in the sedimentary Record

Reference Person: Sabbatini Anna (a.sabbatini@univpm.it)

Host University/Institute: Università Politecnica delle Marche

Research Keywords:	Sedimentary record of anthropogenic impact
	Experimental approach based on Foraminifera
	Experimental approach based on Geochemistry
Reference ERCs:	PE10_9 Biogeochemistry, biogeochemical cycles, environmental chemistry
	PE10_6 Palaeoclimatology, palaeoecology
	PE10_12 Sedimentology, soil science, palaeontology, earth evolution
Reference SDGs:	GOAL 4: Quality Education, GOAL 13: Climate Action, GOAL 14: Life Below Water

Description of the research topic

Marine debris is a global environmental issue. The chemistry of water and sediments, thus environmental quality and eventually the whole trophic chain, are affected by the dispersal of plastics and chemicals. Smoked cigarette butts (CBs) are the predominant human coastal litter item together with plastic debris and associated substances that can be bioaccumulated in marine organisms. CBs represent a vector for the transport and introduction of toxicants, including mainly nicotine, harmful metals, total particulate matter and known carcinogens, to aquatic habitats. Additives in plastic, like phthalates, could cause negative impacts on organisms and accumulate along with the food web.

The aim of the project will be to study the impacts of smoked CB and associated toxicants and phthalates on selected species of benthic foraminifera, a group of unicellular eukaryotic organisms, widespread inhabitants of coastal sediments forming part of a key link in marine trophic chains. We want to test the effects of these emerging pollutants on benthic foraminifera using an experimental laboratory approach combined with mesocosms setup.

In particular, foraminiferal cultures of common coastal benthic species will be used to investigate both cellular and metabolic stress after acute and chronic toxicity assays, incorporation of pollutants and potential effects on the biocalcification processes.

Mesocosm experiments will be performed in coastal areas that undergo an important anthropic seasonal pressure (i.E., touristic zones, offshore outfalls).

Furthermore, we will search for the baseline of the CBs and plastic related impact in sediment cores spanning the last hundred years; this will be of huge importance to evidence trends in the accumulation useful to understand what can be expected for the future. Consequently, as CBs and plastic pollution represent an urgent social and economic problem that requires attention from manufacturers, users, authorities, and the public to prevent the ingestion by biota and water pollution from its leachate, a further and even more important aim of this project will be to promote the consciousness at the community level stimulating activities and strategies (i.E., citizen science) for reducing CBs and plastic litter in the environment. To increase the awareness of environmental problems and gain ecological management, to preserve the Earth's well-being, the research outputs not only will be available for the main stakeholders (ISPRA, ARPA, regions, natural parks) but also be converted in social campaigns targeting beach users or beach clean-ups and in take-action projects sensitive to climate change.

Research team and environment

The Stratigraphy Sedimentology and Paleocology laboratory at the Polytechnic University of Marche (UNIVPM - Department of Life and Environmental Science - DISVA), is the laboratory where the project will be developed. The research activities are focused on the study of sediments and their textural and (paleo)ecological content. The Research Team is young and dynamic and it is devoted to the study of foraminifera to understand the ongoing changes either due to anthropogenic or natural changes. In addition, the functioning mechanism behind biomineralization (and the molecules involved) is basic to understanding the biomineralization process from a geochemical perspective. In fact, it is possible to record environmental and climate changes from the shell isotopic and trace element compositions. Coupling geochemical and biological perspectives will enhance the interpretation of the proxies used for climatic reconstructions and improve future modelling efforts. The Research Team collaborates with chemists of the same University working on the cellular effect of natural and synthetic bioactive molecules; it is active, also, a collaboration with physical oceanographers experts on quantitative methods in marine science. The UNIVPM offers the possibility to use the Actea Mobile Laboratory to collect sediment and water samples and hosts the ""Aquarium"" Laboratory representing a unique infrastructure at the National level that could accommodate the experimental culture area for foraminifera. Recently, thanks to the Italian Excellence Department Projects, the DISVA of UNIVPM has developed a well-advanced technical platform fully equipped for chemical analyses of all classes of environmental pollutants and ecotoxicological analyses.

Suggested skills for this research topic

Successful candidates are expected to have a background in geology, marine biology or ocean chemistry with an interest in biogeochemistry and climate change. Previous research experience with foraminifera will be a plus. We are looking for a candidate who knows how to work both in a team and independently, and he/she is willing to test him/herself with pioneering and transdisciplinary researches.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 1. Earth System and Environment

MEDICHANGE - MEDIcanes risk in a climate CHANGE scenario

Reference Person: Scicchitano Giovanni (giovanni.scicchitano@uniba.it)

Host University/Institute: Università degli studi ""Aldo Moro"" di Bari

Research Keywords:	Medicanes risk
	Coastal flooding
	Sea level rise scenario
Reference ERCs:	PE10_13 Physical geography, geomorphology
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action, GOAL 14: Life Below Water

Description of the research topic

Under ongoing global warming, a global mean sea-level rise is expected for the 21st century (IPCC, 2021 Bamber et al., 2019; Rahmstorf et al., 2012), this could enhance the effects of extreme marine events that, in the future, will probably impact on the coastal landscapes currently emerged. The vulnerability along some part of the Mediterranean coasts is also increasing in response to the occurrence of tropical-like cyclones, known as Medicanes MEDIterranean hurriCANE, which are able to generate wide flooding. Recent studies conducted along the cost of south-eastern Sicily (Scicchitano et al., 2021) demonstrated that generally Medicanes generate storm surge much higher respect seasonal storms, implying that coastal hazard of areas prone to Medicanes occurrence should be better assessed. The Project MEDICHANGE aims to: i) monitor the development and the impact of Medicanes along the Italian coasts of south ionian basin (Sicilia, Calabria, Basilicata and Puglia), ii) define a specific numerical modelling to describe Medicanes propagation on coastal area and calculate their maximum flooding and storm surge, iii) reconstruct the multi-temporal flooding scenarios at 2050 and 2100, for the studied area, using vertical land movements (VLM) and topographic data together with the Intergovernmental Panel on Climate Change (IPCC 2021) projections of SLR in the Representative Concentration Pathways RCP 2.6 and RCP 8.5 emission scenarios, iv) modelling Medicanes propagation and impact, along the studied coastal areas, for scenarios reconstructed at 2050 and 2100, v) GIS analyses for the assessment of Medicane risk at 2050 and 2100. During the Project MEDICHANGE, detailed field survey will be performed after the impact of Medicanes, along the Italian coasts of south ionian basin, in order to reconstruct the maximum flooding of the events. Detailed morphological and environmental data will be acquired through the use of different terrestrial (Laser Scanner, LIDAR, GPS RTK, Unmanned Autonomous Vehicle) and marine (Multi Beam Echo Sounder, Side Scan Sonar, Sub Bottom Profiler) survey techniques and equipment. Data

will be used to define a numerical model, specific for Medicanes, able to accurately estimates storm surge and maximum flooding. Field survey will also focus on the detection of evidences of past Medicanes, with this purpose will be selected coastal lagoon, in the geographic sector object of study, were to perform cores. The global sea-level rise (SLR) projections for the next few decades will be realized taking into account vertical land movements (VLM), evaluated through the analyses of geodetic data from global navigation satellite system (GNSS), synthetic aperture radar interferometric measurements (InSAR), and sea-level data from tidal stations to show the combined effects of land subsidence and SLR along the studied coastal areas.

Research team and environment

The team is composed by several researchers in the SSD GEO/04, two professors (Giuseppe Mastronuzzi and Giovanni Scicchitano), three researchers (Giovanni Scardino, Angela Rizzo and Antonella Marsico) and one PHd student (Teresa Denora). The team develops its researches within the activities of the Department of Earth and Environmental Science of the University of Bari and of the Interdepartmental Research Center for Coastal Dynamics of the University of Bari. It is specialized in: i) analyses of sea level rise during the Holocene through the use of morphological, sedimentological and archaeological data, ii) reconstruction of the impact of marine extreme event along coastal areas, iii) propagation modelling of marine extreme events, iv) reconstruction of multi-temporal flooding scenarios for coastal plain at 2050 and 2100, v) application of Machine and Deep Learning techniques for the assessment of hydrodynamic parameters from videos, vi) application of terrestrial and marine survey techniques in coastal environment. The group manages a laboratory equipped with several terrestrial (Laser Scanner, LIDAR, GPS RTK, Unmanned Autonomous Vehicle) and marine (Multi Beam Echo Sounder, Side Scan Sonar, Sub Bottom Profiler) survey instruments, and various work stations dedicated to processing, remote sensing and GIS analyses.

Suggested skills for this research topic

The candidate will need the following skills for successful conduct the proposed research: i) knowledge of the geomorphological coastal processes, ii) experienced in terrestrial or marine geophysical survey, iii) experienced with data processing and GIS analyses, iv) predisposition to actively participate to multi-tasking field survey campaigns in costal environment.

Curriculum: 1. Earth System and Environment

Disaster risk reduction in coastal areas affected by climate change

Reference Person: Soldati Mauro (mauro.soldati@unimore.it)

Host University/Institute: Università di Modena e Reggio Emilia

Research Keywords: Impacts of climate-related processes on coastal areas

Understanding coastal processes toward correct land management and conservation

Integrated risk assessment and relevant mitigation/adaptation measures

Reference ERCs: PE10_20 Geohazards

PE10_13 Physical geography, geomorphology

PE10_14 Earth observations from space/remote sensing

Reference SDGs: GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

Climate change is heavily impacting coastal areas resulting in both short-term (e.g. storm surges, marine inundation) or long-term processes (sea level rise) that determine disaster risk situations and remarkable socio-economic implications. The land-and-sea interface (the so-called `white ribbon' area) is extremely sensitive to climate change effects and remarkably important for coastal scientists and managers dealing with coastal dynamics. Under the current effects of climate change, it is necessary to draw special attention to this environment, which is often unexplored or not adequately investigated. A sustainable management of coastal shores would be possible through a holistic approach to risk assessment taking into consideration the interaction between subaerial and submarine processes. In this context, this PhD project will foresee integrated geomorphological mapping, monitoring and modelling of selected sites of the Mediterranean, merging ground-based, satellite, aerial remote sensing, as well as marine surveys.

The thesis will focus on the morpho-dynamics of coastal areas enhanced by climate change effects by investigating the whole coastal system, from the cliff edges to the seafloor. The research project may include direct measurements to be carried out in the short- and medium-term, using cutting-edge technology such as X-band radar, multibeam surveys (including back-scatter analysis), ROV and USV mapping, video-monitoring, UAV and TLS surveying, Optical RS and SAR interpretation. Special attention will be given to coastal risk assessment and mapping, by taking into consideration the hazard component, on the one

hand, and the vulnerability component, on the other hand. The frequency and intensity of extreme events have changed drastically over past decades, implying that even recent hazard assessments become unreliable for future decades, and need revision and update.

The outputs of the thesis – including an original methodological approach and newly acquired datasets – can be of interest to managers and end-users, as a tool for a more sustainable and cost-effective management of coastal assets under climate threat. In this respect, the thesis is expected to provide data acquisition and interpretation tools that can serve as a reliable ground for understanding the causes and effects of coastal risks, so as to sensitize relevant authorities to build a collective understanding of how adaptation and mitigation measures can be planned and performed toward an improved governance of coastal risk.

Research team and environment

The PhD student will be part of the Geomorphology Team of the Department of Chemical and Geological Sciences, which is coordinated by the Reference Person of this research topic. The Team comprises 4 staff members (1 Emeritus Professor, 1 Full professor, 1 Associate Professor, 1 Researcher), 2 contract lecturers, 2 contract researchers, 2 PhD students and a number of Master students. The research group has the capacity to provide appropriate training to PhD students and early career scientists thanks to the experience acquired in long-standing national and international research and teaching activities.

The Team has been involved in numerous research projects on coastal risk assessment funded by the Council of Europe in the frame of the EUR-OPA Major Hazards Agreement, and has a long-standing research experience in the field of climate-related geohazards, disaster risk reduction, and land management and sustainable development.

The PhD student will have the chance to interact with the staff in an informal and stimulating atmosphere, and to become part of international research network characterized by an interdisciplinary vocation.

According to the final content of the PhD research, different options for the required stay abroad will be offered to the grantee thanks to the wide network of collaborations with foreign universities and research centres established in recent years by the Reference Person.

Suggested skills for this research topic

The candidate should be able to:

- Recognize and understand geomorphological processes and landforms in coastal areas

- Deal with geological and geomorphological datasets in a GIS environment

- Approach hazard and risk analyses

– Work in a multidisciplinary team and in an international context.

Curriculum: 1. Earth System and Environment

Quantum-chemical approaches to spectroscopy and reactivity for atmospheric chemistry

Reference Person: Tasinato Nicola (nicola.tasinato@sns.it)

Host University/Institute: Scuola Normale Superiore

Research Keywords:	Quantum chemical calculations
	Atmospheric spectroscopy, reactivity and kinetics
	Greenhouse gases, ozone depleting substances
Reference ERCs:	PE4_13 Theoretical and computational chemistry
	PE4_18 Environment chemistry
	PE4_12 Chemical reactions: mechanisms, dynamics, kinetics and catalytic reactions
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

The release in the atmosphere of greenhouse gases (GHGs) and ozone depleting substances (ODSs), mainly produced by anthropogenic activities, is the driving force of global climate change. To understand their impacts and eventually plan mitigation actions, different chemical and physical information relevant to their atmospheric chemistry needs to be determined. On the one side, spectroscopic data, very notably in the infrared region, are required for the interpretation of observational measurements carried out through remote sensing techniques, but also to quantify the radiative forcing of GHGs. On the other side, their atmospheric fate needs to be explicitly characterized, to identify possible harmful degradation products, atmospheric sinks, and ultimately atmospheric lifetimes. The spectroscopic characterization, as well as the determination of chemical reaction rate coefficients and product yields, have traditionally been achieved by laboratory experiments. This, however, is a formidable task, very resource demanding and time-consuming, mainly because of the complexity of the experimental techniques (especially when unstable species are present), the number and variety of molecules involved, and the plethora of chemical processes that take place in different atmospheric environments. For those reasons, theoretical and computational quantum chemistry has become an essential tool in the investigation of topics related to atmospheric chemistry in the last years.

In that context, the project aims at developing and applying computational protocols for the determination of spectroscopic properties of GHGs and ODSs, and the understanding of their loss processes. To become effective, the accuracy reached by the applied computational strategies needs to compete with that of the most refined experimental techniques. This ideally means accuracies within 1 cm-1 for vibrational frequencies, 1 kcal mol-1 (at least) for reaction enthalpies and a factor of 2 for rate coefficients. State-of-the-art computations are carried out to investigate the atmospheric gas- and heterogeneous-phase degradation mechanisms and reaction pathways of volatile organic molecules, thus allowing the identification of reaction products and intermediates, from which the corresponding thermochemistry and chemical kinetics can be derived. The outcomes of the research are expected to give insight into the atmospheric degradation mechanisms of the targeted species, and to fill the existing gaps of knowledge concerning rate coefficients of reactions with main atmospheric oxidants. Hence, it is expected that the results will provide new data for improving the atmospheric modelling of those chemical species and for evaluating direct and indirect effects on climate and air quality.

Research team and environment

The research activity is carried out at the SMART Laboratory (https://smart.Sns.It/) of Scuola Normale Superiore. The SmartLab is dedicated to the development of advanced theoretical models for computational chemistry, their implementation in a number crunching simulation software and application to several chemical issues, with particular emphasis on environmental sciences and astrochemistry/astrobiology. The Laboratory has extensive facilities for developing software and running large-scale atomistic simulations and it manages the Avogadro Computational Cluster. This is equipped with more than 100 servers and 3000 CPUs and with storage with up to 300 TB of raw space for long term conservation of data. The cluster also includes three fat nodes with a high number of dedicated cores (80, 160 and 240, respectively) and massive amounts of RAM (from 4 to 6 TB), ideal for running high demanding calculations completely in memory. Several compilers, libraries and calculations suites are installed and maintained both open source or licensed. SMART also hosts an immersive virtual reality (IVR) laboratory equipped with powerful graphic workstations and last-generation IVR hardware and an immersive CAVE3D theater equipped with Optitrack IR sensors. While the SMART laboratory provides the required infrastructure for the theoretical and computational researches, laboratory experiments can be carried out thanks to ongoing collaborations.

The team comprises:

- Vincenzo Barone (Full professor)

- Nicola Tasinato (Associate professor)

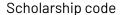- Zoi Salta (Post Doc, SNS)

- Carmen Baiano (PhD)

- Rais Nadjib (PhD)

- Gianluca Rinaldi (PhD)

- Sandra Monica Vieira Pinto (PhD)

Suggested skills for this research topic

Basic knowledge in Thermochemistry, spectroscopy, chemical kinetics, electronic structure and quantum chemistry.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 1. Earth System and Environment

Urbanization influence on climate change by remote sensing data

Reference Person: Teggi Sergio (sergio.teggi@unimore.it)

Host University/Institute: Università degli Studi di Modena e Reggio Emilia

Research Keywords:	Urbanization
	Urban Heat Island and Surface Urban Heat Island
	Remote sensing
Reference ERCs:	PE10_3 Climatology and climate change
	PE10_14 Earth observations from space/remote sensing
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

The correlation between urbanization and climate change is a current and important topic, still not fully defined and studied in many multidisciplinary research fields.

Urbanization is a very complex phenomenon, characterized by many features such as demographic variations, land use changes in urban areas and the growth of settlements and of infrastructures near urban centres (periurbanization or urban sprawl).

Alterations in urbanization involves variations in several parameters that drive the local climate, as the presence of impervious surfaces, soil albedo, thermal and/or greenhouse gas emissions, vegetated and humid areas. The resulting climatic variations most frequently observed are the increase in air temperature (urban heat island - UHI), the increase in surface temperature (surface urban heat island - SUHI) and the frequency of extreme weather events.

The main goal of this project is the study of the correlation between the urbanization increase, with particular reference to urban sprawl, and some climatic changes in the Po Valley in the last 30 years. In order to analyse this aspect also on a local scale, some cities will be included in the study, starting with Modena, for which a large dataset of meteorological and remote sensing images are available..

To evaluate urbanization, several models found in literature will be considered, focusing on models that involve satellite observations. Remote sensing images allow to characterize the urban fabric using surface albedo, vegetated or non-vegetated surfaces, water bodies, surface texture, artificial night lights. This last parameter represents an aspect that has only

recently been included in urban characterization. Furthermore, other spatial parameters will be used, such as CORINE land cover (Copernicus-EU).

The climate change phenomena studied will essentially be UHI and SUHI. The time series of surface nightly and daily temperature maps, will be obtained from remote sensing images in thermal infrared (such as MODIS on a regional scale and Landsat8 / TIRS on a local scale). The climatology of the air temperature near the ground on a regional scale will be obtained from the reanalysis data of the European Centre ECMWF (ERA5-Land reanalysis), while at the local scale the data of the local meteorological stations will be included. In the case of the city of Modena, data from the Modena Geophysical Observatory will be used.

Other spatial data will also be considered such as greenhouse gas emissions databases and local cartography (e.G. Urban plans, road network).

At the end of the project, a model will be defined to estimate some climate change components related to the urbanization increase. This model will contribute to the sustainable development activities of cities, to the understanding of climate change and to the choice of consequent corrective actions for the mitigation of climate change.

Research team and environment

The research activities will be conducted within the LARMA Laboratory of the Enzo Ferrari Engineering Department (www.Larma.Unimore.It) and at the Modena Geophysical Observatory belonging to the same Department (www.Ossgeo.Unimore.It). The research team is composed by three professors, three research technicians, two postdocs and two PhD students. The team members have expertise in remote sensing, urban heat island and surface urban heat island, geographical information systems, atmospheric modelling and dispersion and numerical simulation. Since 1860, the Geophysical Observatory has been dealing with measurements of meteoclimatic parameters such as temperatures, humidity, wind speed and direction and precipitation (it was recognized in 2020 as ""Long-term Observing Station"" by the World Meteorological Organization). Direct and diffuse solar radiation, and radiation in the UV band are also measured in the Observatory. The LARMA laboratory is equipped with numerous software and tools for processing satellite images (ENVI, Definiens Ecognition) and includes dedicated HPC resources.

For this scholarship a period of internship is planned at *Istituto Nazionale di Geofisica e Vulcanologia, Roma*

Suggested skills for this research topic

The candidate should have a solid background in physics, earth/environmental sciences or related disciplines, data analysis and processing. Skills in climatology and remote sensing data processing are also useful.

Type of scholarship and obligations

The type of this scholarship is: Transizioni Digitali ed Ambientali (Digital and Environmental Transitions). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Curriculum: 1. Earth System and Environment

Redesigning Deltas in a time of climate change

Reference Person: Tosi Maria Chiara (mariachiara.tosi@iuav.it)

Host University/Institute: Università Iuav di Venezia

Research Keywords:	Sustainable Deltas region
	Scenario building
	Long term strategies
Reference ERCs:	SH7_6
	SH7_7
	SH7_9
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

The delta areas in the world are dynamic systems where considerable natural resources interact with high population density and significant production potential. These areas of confluence between fresh and salt water are among the most active and innovative areas on the planet, where fast-growing metropolises compete with wetlands with a high level of biodiversity.

The climate crise affecting the entire planet is radicalized in these regions, so that coastal erosion, the rise in the average sea level, subsidence, the intrusion of sea water with the subsequent salinization of groundwater and irrigation systems, flooding and droughts all reveal the increasing fragility of the deltas, jeopardizing the very survival of the people who live there and the local productive activities.

The PhDs main objective is to explore new conceptual and analytical approaches for develop and implement inclusive and situated pathways to sustainable deltas, testing innovative tools and overcoming the emphasis on short term solutions which constrains options to consider sustainable solutions on the long term. Centered on design and design-based approaches the research will seek to explore new strategies and scenarios that consider the delta a living territory where different forces and materials intertwin. New strategies and projects will be compared with the short and long term climatic forecasts providing scenarios that matters not in just one direction (solely water-related, for example) but consider a variety of issues which could be integrated with visions involving the deltaic environment as a whole.

Research team and environment

The PhD candidate will take advantages of the laboratories, tools and infrastructures of the research clusters based at Iuav University of Venice. Their multidisciplinary task force includes urban designers, planners, economists, ecologist, civic engineers conducting national and international research on the interaction between the environment, the economy, and society in the climate crisis. The candidate will benefit from Iuav infrastructures. Iuav runs among others, PhD programs in Urbanism, Planning and New technologies; therefore the environment is very rich of interaction with other PhD candidates and with professors in several disciplines, with the opportunity to attend seminars and courses of great interest. The group has intense research contacts with other institutions in Italy and abroad.

Suggested skills for this research topic

The PhD candidate is expected to have a background in architecture, urbanism, planning as well as experience in the analysis and design of fragile coastal territories. Previous training in architecture, urban design and urban and territorial planning, will be considered a plus. GOAL 11, 13, 15

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 2. Socio-Economic Risk and Impacts

Italian Inner Areas as Engine for Green Transition and Recovery

Reference Person: Arbolino Roberta (rarbolino@unior.it)

Host University/Institute: University of Naples ""L'Orientale""

Research Keywords: Green Transition

Circular Economy

Inner Degraded Areas

Reference ERCs: SH1_12 Environmental economics; resource and energy
economics; agricultural economics

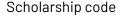**Reference SDGs:**   GOAL 9: Industry, Innovation and Infrastructure, GOAL 11:
Sustainable Cities and Communities

Description of the research topic

The coronavirus pandemic has driven a change in the relationship between Urban and Inner areas, posing the focus of policymakers and scholars on the need to redevelop and recover the latter from a social and economic point of view, still protecting their social, cultural and environmental heritage. Indeed, urban areas has proved difficult to live during those periods when movement restrictions were in force. Therefore, a partial and – if not properly supported – temporary change in user preference towards inner areas.

As highlighted by the National Strategy for Inner Areas (Strategia Nazionale per le Aree Interne), this broad group of areas gathers 60% of Italian surface, hosting less than 30% of population, despite a constant reduction. Together with demographic crisis, other problems characterize these areas: i.E., unemployment, land use, low levels of public and private service supply, social costs such as geological instabilities deriving from both abandonment and degradation of cultural and landscape heritage.

However, the renewed attention towards these areas is a fundamental opportunity to boost their socioeconomic recovery, in green and sustainable ways. Indeed, involving a mix of tradition, conservation and innovation, circular economy and sustainability might be the flywheels to spur economic recovery of inner areas. The policy framework set after the pandemic recognizes these potentials and offers a large set of fiscal, financial and policy instruments to boost these processes. On the one side, the National Plan for Recovery and Resilience (Piano Nazionale di Ripresa e Resilienza, PNRR) lists the enhancement of inner areas among its objectives, based on investments of about one billion on industries (through the Special Economic Zones), infrastructures, service provision, connectivity, modernisation and green transition. At present, fiscal incentives and other instruments for supporting

transition (such as improvement of the housing stock) are largely available in the "ordinary" legislation, incrasing the feasibility of green investments.

In this context, the present project aims at studying the potential of inner degraded areas to become the engine of Italian green and digital transition, as well as the flywheel of economic recovery.

To achieve this objective, an in-depth study of the potentially functional interventions in the current legislation is required, together with a mapping of those areas susceptible of interventions, by studying their social and economic features. These preliminary studies will be the basis for identifying strengths and potential criticisms of both internal areas and policy instruments, thus allowing to provide the policymaker with concrete suggestions to implement concrete and effective interventions. In doing so, the project aims at providing a quantification of the socioeconomic impact of both implemented and planned measures.

The main research output will be the modelling of methodological instruments to support policymakers in regulation improvement and punctual interventions realisation, together with an assessment of expected impacts.

Research team and environment

The PhD will take place at the Department of Social and Human science of the University of Naples L'Orientale. The student will be integrated in a multidisciplinary environment addressing different aspects of knowledge (involving geography, firms management, economics, anthropology, among others). In such an environment, the student will be given the opportunity to develop critical view on different aspects of development. However, the focus will be on economic aspects, thanks to the participation in the economic research activity of the department, with experience in policy evaluation, investment planning, sustainable investment selection, regional sustainable development, quantitative assessment of sustainability.

For this scholarship a period of internship is planned at *Technova Consorzio Politecnico per l'innovazione S.c.a R.I., Napoli*

Suggested skills for this research topic

Ideally, a successful candidate should present a background in economic and policy analysis, together with strong ability to analyse and interpret data. Experience in data analysis (even through econometric modelling software) will be considered an additional asset. A strong interest for multidisciplinary research is required, as well as good knowledge of spoken and written English language.

Type of scholarship and obligations

The type of this scholarship is: Pubblica Amministrazione (Public Administration). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of

the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Curriculum: 2. Socio-Economic Risk and Impacts

Developing innovative approaches for cascading effects to improve flood risk management actions with a specific interest on the functional vulnerability of critical infrastructures.

Reference Person: Aronica Giuseppe Tito (giuseppetito.aronica@unime.it)

Host University/Institute: University of Messina

Research Keywords:	Resilience and risk impact
	Critical infrastructures
	Sustainable engineering
Reference ERCs:	PE8_3
	SH7_6
	PE8_11
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

Risk analysis is central to Civil Protection activities and is the core element of risk management. Specific "Risk Management Plans" are needed to ready Civil Protection structures for tackling and managing an emergency. These identify the objectives that must be followed and achieved for the organisation of a desirable response by the Civil Protection when the event occurs.

The development of risk reduction strategies includes all aspects of risk management, from prevention to recovery. Civil Protection has a central role in ensuring a resilient approach for disaster risk reduction

The project aims at studying innovative approaches for the development of integrated flood risk scenarios taking into consideration critical specific issues of areas at risk and the consequences of high frequency/low damage events that affect them. High frequency floods still involve and require mitigation actions on the part of civil protection and citizens before floodwaters inundate the land and directly affect assets that can benefit from enhanced protocol development based on realistic scenarios.

In particular, the main idea is to develop a supporting decision tool for the comparative analysis of disaster reduction strategies in flood risk management, with a specific interest in

studying the functional vulnerability of critical infrastructures in order to preserve their efficiency during and after hazardous events.

This project will contribute to risk prevention addressing two challenging goals: firstly deriving consistent risk scenarios at the micro-scale, for frequent events, focusing on strategic infrastructures vulnerability; secondly defining effective strategies for managing emergencies, focusing on the individuation of areas at risk of isolation, best routes to reach populations, recovery areas, good practices to avoid the presence of citizens and cars in flooded areas.

The project also aims to support Civil Protection actions of risk reduction in at-risk territories during and after emergencies, keeping at-risk citizens safe, through both flood water avoidance and minimising disruption. Flood events cause both direct and indirect impacts, referring to the losses or disruption caused by the direct contact with flood water or due to the secondary effects.

For example. Transport infrastructures, can suffer structural (direct) damages after a flood event and, consequently, lead to an isolation of flooded and also not flooded areas (indirect effect). The efficiency of urban infrastructure is maintained if their disruption does not cause injuries and their functional role is substituted by other infrastructures following alternative routes. Identifying strategic buildings for citizen people recovery, defining the transferability transitability and partial transitability damage states and providing the alternative routes in both eventualities - including considerations on people behaviour, human resources and costs of alternative actions - is an important contribution to mitigate events' consequences by maintaining efficient infrastructures during and after disasters. Event management protocols benefiting from such considerations.

The main activity of the PhD student will be at the Water Engineering Research Group at the University of Messina, which will be integrated with two training periods, one abroad (6 months) at University of Bristol (one of the main European centres on the topic of the thesis) for an improvement of knowledge to flood resilience for the transport infrastructure and one at the Department of Civil Protection of the Sicily Region to improve the aspects related to disaster reduction strategies during and after hazardous events.

Research team and environment

TThe research activity wilt take place at the Department of Engineering, University of Messina. Within the Research Group of Water Engineering and Hydrology coordinated by Prof. Giuseppe T. Aronica. The Group includes an Associate Professor and other members (PhD students, Post-Docs, Research Assistants) and cover research topics related to flood risk management and flood defense design, flood propagation modelling, hydrological and hydraulic modelling of flash floods and debris flows, flood vulnerability and damage evaluation, pluvial flooding, sustainable urban drainage systems. Flood early warning, stochastic hydrology applied to the analysis of extreme hydrometeorological events. The research activities are supported by several national and International grants in the field of

flood risk assessment and mitigation, damage evaluation, development of disaster risk reduction strategies. The Research Group collaborates with several other research groups in Italy (University of Palermo,IUSS Pavia, Polytechnic Milan, University of Naples, and others) and abroad (University of Exeter, University of Thessaloniki, University of Bristol, Middlesex University, University of Sarajevo and others).

Suggested skills for this research topic

The ideal candidate shuold have a background in civil and environmental engineering studies, in particular in the field of urban and riverine flooding, flood vulnerability and damage evaluation.

Familiarity with programming languages such as Matlab, R, Fortran, will be positively considered, as experiences in statistics, data analysis and socio-economic modelling will be an added value. Fluency in English, both written and spoken is recommended. Finally, the candidate shuold be strongly motivated to work in a collaborative environment, with an interdisciplinary approach. A wllingness for international mobility is required

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 2. Socio-Economic Risk and Impacts

A systemic framework for climate risk assessment and management

Reference Person: Arosio Marcello (marcello.arosio@iusspavia.it)

Host University/Institute: IUSS Pavia

Research Keywords:	Systemic climate risk
	Indirect climate impacts
	Graph and network theory
Reference ERCs:	PE8_3
	PE6_6
	SH1_6
Reference SDGs:	GOAL 8: Decent Work and Economic Growth, GOAL 9: Industry, Innovation and Infrastructure, GOAL 13: Climate Action

Description of the research topic

Assessing the risk of complex systems to natural hazards induced by climate and its change is an important and challenging problem. In today's intricate socio-technological world, characterized by strong urbanization and technological trends, the connections and interdependencies between exposed elements are crucial. In this context of complex relationships, the scope of this research will be a paradigm shift in collective risk assessments: from a reductionist approach (i.E., based on the sum of the risk evaluated individually at each of its elements) to a holistic one (i.E., the whole system is a unique entity of interconnected elements, where those connections are considered to assess risk more thoroughly).

The research will progress on the activities at IUSS on the development of an innovative holistic approach (Arosio et al., 2020, "A holistic graph-based assessment approach for natural hazard risk of complex systems") that allows to analyze risk in complex systems based on a graph, the mathematical structure to model connections between elements. The approach proposes to represent the exposed elements of the system and their connections (i.E., the services they exchange, doi:10.5194/nhess-20-521- 2020) with a weighted and redundant graph. By mean of it, it assesses the systemic properties, such as authority and hub values and highlighted the centrality of some "critical" exposed elements. Furthermore, it is possible to use the graph as a tool to propagate the damage due to extreme climate events into the system, for not only direct but also indirect and cascading effects, and,

ultimately, to better understand the risk mechanisms of natural hazards in complex systems. Finally, the graph can also account for the resilience characteristics of the system according to the United Nations General Assembly definition.

Based on the state of art, internal and external to the IUSS's team, the candidate needs:

- to critically review the most recent literature, tools and database of collective risk assessment, with focus on climate-related hazards;

- to develop a novel methodology for the climate risk assessment using a systemic approach;

- to collaborate both with IUSS research team and the research team of the other Universities in the PhD consortium in a multi-disciplinary context;

- to disseminate results at international conferences and workshops

Research team and environment

IUSS mission is to provide advanced education to undergraduate and graduate students, as well as fundamental and applied research in the fields of Science, Technology, Engineering and Mathematics (STEM), and Human, Social and Life Sciences. At IUSS, PhD candidates will find an open multidisciplinary environment offering real opportunities for developing academic and professional tools for facing the challenges arising from increasing complexity and fast changes in the society and the environment. IUSS is always and actively committed towards internationalisation, inclusion and diversity. The selected candidate will join the research centre on Climate change impAct studies for RISk MAnagement (CARISMA). The CARISMA team is composed by STEM and Social scientists working in the prism of climate change on: data analysis and modelling of Earth system and economic system processes; impact assessment of extreme natural events and anthropogenic activities on human and natural environments; risk management of natural and anthropogenic hazards; formulation and proposal of new economic, political and legal models of sustainable development.

For this scholarship a period of internship is planned at *CRIF SpA, Bologna*

Suggested skills for this research topic

The ideal candidate will have experience with most of these topics: quantitative risk assessment, graph theory, statistical analysis and large dataset. Theoretical knowledge is mandatory and professional application could be an advantage. The candidate should be passionate on research topics, hardworking, self-motivated, have an open-mindedness to look for new solutions and methods of doing things and creativity in analytical thinking to extract meaning from sets of data. The candidate should desire to join a multi- and inter-disciplinary research team, open to learn new topics from other sectors and effectively communicate to colleagues with different background. Competence on programming languages is preferable.

Type of scholarship and obligations

The type of this scholarship is: Dottorati Innovativi (Innovative PhD courses). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 2. Socio-Economic Risk and Impacts

Sustainable mobility determinants in urban contexts: demand and supply analysis and policy design

Reference Person: Bergantino Angela Stefania
(angelastefania.bergantino@uniba.it)

Host University/Institute: University of Bari "Aldo Moro"

Research Keywords: Urban sustainable mobility

Consumers preferences

Urban transport services

Reference ERCs: SH7_9

SH7_7

SH7_6

Reference SDGs: GOAL 11: Sustainable Cities and Communities, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

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Description of the research topic

Reducing air pollution in urban areas is one of the most important urban planning challenges of recent years. Transport is responsible for around 25% of the planet's greenhouse gases, with over 70% of these produced by urban and peri-urban mobility by cars, buses, vans, etc. For the movement of people and goods EEA (2021). For this reason, the EU objective is to reduce greenhouse gas emissions from transport by 90% by 2050.

The research project aims to investigate how virtuous forms of urban mobility - such as active mobility, shared mobility, public transport services - and innovative organizational forms and means of transport - such as unmanned private/collective and urban air mobility vehicles - can offset the negative externalities linked to urban passengers and freight road transport. Considering also the role of mobility in relation to urban inclusiveness and accessibility to essential services, the research could assess how these forms of urban mobility could contribute to inducing a long-term reduction of the environmental footprint pursuing the UN Sustainable Development Goals (SDG11, SDG12 and SDG13).

The project will have a threefold approach: i) it will assess the factors that can support the transition toward less impacting forms of transport and urban mobility starting from the analysis of the state of the art of the supply (various forms and organizational structures of the new vehicles and fuels available or developing) and of the elements that guide demand

(individual and group behaviour in relation to the adoption of these solutions/technologies and to mobility and, more generally, urban environment perception), ii) it will define the elements for the design of public policies and incentives adopting a behavioural approach and provide a policy assessment and evaluation in terms of modal shift, spatial distribution of mobility, behavioural change and environmental impact; iii) it will yield insights for public/private operators active in this segment of the market still relatively unknown.

Considering the nature of mobility several research lines can be developed within this broad framework: i) identifying and assessing local factors that facilitate the diffusion of sustainable mobility practices - which include territorial factors (presence of urban mobility plans, structure of the city and distribution of services, state of the infrastructures), normative factors, demand factors (users' willingness to pay and use a sustainable form of commuting, socio-economic factors facilitating the modal switch) and supply factors (product design and mobility planning maximizing the use of sustainable commuting and last-mile logistics); ii) studying consumer's attitudes and preferences using stated preference/revealed preference and geospatial data provided by local service operators (demand-side analysis) for different forms of sustainable transport; iii) defining firms' opportunities (sharing services, unmanned vehicles, new fuels, last-mile logistics, etc); iv) develop guidelines for municipalities and policymakers to promote sustainable forms of mobility.

The demand side may be studied with analytical approaches such as multi-criteria analysis, agent-based models, discrete choice models and spatial econometrics using GPS data of current users and available satellite data. The candidate will also focus on the services provided by local transport operators (supply side) and the policies to support these services at the urban level (municipalities, metropolitan cities, regions), including urban planning and intervention on the spatial structure of the city. About the supply-side analysis, an overview of the service characteristics (pricing strategies, the density of service, urban policies, public funding, design, technologies, etc.) will be studied at the urban and national level, with a comparative overview of international best practices, to understand the main trends and innovations in the sector and their impact on the individuals' behaviour, on firms' strategies, on policy design.

Research team and environment

The research team is led by Professor Angela Stefania Bergantino, full professor of Applied Economics and Transport Economics at the University of Bari. Professor Bergantino has held and currently holds senior positions in the transport sector at the national level. She was president of the Italian Society of Economics of Transport and Logistics (2016-2021) as well as a member of the "Technical Mission Structure" of the Ministry of Infrastructure and Transport and consultant, over the years, for other Ministries and national and international research bodies. She sits as an independent in the Board of ENAV SpA (sustainability committee) and in Exprivia SpA. In the past, the team has already focused its attention on the role of sustainable territorial infrastructures and smart mobility as a driving force for

sustainable accessibility and the regional economy in general. The project proposal has a strong innovative content with respect to both the multidisciplinary composition of the working group and the ability to integrate heterogeneous aspects of the theme of sustainability declined on an urban scale. The research team is also composed by prof. Andrea Morone, Stefano Galavotti, Gabriele Tedeschi, Mario Intini, Ada Spiru (specialized in sharing mobility, transport economics, economics of public choices, experimental economics, environmental economics, econometric modelling, regulation) and several post-doc and PhD students in economics. The group cooperates also with Giuseppe Pirlo (informatics) and Alessio Pollice (statistics) on smart cities and specific analytical competences. The PhD candidate will use the laboratories, classrooms and research infrastructures made available by the Department. These are i) experimental economics laboratory (ESSE); ii) the Economics laboratory applied to transport, territory and businesses (LEATTI) - both equipped with computers, printers and simulation and statistical software specific to research activities.

Suggested skills for this research topic

Candidates should preferably have an academic background in economics and data analysis, analytical capabilities, the ability to handle and analyze large datasets and perform quantitative research in econometrics and social sciences. Fluency in English is recommended.

Curriculum: 2. Socio-Economic Risk and Impacts

Climate Change Impact on Economic Systems and Policies for an Orderly Transition

Reference Person: Caiani Alessandro (alessandro.caiani@iusspavia.it)

Host University/Institute: IUSS Pavia

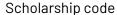|	
Research Keywords:	Climate Change
	Macroeconomic Modeling
	Physical and Transition Risks
Reference ERCs:	SH1_1
	SH1_12
	SH1_3
Reference SDGs:	GOAL 8: Decent Work and Economic Growth, GOAL 10: Reduced Inequality, GOAL 13: Climate Action

Description of the research topic

The candidate should have a background in economic studies, in particular in the field of macroeconomic analysis. His training and research activity will center on the study and development of models aimed at achieving a better understanding of the interactions between climate, the environment, and the economy. The focus will be on the effects of climate change on the real and financial spheres of the economy, with the aim of identifying the most suitable economic policies and the regulation schemes to mitigate the economic risks connected both to global warming and to the transition from a carbon-intensive to a low-carbon economy. The candidate will be encouraged to adopt a multidisciplinary approach and to use a wide range of tools such as dynamic heterogeneous-agent models (.E.G. Agent-Based Models), Integrated Assessment Models, econometric models, network analysis and machine learning techniques, behavioral and experimental economics methods. The research activity will be carried out in the research centre on Climate change impAct studies for RISk MAnagement (CARISMA) of IUSS.

Research team and environment

IUSS mission is to provide advanced education to undergraduate and graduate students, as well as fundamental and applied research in the fields of Science, Technology, Engineering and Mathematics (STEM), and Human, Social, and Life Sciences. At IUSS, PhD candidates will find an open multidisciplinary environment offering real opportunities for developing academic and professional tools to face the challenges arising from increasing complexity

and fast changes in the society and the environment. IUSS is always and actively committed towards internationalisation, inclusion and diversity. The selected candidate will join the research centre on Climate change impAct studies for RISk MAnagement (CARISMA). The CARISMA team is composed by STEM and Social scientists working in the prism of climate change on data analysis and modelling of Earth System and Economic System processes; impact assessment of extreme natural events and anthropogenic activities on human and natural environments; risk assessment and management of natural and anthropogenic hazards; and formulation/proposal of new economic, political and legal models of sustainable development.

Suggested skills for this research topic

Background in Economic Studies

Good Programming Skills

Econometric & Statistical Skills

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 2. Socio-Economic Risk and Impacts

Irreconciliable sustainabilities? The critical macro financial side of green transition; a macro modelling perspective

Reference Person: Caverzasi Eugenio (eugenio.caverzasi@uninsubria.it)

Host University/Institute: Università degli Studi dell'Insubria

Research Keywords:	Green transition financial sustainability
	AB-SFC models
	Macro Finance on public and private debt sustainability
Reference ERCs:	SH1_15 Public economics; political economics; law and economics
	PE3_15 Statistical physics: phase transitions, condensed matter systems, models of complex systems, interdisciplinary applications
	SH7_6 Environmental and climate change, societal impact and policy
Reference SDGs:	GOAL 8: Decent Work and Economic Growth, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

Macroeconomic research has tried, in recent years, to offer its contribution to the studies on the transition toward a more sustainable socio-economic system (see the Nobel prize to Nordhaus in 2018). The perspective applied until now focuses on the interactions between economic activity and pollution, and on the feedbacks effects on one-another: economic activity creates pollution which in turn increases temperatures, causing potentially devastating effects on the environment and this may be harmful to the economic system. In a nutshell, the question is: what is the level of GDP growth that we can maintain without excessively affecting the environment?

Recent publications cast doubts on this perspective (e.G. BIS, 2020; Keen et. Al 2021), underlying (i) how non-linearities and tipping points make forecasting unreliable in the medium run and, most importantly, (ii) how, due to the disastrous potential consequences, errors are simply unacceptable on this issue.

This project aims at proposing a different point of view. The goal is to understand how to make a green transition financially sustainable. Both the public and the private sector will be

involved in the transition, and both may rely on different sources of financing. Where to find the required funds? How to avoid bubbles and inflation? How to combine this with the current high level of public debt?

In order to provide answers to these questions, the model will rely on AB-SFC (Agent-Based Stock-Flow Consistent) models, a rather innovative macro modeling approach in which the bottom-up perspective of AB models combines with the comprehensive macro accounting of SFC models, which fully integrate the real and the financial side of the economy (Caiani et al. 2016). This gives the chance not only to simulate different financial and productive structures but also to assess the implications and feedback between the micro-level (where most policies must be implemented) and the macro-level (where the outcomes emerge); hence developing a complex system to inform policymakers and further research.

The financial side will be developed to assess the impact of the numerous proposals which are being put forward, related to monetary and fiscal policy on the one hand (Green New Deal, Green Quantitative Easing, Green Taylor Rule, Green Capital Adequacy Ratio), and on the financial system on the other hand (es. Green Bond, Green portfolios). The real side of the model will try to incorporate elements and data obtained by the collaboration with the other departments of the Uninsubria involved in the project (more on this below).

The problems that this project addresses have indeed self-evident implications in empirical and quantitative terms. Which are the foreseeable private and public debt levels? Which is the required speed of transition of financial portfolios? What is the level of investment and returns needed in order to avoid bubbles and financial crashes? These issues represent possible and highly promising extensions of this project.

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Keen, S., Lenton, Tm M. Antoine Godin, A., Devrim Yilmaz, D., Grasselli, M.Timothy and Garrett, J. 2021. Economists' erroneous estimates of damages from climate change,

Nordhaus W.D. 1991. The Cost of Slowing Climate Change: a Survey. The Energy Journal 12,

Research team and environment

The PhD student will have the chance to take part in a group of students and researchers collaborating on similar topics with Eugenio Caverzasi and his co-authors at the Università Politecnica delle Marche (Ancona), Greenwhich University, University Jaume I, (Castellon), Scuola Superiore Sant'Anna (Pisa).

The project will be carried out in collaboration with colleagues of the Department of Economics of the Università degli Studi dell'Insubria and with other members of the Board of the Ph.D. Program in Methods and Models for Economic Decisions (MMED), for which Eugenio Caverzasi is a lecturer and member of the board, with among others professor Elena Maggi, an active member of the PhD-SDC network.

For the modelization of the non-financial sector and of the impacts of economic activities on the environment, the Ph.D. Student will also have the possibility to collaborate with professor Mauro Guglielmin from the Department of Applied and Theoretical sciences and professor Nicoletta Cannone from the Department of Science and High Technology.

Moreover, the Economic team of the Department of Economics collaborates with several national and international universities, such as the Polytechnic University of Milan, the University of Padova, Venice International University, IUAV Venice, the University of Torino, the University of Milano-Bicocca, the University of Lugano, the Joint Research Center, the University of West of England Bristol, and with the Friedrich Schiller Universität Jena and the Hohenheim University, specialized in bioeconomy.

Suggested skills for this research topic

Ideally, the candidate should have a Master's degree in Economics, with good quantitative and programming skills.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 2. Socio-Economic Risk and Impacts

Innovative start-ups for a more innovative and sustainable economy

Reference Person: Colombelli Alessandra (alessandra.colombelli@polito.it)

Host University/Institute: Politecnico di Torino

Research Keywords:	Innovative start-ups
	Eco-innovations
	Digital technologies
Reference ERCs:	SH1_9
	SH1_10
	SH1_12
Reference SDGs:	GOAL 9: Industry, Innovation and Infrastructure, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

The research is positioned at the intersection between entrepreneurship and sustainable development. The project will analyse the trends and practices of innovative companies responding to the challenges of climate change and acting towards a sustainable economy within the context of the European Green Deal, focusing on the green strategies of innovative startups. The project includes three interrelated research themes:

1) INNOVATION: What is the role of start-ups for the generation and dissemination of green technologies in support of a more innovative and sustainable economy? Are these innovations linked to other relevant aspects of sustainability, such as diversity and inclusion, resilience (especially in the post-COVID world) and good governance?

2) PERFORMANCE: How can start-ups jointly leverage digital and green technologies and best practices to become more competitive while helping the transition to a more sustainable economy? What are the key trade-offs? Which companies are the most successful at linking climate risk management, eco-innovation and financial outcomes?

3) POLICIES: How much do regional, national and European policies and institutions encourage and protect the eco-innovative and sustainable activities of entrepreneurs? Are other policies that encourage green entrepreneurship (labels, reporting requirements, value

chain disclosure, anti-greenwashing actions) complementary to those targeting innovation systems?

Research team and environment

Beyond Prof. Colombelli, the closest research team includes another researcher RTD-A (Chiara Ravetti) who specializes in socio-economic sustainability and has already been working with Prof. Colombelli on the identification of green innovative start-ups in the Italian context; and another PhD student working on the research project "Sustainable business strategy, organization and innovation". Furthermore, the doctoral student will be part of the Department of Management and Production Engineering of the Politecnico di Torino, which concentrates economics and business expertise across numerous areas related to the research project (strategy, digitalization, industry 4.0, innovation, entrepreneurship, social innovation, incubators). Moreover, the PhD student will be part of the Entrepreneurship and Innovation Center (EIC), a knowledge-hub specialized in entrepreneurial and innovative ecosystem. During the PhD, the doctoral student will have access to the equipment of the Laboratory of Production and Economics (LEP) and, in particular, the following tools: software for economic-statistical analysis (Stata, Matlab), proprietary databases with characteristics of companies and patents such as Amadeus and Orbit, data on innovative start-ups, SMEs and particular cases of sustainable entrepreneurship (B-corporations).

Suggested skills for this research topic

The ideal candidate is a proactive, highly motivated and independent person, with an understanding of the economic and business challenges posed by climate change and sustainability transitions, capable of quantitative as well as qualitative data analysis (knowledge of econometrics and statistics constitutes a preferential skill, but is not a prerequisite)

Curriculum: 2. Socio-Economic Risk and Impacts

Environmental policies and consumption choices for low carbon and circular transitions

Reference Person: D'Amato Alessio (damato@economia.uniroma2.it)

Host University/Institute: University of Rome Tor Vergata

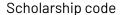|	
Research Keywords:	Environmental Economics and Policy
	Consumers behaviour
	Sustainability transitions
Reference ERCs:	SH_1_12
	SH_1_8
	SH_1_7
Reference SDGs:	GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

The aim of this research project is to make advancements in the analysis of the barriers and drivers of the low carbon and circular economy transitions, adopting an economic and econometric lens but in a way that will be open to interdisciplinary approaches. The scrutinized transitions require actions both from institutions (EU, State, regional and local level) and from firms and consumers, in order to be feasible, and a significant number of potential complementarities and trade-offs needs to be addressed, in line with the multiplicity of objectives included both in U.N. Agenda 2030 and in the EU Green Deal. This project will contribute and provide food for thought both for research and for policy making, focusing specifically on the interlinkages between policies and consumers' behaviours. More specifically, the aims of this project will be twofold:

1. Highlight relevant (traditional and innovative) policies that are expected to enhance the transition, measuring at the same time the degree of implementation, and

2. Analyse empirically and rationalize theoretically the most relevant drivers of the low-carbon and circular economy transitions, by measuring consumers' attitudes and behaviours, and by understanding relevant drivers that may potentially improve or worsen policy and other interventions' results by triggering complementarities or trade-offs.

Under a policy perspective, a broad as well as case-study based approach may be adopted, focusing on interventions ranging from traditional ones (e.g. from environmental market

based approaches to demand side Green Public Procurement strategies), to "behavioural" ones, for example based on consumers' motivation and choice architecture. The overall outcomes of the project are expected to be high level research results, potentially worth consideration in highly reputed international journals or other publication venues, and will be presented in top conferences in the relevant fields (e.g. Ecological and Environmental Economics conferences). They are however expected to also produce policy relevant actionable insights.

Research team and environment

The project will benefit of the very lively and high level research environment of the Department of Economics and Finance (DEF), Faculty of Economics, at the Tor Vergata University. The high quality of research is, in general, testified (among other things) by the award of the 2018-22 Department of Excellence MUR funding. Also, research in Environmental Economics has a long tradition in the context of the Department's activities, and several relevant events have been hosted by the Faculty of Economics (including: the 2011 EAERE Annual Conference, the 2017 IAERE Annual Conference, the 2019 IAERE School on Green and Climate Finance, the 2021 SEEDS Workshop). Researchers from DEF that work in the fields of Environmental and Ecological Economics have been and are involved in high level publication efforts (including, among others, papers published in international journals such as Ecological Economics, Environmental and Resource Economics, European Economic Review, Resource and Energy Economics) on topics related to the project. Finally, project development will also benefit from the involvement of the University of Tor Vergata in the SEEDS inter-university network (www.sustainability-seeds.org). SEEDS units are involved in international projects, such as the 2022-26 ETC/CE - European Topic Centre on Circular Economy and Resources use, that supports the European Environment Agency (EEA) in designing strategies along the green and circular economy transitions.

For this scholarship a period of internship is planned at *SEEDS, Ferrara*

Suggested skills for this research topic

The ideal candidate for this project has a degree in economics or related fields, and also features a good quantitative background (statistics and/or econometrics), together with knowledge of environmental and resource economics and a strong interest in learning advanced techniques for analysis. The interdisciplinarity of the project may also imply, in principle, the possibility of mixed approaches (quantitative/qualitative).

Type of scholarship and obligations

The type of this scholarship is: Pubblica Amministrazione (Public Administration). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 2. Socio-Economic Risk and Impacts

The Dark Side of Innovation: Predicting and Assessing Patent Toxicity

Reference Person: Giuliani Elisa (elisa.giuliani@unipi.it)

Host University/Institute: University of Pisa

Research Keywords: Innovation

                            Patents

                            Toxicity

Reference ERCs: SH 1

                            SH1_9

Reference SDGs: GOAL 3: Good Health and Well-being, GOAL 9: Industry, Innovation and Infrastructure, GOAL 12: Responsible Consumption and Production, GOAL 14: Life Below Water, GOAL 15: Life on Land

Description of the research topic

The proposed research project investigates the nature and dynamics of dark innovations, i.e. Innovations that possess intrinsic features that can damage human health and the ecosystems. Grounded in the broader area of innovation studies, the proposed research project aims at exploring the extent and modalities under which companies invent "dark" technologies and contribute to their diffusion and perpetuation in the market. The main unit of analysis is expected to be patent data as a key measure of innovation or firm-level innovation. More practically, the research project focuses on the chemical industry (or industries where chemical compounds are core e.g. Cosmetics or household products) and the successful candidate is expected to undertake advanced patent analysis. The proposed research will touch upon three thematic issues:

1) It will contribute to the measurement of the impact of patents on innovation by expanding the current spectrum of patent measures and by estimating patents' potential environmental and human health hazards. The focus is likely to be on chemical patents with the aim of using methods of computational chemistry (e.g. QSAR models) to assess their potential toxicity. Knowing well in advance how much a new chemical compound is toxic will help to predict future hazards and have a better understanding of the extent to which research conducted in R&D labs is helping (or not) to meet pressing environmental targets - which is a domain that has so far been almost completely overlooked by innovation scholars.

2) It will contribute to addressing environmental challenges and help meeting the EU Green Deal goal of a toxic free future. Questions about whether innovations on agro-chemicals or other chemical sub-industries will make us safer in the future are very important as growing scientific evidence is being produced about the nexus between exposure to given toxicants – even at low doses – and numerous of the dominant diseases of our times, including Alzheimer, autism and cancer. Hence, it is very important that we know more about the intensity, geography and ownership of the inventive activities of potentially highly hazardous chemicals. This project seeks to make an unprecedented step in this direction by combining patent analysis with methods of computational chemistry.

3) Third, the proposed project aims at assessing the impact of public policy and the regulatory landscape on patent production. In Europe there is a stringent but also relatively recent (2007) legislation on chemicals (REACH – Registration, Evaluation, Authorisation and Restriction of Chemicals), but it is still not well known whether it works as intended, and this project will for the first time undertake an impact evaluation study on the efficacy of the REACH regulation to prevent toxic patents from being produced and their related products marketed in the European Union or elsewhere.
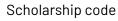
Research team and environment

The PhD student will be affiliated to REMARC. REMARC is part of the Department of Economics and Management (DEM) of the University of Pisa (UNIPI). Its primary goal is to conduct cutting-edge research on responsible management and sustainable development and to have an impact on managers, policy makers and other stakeholders. People at our centre work on three main focus areas – i.e. International Business and Human Rights; Communicating and Practising Corporate Social Responsibility and Societal Transition for a Sustainable Economy – and on a set of smaller related projects, including research on Responsible and Dark Innovation. Our team includes DEM faculty members and external collaborators from different disciplines including Economics, Management, Statistics, Political Science, International Law, Development Studies and Business Ethics. REMARC is part of the Sustainability Centres Community (SCC), hosted by the Network for Business Sustainability (NBS), and member of the BHRights Initiative. The center has strong international connections through the network of external affiliates.

Suggested skills for this research topic

Background in economics, management and related fields, or alternatively, background in chemistry, pharmacology or related fields, with an interest for innovation studies.

Type of scholarship and obligations

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

The type of this scholarship is: Ricerca PNRR (PNRR Research).This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 2. Socio-Economic Risk and Impacts

Sustainable Tourism, impacts of the introduction of the eco-labels on family desitination choices

Reference Person: Guerriero Carla (carla.guerriero@unina.it)

Host University/Institute: Università degli Studi di Napoli Federico II

Research Keywords: Household collective model of decision

Sustainable Tourism

Environmental Economics

Reference ERCs: SH1_12

SH1_8

Reference SDGs: GOAL 11: Sustainable Cities and Communities

Description of the research topic

Climate change is the greatest threat humanity now faces, with profound implications for world peace and stability (United Nations, 2021). Yet climate scientists judge the resolutions of the latest COP26 as still insufficient to meet the targets of the Paris agreement (Masood and Tollefson, 2021).

Ecolabels (e.G. Bandiera Blu) identify the quality of touristic destinations amenities and have been shown to be environmentally preferable in their category, enabling consumers to make informed on tarvel destinations environmental performance (Schwartz et al., 2020). However, the effect of ecolabels on families' travel destination choices has not yet been studied (Potter et al., 2021).

Families with children may be more environmentally sensitive. Young people are not only victims of climate change; they can also be powerful agents, as FridaysForFuture demonstrates. But there is only limited evidence concerning the power of children in households' decision-making.

Sustainable Families addresses a set of research questions:

- Household members' preferences: how does introduction of ecolabels affect the choices of individuals from different generations on travel choice destinations? Do similarities/differences between members vary with the family's socioeconomic status?

- What decision-making power is wielded by each member of the family? Who is the ultimate decision maker when it comes to sustainable travel destination choices? When do children

start influencing decisions on sustainable travel choices and how does their influence change with socioeconomic status?

Research team and environment

Dipartimento di Scienze Economiche e Statistiche offers a vibrant environment for international students. The diversity of research areas covered by the faculty allows students to write their thesis in several fields of economics and finance. Doctoral students are exposed to a vibrant research environment, by participating to the weekly seminars organized by CSEF (https://csef.It/), and interacting with its Research Fellows as well as the international visitors frequently present at CSEF.

For this scholarship a period of internship is planned at *Legambiente Iride, Napoli*

Suggested skills for this research topic

The ideal candidate should have a strong background in microeconomics and statistics.

Type of scholarship and obligations

The type of this scholarship is: Transizioni Digitali ed Ambientali (Digital and Environmental Transitions). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 2. Socio-Economic Risk and Impacts

Detecting SMEs' contribution to SDGs environmental challenges with big data

Reference Person: Lattanzi Nicola (nicola.lattanzi@imtlucca.it)

Host University/Institute: IMT School for Advanced Studies Lucca

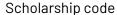|	
Research Keywords:	Small and medium-sized enterprises
	Sustainable Development Goals
	Machine learning
Reference ERCs:	SH1_10 Management; strategy; organisational behaviour
	SH1_9 Industrial organisation; entrepreneurship; R&D and innovation
Reference SDGs:	GOAL 6: Clean Water and Sanitation, GOAL 13: Climate Action, GOAL 14: Life Below Water, GOAL 15: Life on Land

Description of the research topic

The research line is focused on the assessment of SMEs' contribution to the United Nations' Sustainable Development Goals (SDGs), analyzing big data collected from the Internet and online social networks with advanced methodologies (e.G. Machine learning, complex networks methods). Specific focus will be given to the assessment of SMEs' contribution to the environmental group of SDGs (namely, goals 6, 13, 14, 15). SDGs were established in 2015, and have put substantial pressure on international economies and firms to meet them by 2030. They are addressed to all players in society, but academics and professionals acknowledge the relevance of firms in particular. Although firms have increasingly been using the Internet to disseminate their activities concerning sustainability, few studies include websites and online social networks to understand the extent to which companies are contributing to SDGs. Specifically, this research line aims at developing an empirical investigation of firms' advancements towards SDGs in the post-Covid scenario, which pushed the need for companies to change their business models into more sustainable ones. It combines big data and naturally occurring information from the Internet and online social networks to collect information on firms' advancements towards environmental SDGs.

The ultimate target of this research line is the proposal of a solid and comprehensive methodology for the assessment of SMEs' contribution to environmental SDGs in a quick and low-cost way, which could support managers, entrepreneurs and policymakers when designing their strategies and decision-making.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Research team and environment

The IMT School for Advanced Studies Lucca is a Public University School for Higher Education and Research with a special statute that focuses on the analysis of economic, societal, technological and cultural systems. The campus includes spaces for research and laboratories, courses, and living and recreation. The PhD candidate will have the opportunity to work in collaboration with scholars affiliated to the Laboratory for the Analysis of compleX Economic Systems (AXES) of the IMT School for Advanced Studies Lucca. AXES is a research unit whose work spans different fields of economics: from economic theory to applied econometrics, from international economics to political economy, from spatial and urban economics to industrial organization and business economics. Researchers incorporate skills and tools from different disciplines, including graph theory, the physics of complex systems and data science. AXES hosts seminars and dissemination events on a regular basis, and the chosen PhD candidate will be expected to attend these events as well as be actively involved in the unit's dissemination and other research activities. Scholars affiliated to AXES have published in top journals including the Journal of Business Ethics, Scientific Reports, Journal of Small Business and Enterprise Development, PlosONE, and Machine Learning, among others. Website: https://axes.lmtlucca.lt/.

Suggested skills for this research topic

A Master degree in economics, management studies, or a similar field is preferred. Because the project's methodological focus will be quantitative, it is highly required that the candidate has a strong background in statistics and/or econometrics. Familiarity with some statistical software packages (e.G., R, Stata) and/or programming languages (e.G., MATLAB, Python) is appreciated. Fluency in English, both written and spoken, is recommended. We cannot expect candidates to be proficient in most of the needed knowledge fields because the study is heavily inter-disciplinary. As a result, we want individuals who are eager to study how to use a wide range of tools and become familiar with a broad range of disciplines, including network analysis and machine learning techniques.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 2. Socio-Economic Risk and Impacts

The twin-transition geography: green & digital transitions across heterogeneous regions

Reference Person: Montresor Sandro (sandro.montresor@gssi.it)

Host University/Institute: Gran Sasso Science Institute (GSSI)

Research Keywords:	Green-transition
	Regional-eco-innovation
	Digital-transformations
Reference ERCs:	SH1_12
	SH7_7
	SH1_9
Reference SDGs:	GOAL 9: Industry, Innovation and Infrastructure, GOAL 11: Sustainable Cities and Communities, GOAL 12: Responsible Consumption and Production

Description of the research topic

The research project aims to investigate the extent to which the green and the digital transitions can be combined to make local economies evolve along smart, sustainable and inclusive patterns of growth. While not new, the debate about the so-called "twin transition" has been revived by the Covid19 crisis, with recovery plans making it an absolute priority, especially in Europe. However, this is occurring with scarce research on the enabling conditions of the twinning at stake and with little attention to its distribution across regions marked by heterogeneous levels of socio-economic development. In the absence of in-depth regional research on the topic, policy agendas might end up following dangerous "one-fits-all" recommendations, obtaining even perverse effects. More dedicated research appears therefore necessary.

Greenhouse gas emissions and the entailed raise of global temperatures are making the access to food and water uncertain, weather extremes and natural disasters more frequent, and the threats to international peace and safety more insistent. A green transition is necessary to "act forward". At the same time, the digital transition towards more powerful and empowering digital technologies needs to be intertwined with the green one. On the one hand, digital technologies pose serious environmental threats, which span from the depletion of rare materials in their production to the high energy consumption in their use. On the other

hand, digital technologies offer important environmental opportunities, both in improving green efficiency and footprint of current production and consumption modes and in facilitating the development of new green technologies for that to happen.

The research project at stake addresses the extent to, and the conditions on which these digital-green threats and opportunities are neutralize and exploited, respectively, across local areas that differentiate into core and peripheral, urban and rural, industrial and agricultural, to mention a few elements of socio-economic heterogeneity.

The research project builds on and extends recent research in the geography of eco-innovation field, in transition ecological studies, and in the literature about new green industrial path development. On this basis, it will address a series of more specific research topics, among which:
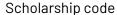
- Regional patterns of "green digital" and "digital for green" production and consumption.

- Regional knowledge recombination at the core of new green & digital technologies.

- Regional items and bundles of green and digital activities.

- The twin transition relation with regional cohesion and growth.

- The twin transition in-between societal challenges and policy making.

The research will be realized by assembling a new bunch of datasets that, mainly but not exclusively with respect to European regions, will collect and harmonize primary and secondary data, both micro geo-referenced and meso-ones, functional to the construction and econometric analysis of key variables and relationships in the relevant domains of the research, among which: local introduction and adoption of green and digital technologies, and of green and digital patterns of production and consumption; environmental impact of the local production and use of digital technologies; local policy initiatives across the digital and green domain and their detectable outcomes.

Research team and environment

The research will be carried out within the Social Sciences Area (SSA) of the Gran Sasso Science Institute (GSSI), located in L'Aquila.

The SSA team is made up of about 20 researchers actively involved in the GSSI mission of carrying out frontier research and high-level doctoral education in Regional Science and Economic Geography. In this field, the area offers its 4-year International PhD Program, whose faculty includes outstanding international scholars and whose program comprehends courses of relevance for the research project at stake and for the National PhD Program in

Sustainable Development and Climate Change (https://www.Gssi.lt/education/regional-science-economic-geography).

The SSA research team is engaged with five research tracks: i) Inner Areas and Peripheral Development; ii) Disasters and Regional Resilience; iii) Human Capital, Migration and Local Labour Markets; iii) Culture, Tourism and Regional Urban Development; iv) Regional Policy Evaluation and Local Urban Governance; v) Business, Innovation and Environmental Sustainability Within and Across Regions. The research project at stake will mainly refer to research track v), but it will also intersect with the other four (i) and ii) in particular).

The candidate will have the opportunity to interact with the students of the PhD program of the house, and to get advised by top-scholars in regional and innovation studies in a truly interdisciplinary environment: both within the SSA, comprehending applied economists and economic geographers using heterogeneous approaches (https://www.Gssi.lt/people/professors/lectures-social-science-gssi-cities), and with the other GSSI areas with which it regularly interacts, that is, Physics, Mathematics, and Computer Science.

Suggested skills for this research topic

The successful candidate is expected to have a good background of applied economic studies and at least an introductory level of knowledge of the main issues and concepts in regional and (eco-)innovation economics. Moreover, the candidate should have basic econometric and statistical skills and competencies in handling large databases, in particular about innovation proxies like R&D and patent data.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 2. Socio-Economic Risk and Impacts

Food system and biodiversity loss: a transition to more sustainable behaviors

Reference Person: Morone Piergiuseppe
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Host University/Institute: UnitelmaSapienza University of Rome

Research Keywords:	Food system
	Unsustainable consumption
	Sustainability transition
Reference ERCs:	SH1_12
	SH1_7
	SH7_6
Reference SDGs:	GOAL 2: Zero Hunger, GOAL 12: Responsible Consumption and Production, GOAL 15: Life on Land

Description of the research topic

Europe is currently facing several environmental, economic and social challenges, aggravated by the COVID-19 crisis. However, the ongoing pandemic could provide an opportunity to rethink economic and business models and policy, to favor innovation and a Green Deal-oriented transition. In this regard, there is growing interest in the development of new production and consumption models. Such new models are crucial to address sustainability challenges and to support an economic model that is more resilient to exogenous shocks and able to address the 'just transition' pillar of the Green Deal (e.G. Ingrao et al. 2018).

This need to deploy new consumption and production models also applies to the food system. Indeed, there is increasing recognition that the prevailing food system is environmentally unsustainable and socially unjust, a situation which has prompted different initiatives around the world to propose, reinvent or institutionalise more sustainable practices, from individual to global levels, and to develop more sustainable food systems (Allen, 2014).

Unsustainable mass consumption models have long characterized the European manufacturing sector and - since the mid-twentieth century - have also expanded to the food system. The negative consequences of these mass consumption models are amplified in food systems by the difficulty to include negative externalities in food prices.

Another distortion which regards specifically the prevailing food system is food waste/surplus. The Food Loss Index of the UN Food and Agriculture Organisation (FAO) estimates that 13.8 % of the food produced in 2016 was lost 'from the farm up to, but excluding, the retail stage'. This waste is generated throughout the supply chain, from agricultural residues through industrial processing wastes to final household and catering consumption surpluses.

Unsustainability of the current food system regards also the growing demand for nutrients from meat-based Western food production and consumption patterns. This trend places enormous pressure on the environment and threatens biodiversity as intensive farming and husbandry is considered to be among the major drivers of biodiversity loss (Willett et al., 2019).

Against this background, this research project will be articulated along the following three research lines:

1. Assessing the impact of current unsustainable food production and consumption behaviors (specifica ttention will be given to biodiversity)

2. Identifying measures to prompt the needed changes in consumer behaviors (this will be done mostly through behavioral and experimental economics methods, including nudging techniques)

3. Measuring the existence of a green premium for biodiversity (both w.r.t. green consumption and green finance).

Research team and environment

Research at UnitelmaSapienza (a young online & distance learning University directly linked to Sapienza University of Rome) is carried out in various Laboratories, Research Centers and Research Groups. The Bioeconomy in Transition Research Group (BiT-RG) is involved in research concerning the emergence of a circular and bio-based economy relying on the use of renewable resources for the production of novel products for various applications.

The scientific coordinator of the BiT-RG is Piergiuseppe Morone, Full Professor of Economic Policy at UnitelmaSapienza. The group includes 14 additional members: prof. Donald Huisingh (honorary member), 12 researchers from prestigious Italian and foreign universities and 1 administrative technician from the Management Control and Research Area of the University (professional profiles available at the following link: https://www.Bioeconomy-in-transition.Eu/people/).

Most of the BiT-RG research activities are channeled in the Sustainability Transition strategic area:

Modern society has a dire need of bringing together economic efficiency, low environmental impact technologies, and alternative feedstocks to conventional fossil fuel and raw materials. This need calls for an efficient management of biomasses. Bearing these facts in

mind, a transition from a society heavily based on mass consumption, uncontrolled waste generation, and heavy fossil fuels exploitation toward one based on resource-efficiency, new production and consumption behaviours, waste reduction, reuse, and valorization, seems a desirable and much needed feat. This change involves a paradigm shift, which goes beyond technological change - it involves big societal and institutional changes as much as the development of radically new technologies.

Suggested skills for this research topic

Knowledge of quantitative and qualitative methods for empirical research in behavioural economics, including survey analysis for consumers and field and laboratory experimental economic analysis; interdisciplinary skills and motivations to create bridges between fields.

Type of scholarship and obligations

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Curriculum: 2. Socio-Economic Risk and Impacts

Climate extremes and policy action. The role of social networks.

Reference Person: Palma Alessandro (alessandro.palma@gssi.it)

Host University/Institute: Gran Sasso Science Institute (GSSI)

Research Keywords:	Climate extremes
	Social networks
	Adaptation policy
Reference ERCs:	SH1_12
	SH1_15
	SH7_6
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 8: Decent Work and Economic Growth, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

The effects of global warming are manifesting much in advance than previous forecasts. The formation of "climate extremes" such as drought, tornadoes, heavy precipitations and heat waves are the most concerning issue of global warming as their frequency, duration and intensity have dramatically increased over the last 5 years in a scenario that is becoming the ``new norm". While there is an urgency for a policy response, a tighter environmental regulation is difficult to achieve, especially in advanced economies, where the marginal cost of additional regulation is higher and difficult to be accepted by firms and consumers who are not directly exposed to climate risks. Still, climate extremes are increasingly manifesting in several EU countries, with Italy being one of the most affected regions. As a consequence, policy makers are struggling to find an effective strategy to rapidly adapt to the "new abnormal" and strengthen resilience of the socio-economic systems. Yet, recent evidence shows that policy action against climate change increases when the local population is directly exposed to climate risks. More informed and aware individuals would thus induce policy makers to take a more effective action but little evidence exists on this issue.

This project investigates the causal effect of extreme weather events in Italy on two relevant dimensions: the damages generated and the individual involvement in addressing climate challenges at a local level. For the first dimension, it considers several outcomes such as public expenditures for recovery, health data and different proxies of local economic activities to capture several aspects of the damages associated with climate extremes. The second dimension of the analysis relies on big data from social networks to examine how the

local population responds to climate extremes, following the hypothesis that "climate awareness" and the population involvement increases as climate change manifests its effects. Especially in relatively less-exposed areas, individuals hit by climate extremes are expected to react on their social networks, disseminating information about risks and consequences of climate disasters, increasing the awareness and response of the local population and policy makers. This mechanism would increase the acceptability of new environmental regulation, reducing the gap between informed individuals and those with weaker beliefs, who represent a barrier to a more effective climate action.

The project employs three main data sources. First, daily georeferenced data on extreme events are obtained from the European Severe Storms Laboratory. Second, data on local effects include damage estimates (Protezione Civile and ISPRA), health outcomes (e.G. ISTAT mortality data, hospital dismissions), proxies of economic outcomes (e.G. Electricity consumption). Third, for the analysis of individual response, the project employs big data from social networks (Twitter and Facebook). Empirical methods rely on state-of-the-art causal inference techniques for suitable identification strategies (e.G. Event study analyses, diff-in-diffs and regression discontinuity) by exploiting exogenous variation of the climate extremes in a setting characterized by a granular geographical level and a high time frequency.

Research team and environment

The research will be carried out within the Social Sciences Area (SSA) of the Gran Sasso Science Institute (GSSI), located in L'Aquila.

The SSA team is made up of about 20 researchers actively involved in the GSSI mission of carrying out frontier research and high-level doctoral education in Regional Science and Economic Geography. The Area offers a 4-year International PhD Program, whose faculty includes international scholars and relevant courses for the research project at stake and for the National PhD Program in Sustainable Development and Climate Change (https://www.Gssi.It/education/regional-science-economic-geography).

The SSA is engaged with five research tracks: i) Inner Areas and Peripheral Development; ii) Disasters and Regional Resilience; iii) Human Capital, Migration and Local Labour Markets; iii) Culture, Tourism and Regional Urban Development; iv) Regional Policy Evaluation and Local Urban Governance; v) Business, Innovation and Environmental Sustainability Within and Across Regions. The research project at stake will mainly refers to research track v) and to research tracks iv and ii) to a lesser extent.

The candidate will have the opportunity to interact with PhD students of the house, and to get advised by top-scholars in climate change economics who will be involved as a part of the PhD program in a truly interdisciplinary environment along with the other GSSI areas (Physics, Mathematics, and Computer Science). Additional advising and visiting opportunities may come from the following top-scholars: prof. Olivier Deschenes (UC Santa Barbara and IZA), prof. Claudia Persico (American University), prof. Joshua Graff Zivin (UC San Diego).

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

For this scholarship a period of internship is planned at *SEEDS, Ferrara*

Suggested skills for this research topic

The successful candidate should have a strong background of applied economic studies and public economics, including some introductory knowledge of environmental economics. In addition, the candidate should have an intermediate level of econometric skills and a strong attitude in data manipulation (including large geo-referenced micro-data databases). A a good command of common statistical softwares for data analysis would be a key asset (R or Stata).

Type of scholarship and obligations

The type of this scholarship is: Pubblica Amministrazione (Public Administration). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 2. Socio-Economic Risk and Impacts

Assessing droughts socio-economic impact combining social media and drought indexes

Reference Person: Pernici Barbara (barbara.pernici@polimi.it)

Host University/Institute: Politecnico di Milano

Research Keywords:	Droughts
	Social Media
	Socio-economic indicators
Reference ERCs:	PE6_10
	SH7_6
	PE6_11
Reference SDGs:	GOAL 10: Reduced Inequality, GOAL 13: Climate Action, GOAL 16: Peace and Justice Strong Institutions

Description of the research topic

Socio-economic costs of droughts are progressively increasing worldwide due to undergoing alterations of hydro-meteorological regimes induced by climate change. Although drought management is largely studied in the literature, traditional drought indexes (e.G. SPI, SPEI, SMRI, SRI, SSI) build on physical hydrometeorological variables and combinations thereof and might fail in detecting socio-economically critical events and quantify the actually perceived impact by society and associated distributional and societal equity. Besides, these indexes cannot be projected or forecasted and are thus useful for monitoring ongoing droughts, but cannot provide anticipatory capacity for managing future events.

This interdisciplinary research will develop a framework for collecting and analyzing information about droughts from different sources, supporting the study of drought management with new information extracted from social media to provide a richer set of information and methods for estimating socio-economical impact and costs and how they distribute spatially and socially. A data analysis pipeline to retrieve drought occurrences and perceived impact from social media will be developed. The goal of the social media analysis will be to extract visual information about drought events, developing innovative tools for an accurate selection of posts related to drought events and different types of impacts to be evaluated. Starting from a given goal of the analysis, the research will develop multilingual and location-based search mechanisms in social media. The pipeline will include methods for filtering and de-biasing extracted posts to gather visual evidence of drought events over the

years. From the collected information, the areas which are perceived as most critical in the posts will be identified and impact indicators will be assessed. The drought events and associated impact estimates retrieved from media will be contrasted with a broad range of physical drought indicator, including SPI and SPEI, and where available ad hoc indicators (Zaniolo et al., 2018) accounting for local regulation and water backup (e.G. Presence of snow, groundwater, or large storages). The focus will be on agricultural droughts at the EU continental scale using feature extraction algorithms for processing large, spatially distributed gridded datasets of candidate drought drivers and for constructing an ad-hoc index able to reproduce the drought impacts on agricultural production as captured by the Normalized Difference Vegetation Index, which is a remotely sensed index representing the crop growth state. The information derived from social media will be assessed, in particular in relation to possible biases, to completeness and uncertainty of information, combining inputs both from the physical drought indicators and an assessment of the indicators derived from the social media analysis. Improvement techniques for data collection from social media will focus on increasing the completeness of information, using also machine learning methods, in order to enrich the collected information to meet the final goal of this research to develop new indicators for the socio-economic impact of droughts.

Research team and environment

The research will be carried out at the Department of Electronics, Information, and Bioenginering (DEIB), Politecnico di Milano. DEIB is one of the major ICT university departments in Europe, with over 1000 members. DEIB facilities several high-performance computing facilities on site (PoliCloud) and free access to national supercomputing cores, and scientific publications. A large warehouse of case studies, models and software tools for planning and management of water resources is available. Beside traditional ICT areas, DEIB has a strong international reputation in cross-disciplinary fields, including the application of Systems Analysis and Control Theory to the field of water resources modelling, management and decision making. The selected candidate will conduct research between the Information Systems Open Lab (ISOLab, Prof. Barbara Pernici, who will supervise the thesis work) and the Environmental Intelligence Lab (EI-Lab, Prof. Andrea Castelletti, who will be a co-advisor for the thesis). The ISOLab activities include research themes on Big Data, Industry 4.0, and IS infrastructures. ISOLab provides access to several Cloud platforms and specific softwares (e.G., scientific simulations, social media analysis tools, such as VisualCit). ISOLab participates in and coordinates several EU-funded projects, in particular in the sector of social media analysis and data management and governance. The EI-Lab's mission is advancing environmental decision-analytics for supporting human decisions in complex engineering systems including multiple actors and exposed to evolving multisectoral demands and global change. EI-Lab participates in and coordinates several projects on topics relevant for the PhD programme in Europe, Asia, Africa, and North America.

During his research, the PhD candidate will collaborate closely and spend a period of 6 months at the Climate Observatory of the Regional agency for prevention, environment and energy of Emilia-Romagna (ARPAE) in Bologna, focusing the research on characterization and

management of extreme low waters using traditional indices, artificial intelligence and innovative digital tools (e.g. social media).

In addition a period of 6 months will be spent abroad at the Justus Liebig Universitaet Giessen, working on evaluating climate impacts. The university participates in the EU H2020 Project CLINT (Climate Intelligence: Extreme events detection, attribution and adaptation design using machine learning), coordinated by Politecnico di Milano.

For this scholarship a period of internship is planned at *ARPAE Emilia-Romagna, Bologna*

Suggested skills for this research topic

Qualifications for this position include an M.Sc. in computer engineering or computer science. Candidates with a background in water resources engineering or other related fields of environmental engineering and environmental sciences are also encouraged to apply. Strong numerical and computational skills are required, as well as English language skills both in oral and written communication.

Type of scholarship and obligations

The type of this scholarship is: Pubblica Amministrazione (Public Administration). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Curriculum: 2. Socio-Economic Risk and Impacts

Environmental awareness in the framework of sustainable development goals

Reference Person: Polinori Paolo (paolo.polinori@unipg.it)

Host University/Institute: University of Perugia

Research Keywords: analysis	The economics of climate change and social preferences
economic system	Analysis of the interactions between climate change and socio-economic system
	Exploring climate change risks impact on society
Reference ERCs:	SH1_3 Microeconomics, behavioral economics
	LS9_6 Food sciences
	LS9_6 Food sciences
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 8: Decent Work and Economic Growth, GOAL 12: Responsible Consumption and Production

Description of the research topic

This project analyzes the notion of Environmental Awareness (EA) from different and complementary dimensions (theoretical, empirical, experimental). The aim is to identify policy suggestions to contribute to the implementation of the Sustainable Development Goals and of the Next Generation EU that also strengthens the EU agricultural budget for 2021-2027 in order to promote sustainable development and mitigate the climate change. The theoretical dimension focuses on construction and simulations of models, also in a bounded rationality context, of consumer preference schemes and of firms' investment behavior. The empirical dimension focuses on the nexus between what consumers declare and what they actually do in terms of sustainable behavior. The analysis will focus on consumers' and firms' willingness to pay or willingness to accept (WTP/WTA) for the green product. The experimental dimension focuses on the estimation of EA into several sectors of green products. The research program includes survey analysis and experimental analysis, offering a special focus on several issues connected to the EA, such as energy sector, green attitude-behavior gap, water conservations issues, waste recycling, circular economy, agricultural issues. The vision is multidisciplinary, while entailing economic, psychological and social perspectives. The project plans to develop high level research on theoretical, applied and experimental dimensions and to make obtained results applicable to our society

and economic system, with the goal to spread awareness to the young society, to make them capable of building up stronger values of respect for human and environmental health. In particular, the project is designed to be able to identify (i) effectively implementable policy suggestions, (ii) guidelines for consumers and/or institutions (i.E. Schools), measuring and promoting EA among segments of the population (especially young). Furthermore, the project is designed to provide policy suggestions, guidelines, informative campaigns and best-practices (e.G. For public administrations, corporate sector, utility companies, regulatory authorities non-governmental organization, consumers, young students.

Research team and environment

The research team is interdisciplinary drawing from the fields of energy economics (Department of Economics, Perugia), political economics (Department of Economic and Legal Studies, Naples) and agricultural economics (Department of Agricultural, Food and Environmental Sciences, Perugia). Team is focused on high-quality research with frequent exchange between team members, the members of the department, and external academics and professionals. Furthermore, our team collaborates with Universities, Government bodies, European and International institutions in the fields of economic growth, energy and environmental economics. They have collaborated with the T20 Italy. The members of the research group are internationally recognized and have published several scientific papers in the leading international journals in their fields. They have participated in numerous national and international conferences of scientific relevance. The academic environment in which our team works includes doctoral fellows, research fellows and professors in a broad variety of research fields such as energy and environmental economics, regulatory economics, econometrics, behavioral economics, political economics, agricultural economics, mathematical economics, circular economy and transport policy.

The research group studies tools to promote local energy autonomy and the energy transition, focusing on the energy sector. Our activities include participation to national and international research projects, seminars with doctoral fellows and visiting professors, PhD workshops, and conferences. Department includes computer labs and rooms for doctoral fellows. Database access and a large variety of electronic journals in the fields of economics, finance, business, and statistics are also available.

Suggested skills for this research topic

Candidates should preferably have an academic background in economics or agricultural economics, analytical capabilities, ability to handle and analyze datasets and to perform quantitative research in econometrics and social sciences. Fluency in English is recommended. Ideally the successful candidate should have solid research training in relevant disciplines, and intellectual curiosity

Curriculum: 2. Socio-Economic Risk and Impacts

Transition towards more sustainable production and consumption in agri-food systems

Reference Person: Raffaelli Roberta (roberta.raffaelli@unitn.it)

Host University/Institute: Università di Trento

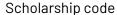|	
Research Keywords:	Greenhouse gases emissions
	Mitigation policy actions
	Farmers' and consumers' preferences
Reference ERCs:	SH1_12 Environmental economics; resource and energy economics; agricultural economics
	SH1_7 Behavioural economics; experimental economics; neuro-economics
Reference SDGs:	GOAL 12: Responsible Consumption and Production

Description of the research topic

A transition towards more sustainable food systems that are economically viable, socially inclusive and environmental-friendly is urgently needed (Runhaar 2021). While the EU Green Deal and the Common Agricultural Policy (CAP) set the general policy framework to make this transition happens at EU level, each member state has to develop and implement its specific policy responses. Unfortunately, there is a large gap in the understanding of lock-ins and levers that determine the success or failure of such policy responses in changing the behaviour of economic agents operating in the agri-food supply chains (Kuhmonen 2018).

This project aims at exploring factors and drivers that influence the farmers' and consumers' acceptability of policy interventions that were already implemented or could be operationalized in the short-medium term to facilitate this transition in Italy.

The project will focus on policy initiatives that are designed to reduce the production of greenhouse gas emissions (GHGs) or enhance carbon sequestration (eg. "carbon farming"). This focus is due to the fact that agriculture is an important emitter of GHGs and emissions from agriculture were growing over the entire 2000-2018 (FAO, 2021).

Thanks to a detailed review of the policy initiatives that could be designed at national level to reduce GHGs due to agriculture in the short-medium term, the most promising policy initiatives will be selected. The project will investigate farmers' and consumers' perceptions regarding the performances of these policy initiatives in terms of economic, social and environmental sustainability as well as their preferences for such policy initiatives. The

ultimate goal of the project is to identify lock-ins and levers that could affect farmers' and consumers' acceptability of these policy initiatives intended to reduce GHGs and curb climate change. Ultimately, this project will provide important information to policy makers and help to realize EU ambitions in terms of climate neutrality.

To address this topic both qualitative and quantitative research approaches are needed and primary and secondary data will be collected. Primary data will be collected by using stated preferences methods such as discrete choice experiments and economic experiments. Discrete choice experiments are a survey-based technique which is extensively used in the literature to elicit preferences for alternative policy actions (see for example, Cerroni et al., 2019), while economic experiments are the core of experimental economics, a discipline which is increasingly used to explore public policies related to the agriculture and the environment (Colen, et al., 2019).

Cerroni S., Notaro S., Raffaelli R. (2019) Beliefs and preferences for food-safety policies: A discrete choice model under uncertainty, European Review of Agricultural Economics, 46 (5), 769-799.

Colen, L., Gomez y Paloma, S., Latacz-Lohmann, U., Lefebvre, M., Préget, R., & Thoyer, S. (2016) Economic experiments as a tool for agricultural policy evaluation: Insights from the European CAP. Canadian Journal of Agricultural Economics, 64(4), 667-694.

FAO (2021) Emissions due to agriculture Global, regional and country trends 2000-2018. Source: https://www.Fao.Org/3/cb3808en/cb3808en.PdfKuhmonen, T., (2018). Systems view of future of wicked problems to be addressed by the Common Agricultural Policy. Land Use Policy, 77, 683-695.

Runhaar, H. (2021). Four critical conditions for agroecological transitions in Europe. International Journal of Sustainable Agricultural Research, 19(3): 227-233.

Research team and environment

The research team is composed by three experienced agricultural economists, namely Roberta Raffaelli (full professor), Simone Cerroni (associate professor), and Sandra Notaro (associate professor), and two environmental economists (Carlo Fezzi and Michela Faccioli). They have extensive experience in carrying out discrete choice experiments (both in field and online) and economic experiments in the lab. The team is deeply involved in the PhD program in Sustainability: Economics, Environment, Management and Society (SUSTEEMS). It is an interdisciplinary doctoral program which addresses the complex issue of sustainability form an economic, environmental, and managerial point of view. This PhD program involves economists, agricultural economists, engineers, professors in business and management, jurists, and a sociologist. This program offers to PhD students 300 hours of advanced courses and a stimulating and supporting environment for carrying out their research. The Department of Economics and Management also hosts the Cognitive and Experimental

Economics Laboratory (CEEL). CEEL is an interdisciplinary research hub, involving scientific competences from economics, cognitive psychology, consumer and business research. CEEL provides a computer network of 24 terminals located in isolated cubicles. Ad-hoc software solutions are adopted to design and run the experiments. 12 cubicles are also endowed with a system to collect physiological measures like galvanic skin response. The latter is measured via the BIOPAC MP 160. CEEL also employs a lab technician who oversees all lab-related activities. In the CEEL the PhD students can design and carry out economic experiments.

Suggested skills for this research topic

The candidate should have a strong background in agricultural and environmental economics, quantitative methods including survey based research and experimental economics.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 2. Socio-Economic Risk and Impacts

Water-in-food, conflicts, and migrations

Reference Person: Riccaboni Massimo (massimo.riccaboni@imtlucca.it)

Host University/Institute: IMT School for Advanced Studies Lucca

Research Keywords:	Virtual Water
	Conflicts
	Migrations
Reference ERCs:	SH1_2
	SH7_2
	SH7_6
Reference SDGs:	GOAL 2: Zero Hunger, GOAL 10: Reduced Inequality, GOAL 12: Responsible Consumption and Production

Description of the research topic

This is an interdisciplinary research project that analyzes the causes and consequences of the water-in-food trade and the socio-economic impact of water scarcity. Water is virtually embodied in many commodities, especially food and beverages. Therefore, international trade represents a way to transfer water across borders. In principle, the water-in-food trade could enhance water efficiency by saving water in water-scarce countries which can import virtual water. Also, human migrations might be beneficial to the water endowments of origin countries for reducing the pressure on local resources. In previous studies, we have found that this vision is over-simplistic since trade and migration patterns depend on complex economic, political, social, demographic, and environmental drivers. For instance, in Metulini et al. (2016) we show that migrants strengthen the commercial links between countries, triggering trade fluxes caused by food consumption habits persisting after migration. Sometimes, when the water suitcase of migrants exceeds the water footprint of inhabitants, migration flows turn out to be detrimental to the water endowments of origin countries. On the other hand, we find that water-in-food imports in water-scarce countries help in reducing conflicts and refugee movements (Metulini, Riccaboni, and Serti, 2020). Water availability is tightly linked to Food security, intended as the ability to meet the energy needs of the world population. At present, however, there is limited knowledge of how virtual water trade affects food security. The main goal of this project is to analyze real-world data (remote sensing, trade, migration, wars, and conflicts) to simulate future scenarios of virtual water trade and its impact on sustainability. More specifically, the main objectives are (a) a better understanding of the global dynamics of water-in-food flows and (b) the evaluation of the

impact of such flows on food safety and sustainability. The project aims to inform the policy agenda of international agencies (e.G., FAO, WTO, OECD) as well as regional and national authorities to reduce the water footprint of trade and to enhance sustainable trade.

Research team and environment

The research will be conducted in an interdisciplinary environment at IMT School of Advanced Studies in Lucca. The research team is made up of the members of the AxES research unit at IMT Lucca (axes.Imtlucca.It) led by Prof. Riccaboni. The Laboratory for the Analysis of CompleX Economic Systems (AXES) is a research unit whose work spans different fields of economics: from economic theory to applied econometrics, from international economics to political economy, from spatial and urban economics to industrial organization and business economics. We all share a common interest in original socio-economic research that provides information critical to policy-making with a problem-solving approach. In our research, we incorporate skills and tools from different disciplines, including network theory, the physics of complex systems, data science, decision science, or political science. In fact, we believe that a modern approach in economics requires considering the solution of economic problems more important than sticking to academic disciplines. Under such a multidisciplinary perspective, we strive to utilize the most recent developments in big data and machine learning, seeking to combine them with more traditional econometric approaches in our research.

Suggested skills for this research topic

The ideal candidate has a background in economics, social or political sciences with an interest in international studies and sustainability. Good command of statistics, econometrics, or numerical methods will be a plus.

Type of scholarship and obligations

The type of this scholarship is: Transizioni Digitali ed Ambientali (Digital and Environmental Transitions). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 2. Socio-Economic Risk and Impacts

Sustainable mobility: models, methods and case studies.

Reference Person: Rotaris Lucia (lucia.rotaris@deams.units.it)

Host University/Institute: Università di Trieste

Research Keywords:	Sustainable logistics
	Acceptability of sustainable mobility policies
	Sharing mobility
Reference ERCs:	SH7_9 Energy, transportation and mobility
	SH7_6 Environmental and climate change, societal impact and policy
	SH1_12 Environmental economics; resource and energy economics; agricultural economics
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

Improving the sustainability of the transport system is a major challenge for the EU since a quarter of EU's greenhouse gas emissions are due to transport activities whose environmental footprint continues to rise as transport demand grows. The EU goal is to reduce by 90% the greenhouse gas emissions produced by the transport sector by 2050. The research project should be focused on how production and consumption models should change to reach this ambitious goal and on the policies that should be introduced to support this change. The acceptability of such transport supply and demand management measures should be tested and evaluated taking into account the producers' organizational and resource constraints and the consumers' socio-psychological constructs and latent attitudes.

The research project could also assess the environmental impact caused by both the production and the consumption of transport services analyzing which technological or organizational innovations could reduce it. The wide spreading paradigm of the sharing economy is significantly changing the way in which transport services are supplied and used both in densely inhabited urban areas and in peripheral rural areas. However, very little is known on the impact that these cooperative forms of transport services produce in terms of social inclusion, environmental impact, public transport use and car ownership. The research project should further explore these issues.

The research project could be aimed at studying how innovative systems for collecting, integrating, sharing and distributing products and information could be designed in order to optimize the agri-food supply chains, a sector where the adoption of the circular economy paradigm seems more promising. With reference to this specific sector, best practices of short supply chains and alternative food networks, besides the estimation of local food demand and "food miles" could be studied. The research should be aimed at analyzing how to increase the value shared by all the members of the supply chain (with particular attention to farmers' income) while improving the environmental and social sustainability of the agri-food sector. A special focus could be made on reverse logistic activities, since they allow to increase material productivity while reducing the environmental impact by ensuring that end of life products and materials used to transport inputs, components and final products that are reintroduced into the business system. Indeed, logistics service providers are increasingly looking at reverse logistics as an additional business opportunity.

An additional research topic could deal with the use of biofuels, e-fuels and green and clean energy vehicles within the supply chains for freight transport. Indeed, cost-benefit analysis and life cycle assessment of the environmental impacts produced by sustainable reverse logistics and clean energy freight vehicles of critical supply chains such as the agri-food one is seldom performed and should be further studied. The role played by consumers in fostering the transition of the supply chains and the logistic activities toward more sustainable models should be studied too.

Research team and environment

The research team is interdisciplinary drawing from the fields of transport economics, political economics, regional economics and agricultural economics. Our team is focused on high-quality research with frequent exchange between team members, the members of the department, and external academics and professionals. The unique academic environment in which our team works includes doctoral fellows, research fellows and professors in a broad variety of research fields such as economic geography, labour economics, behavioral economics, international macroeconomics, financial economics, econometrics, business management and organization, statistics and mathematics. Our activities include participation to national and international research projects, seminars with doctoral fellows and visiting professors, PhD workshops, and conferences. The recently renewed building hosting the Department and located within the main campus of the University of Trieste includes computer labs, three thematic labs in Innovation and Technology Transfer, Merceology and Economic and Political Geography, and rooms for doctoral fellows. Database access and a large variety of electronic journals in the fields of economics, finance, business, and statistics are also available.

Suggested skills for this research topic

Candidates should preferably have an academic background in applied economics, analytical capabilities, ability to handle and analyze datasets and to perform quantitative research in econometrics and social sciences. Fluency in English is recommended.

Curriculum: 2. Socio-Economic Risk and Impacts

The role of Public Administration in the transition towards a sustainable and circular bioeconomy: policies, practices and assessment methods.

Reference Person: Salomone Roberta (roberta.salomone@unime.it)

Host University/Institute: University of Messina

Research Keywords:	Circular bio-economy
	Public administration
	Sustainability assessment
Reference ERCs:	SH7_6 Environmental and climate change, societal impact and policy
	SH1_10 Management; strategy; organisational behaviour
	SH1_9 Industrial organisation; entrepreneurship; R&D and innovation
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

Achieving a sustainable and circular bioeconomy (BE) is among the EU's priorities. The link between BE and the circular economy is highly emphasized and often associated with the implementation of a sustainable production model, but the effects that new processes and new cascade recycling applications could have in terms of GHG and other emissions are not yet fully known. In fact, it is not taken for granted that circular BE strategies always and in any case involve an improvement in sustainability performances.

In addition, a sustainable and circular bioeconomy requires innovative technical solutions, but also a proper policy structure and administrative guide able to stimulate a change of production and consumption patterns and the use of waste and recycling material, taking into account possible rebound effects. Thus, understanding the Public Administration (PA) role in the transition towards a sustainable and circular bioeconomy is key because PA should promote, facilitate and enable the transition to a circular and climate-neutral economy. Indeed, PA should ensure a system change across decision-takers, as well as define proper assessment methods able to measure the sustainability of circular bio-based products and processes able to capture complexity and interdependencies, and provide a comprehensive

and objective balance useful to address the sustainability of integrated production and consumption systems.

Candidates are invited to present research proposals which may investigate one or more of the various areas of the bio-economy, may refer to different levels of Public Administration and government approaches (local, regional, national, international), and may have various object of analysis (cities, materials, technologies, etc.), but should always focus the attention on the sustainability assessment of the investigated circular bio-economy strategies/options and how PA can promote, facilitate and enable the transition.
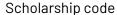
Thus, the main goals of the proposals within this call should be oriented in the understanding of: a) circular bioeconomy initiatives and approaches, adopted by the PA in their operational and strategic activities; b) successful policies and practices able to accelerate the transition; c) assessment methods useful in measuring the extent of the sustainability of circular bio-economy strategies/options. Other related goals could be explored only if focused on the organization and strategic management of PA for the development of an integrated territorial system of circular bio-economy supply chains.

Research team and environment

The research will take place at the Sustainability Lab, of the Department of Economics of the University of Messina. The Sustainability Lab is a study and research laboratory for corporate sustainability and Life Cycle Management, equipped with 5 computers, 4 printers, 1 server. Software: SimaPro Analyst, GaBi Professional, Adobe Acrobato 20 Pro, DeltaGraph, Nvivo, Vensim Pro, VOSviewer. Database: Ecoinvent 3 for SimaPro, Social Hotspot Database (SHDB) for SimaPro, Product Social Impact Life Cycle Assessment (PSILCA) for SimaPro, Ecoinvent 3 for GaBi. At the moment the researchers working at the Sustainability Lab are involved in the following projects: CRESTING CiRcular Economy: SusTainability ImplicatioNs and Guiding progress - Marie Skodowska Curie (MSCA) Innovative Training Network - European Commission (2018-2021) G.A. No 765198 - UNIME partner - http://cresting.Hull.Ac.Uk ELETTRORIGENERA Regenerative electrolysers for the conversion and accumulation of surplus electricity from renewable sources in hydrogen and efficient reuse of energy in residential applications - P.O. FESR SICILY 2014/2020, Action 1.1.5 - UNIME partner - PRIN 2017 "Promoting Agri-Food Sustainability: Development of an Italian Life Cycle Inventory Database of Agri-Food Products" (ILCIDAF) - PRIN 2017EC9WF2_002 - UNIME partner THALASSA - TecHnology And materials for safe Low consumption And low life cycle cost veSSels And crafts - PON "Research and Innovation 2014 and 2020" and FSC - Progetto ARS01_00293 - CUP B46C18000720005

Suggested skills for this research topic

We are looking for candidates with a background or experience within at least one of the following areas: Sustainability Management, Industrial Ecology, Industrial Management, Environmental Sciences, Sustainability Assessment. The person we look for is expected to

have: Good command of written and verbal English; Proficiency in advanced computer skills including Microsoft Word, Excel, PowerPoint and Outlook, as well as other products included in Microsoft Office 365 Business; Ability and willingness to work in collaborative, multi-disciplinary environment, with an inter-disciplinary approach and interest, and preferably with documented experience of both quantitative and qualitative research work; availability to stably work in Messina but also to travel and move whenever required; knowledge and understanding in environmental systems analysis, like life cycle assessment, is seen as a merit; proven record of designing and writing scientific publications is desirable but not required.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Curriculum: 3. Technology and Territory

Carbon reduction target: supporting the energy-environmental management studies (with a focus on consulting services)

Reference Person: Anglani Norma (norma.anglani@unipv.it)

Host University/Institute: University of Pavia

Research Keywords: competences	Energy-environmental studies, enhancement of professionals' competences
	Artificial intelligence and machine learning
	Optimized energy configurations from the carbon neutrality standpoint
Reference ERCs:	PE7_2
	PE7_3
	PE7_12
Reference SDGs:	GOAL 4: Quality Education, GOAL 7: Affordable and Clean Energy, GOAL 9: Industry, Innovation and Infrastructure, GOAL 11: Sustainable Cities and Communities, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

The pragmatic objective of the research is an enhancement in innovation of processes and services in the energy-environmental consulting area.

The main aim is to support the job profile of professionals in the environmental-energy consulting field by providing more interdisciplinary tools related with the concept of sustainability (specifically, carbon neutrality) and therefore a partnership with an already identified consulting company in the energy field will strengthen the project.

Carbon neutrality means the full offset of an equivalent level of carbon dioxide emissions, due to a specific activity, event, product, or service.

All sectors -from industry to the civil sector- are called to contribute to this achievement and the role that energy consultants will have to play, will become increasingly crucial.

The research will focus on the use of artificial intelligence (AI)/ machine learning (ML) techniques to improve (i) both benchmarks in the elaboration of energy-environmental models (from a microgrid up to a whole service), and (ii) the reliability of the results of the studies, in support of a progressive carbon neutrality.

Practically, how to use new techniques, will allow to establish unconventional correlations between different datasets for the evaluation of appropriate Key Performance Indicators (KPIs), addressing in a more and more precise way the technical-economic feasibility of an energy efficiency action or measure.

Not only AI/ML will be used but also LCA approach (life cycle assessment) under the carbon footprint standpoint will be applied to services (as for instance to a local healthcare system) or product such as a power converter (one of the major elements for the spreading of more renewable and smart/ microgrids) to study their impact.

Methodologically, the work of the candidate will start with a bibliographic analysis of the current use of AI/ML techniques in the field of energy consulting, still in its infancy, and it will proceed with the search for open-source datasets and cataloguing of potentially useful information, depending on the studies to be produced, constantly interfacing with the company.

Then it will move on to analysis tools by evaluating the use of useful packages for scientific calculation, machine learning and processing on large data (i.E. Anaconda, an open source distribution of Python (and R)). The choice of the tool is important especially considering market-oriented applications, which must efficiently support the presentation to the customer of the used methodology.

In this context, AI/ML is seen as a set of approaches, methods, and technologies helping to consider - with an increased degree of autonomy and reliability - possible relationships between information, which cannot be directly linked. This, to support the identification of benchmarks, useful to assess the energy/economic impact of actions/ technologies that lead progressively to carbon neutrality of for instance the LCA studies

Objectives and results: proficiency in the use of these tools allows to create an analytical ability to search for the best tools to refine the investigation and to correlate information supporting the energy studies towards carbon-neutrality.

Research team and environment

The candidate will be part of a wide-interest small research group, mainly made up of electrical and electronic engineers, all devoted to research dealing with energy management and power electronics, nonetheless the candidate will be able to benefit by the wide international contacts the group has been building over the years and also from the presence of AI/ML teams working at UNIPV.

The group (affiliated to the energy lab -LABEN- and power electronics Lab PEDEN1) is made up of one full, one associate professor, one assistant professor (from 2022) and several PhD candidates. Exchanges and stages abroad are encouraged to foster an open minded and fruitful personal growth. The candidate will have to be keen to group work.

Besides, the partnership with the consulting company will provide several assets such as: i) the PhD candidate will split her/his time between the university lab (first period) and the

company (last period), so to test the new skills on AI/ML and LCA on international case studies, ii) the research activities will be carried out along with a placement activity. This is also in favor of an action of empowerment of PhD holders in the energy consulting companies

PI CV: Prof Norma Anglani received her MEng degree in Electric Engineering and her Ph.D. In Electrical Engineering from the University of Pavia (Italy) in 1993 and 1999 respectively. Since 1999 through 2001 she has been post-doctoral fellow at the Lawrence Berkeley National Laboratory both in the Energy Analysis Group and in the Energy Efficiency Standards group. She is now Associate professor at the University of Pavia, Italy and her research field is energy efficiency and energy modelling. She was visiting scholar at Nottingham University, NTNU, Trondheim (Norway) and Northeastern University, Boston USA). She has published over 70 peer reviewed scientific papers.

Professor Anglani is currently IEEE Senior member, IEEE WiE member, IEEE-IAS and IEEE-PELS member. She served as IEEE-IAS WiE Liaison for the term (2019/2020). She is associate editor of the IEEE Transactions on Industry Applications, Guest Associate Editor for the Special Section on Emerging topics of power electronics interfaced battery energy storage system. She was in the Organizing Committees of ECCE since 2017 - through 2023 as WiE Chair, as well as Publication Chair, Vice Chair, Topic Chair, Session Chair and Reviewer and Speaker.

Norma Anglani has been PI and Co-PI in industrial, EU and government funding bodies' grants and she holds collaborations with foreign institutions around the world.

Her research interests are in the area of energy and optimization of the energy resources both for industrial processes (e.G. Compressed air systems and use of efficient technologies) and for the civil sector. Currently, she is responsible for research activities in the field of energy management and have been supervised the works of several PhD students and junior researchers working on hybrid micro-grid and energy systems planning and optimization. Main scientific publications deal with (i) the role of renewables and the feasibility of hybrid micro- grids also in developing countries, remote settings and portable renewable generators with storage; (ii) compressed air systems and their optimization; (iii) a new energy system model for the sustainability of the Lombardy Region. Recently she was the PI for the elaboration of the next Sustainable Energy and Climate Action Plan (SECAP2019) with respect to the energy-related issues.

Https://scholar.Google.lt/citations?user=kadlE0EAAAAJ&hl=it

For this scholarship a period of internship is planned at *ALENS SrL, Pavia, an energy and environmental consulting company*

Suggested skills for this research topic

An electrical or energy engineering background is favourable for approaching the complexity of an energy/environmental study but also environmental engineering with a focus on renewable energy can be a suitable origin field.

Basic knowledge of Python or knowledge on ML/AI techniques is a very welcome addition

Type of scholarship and obligations

The type of this scholarship is: Dottorati Innovativi (Innovative PhD courses). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 3. Technology and Territory

Ocean space utilization for energy harvesting purposes

Reference Person: Arena Felice (arena@unirc.it)

Host University/Institute: Mediterranea University Of Reggio Calabria

Research Keywords:	Water wave mechanics
	Energy harvesting
	Offshore engineering
Reference ERCs:	PE8_3
	PE8_5
	PE8_6
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 9: Industry, Innovation and Infrastructure, GOAL 13: Climate Action

Description of the research topic

The research program deals with the development of offshore islands (as fixed or floating structures) for ocean space utilization, in which wave (marine) energy is exploited for energy supplying and to reduce CO_2 emissions.

The research activities will be developed by considering:

-       analysis and development of innovative models, analytical and/or numerical, of marine structures (i.E. Fixed breakwater, offshore floating structures), with OWC devices;

-       study of the hydrodynamics problems for the modelling of large floating structures, including structures in which OWC devices are embodied;

-       risk analysis of marine structures in severe meteocean conditions, by taking into account extreme waves during sea storms; this analysis will include the study of the action of extreme waves (freak waves) on the OWC wave energy converters;

-       data processing from experimental activities with physical modeling of Oscillating Water Column systems, on fixed and floating structures. These data are available at NOEL laboratory.

Both Monte Carlo approaches and experimental data will be used for the analysis of the dynamic response.

The hydrodynamic analysis will be conducted in the context of the potential theory for an irrotational flow with a free surface (to determine excitation forces, added mass and radiated damping).

Research team and environment

The research team operates at the NOEL (Natural Ocean Engineering Laboratory): a laboratory established within UNIRC. It is composed by a highly specialized team working in the field of ocean engineering and marine energy. Actually, the team involves 1 Full Professor, 2 Associated Professor, 3 Researchers, 2 Post-docs and 2 PhD Students. The team has a 30-year experience in conducting field experiments on small-scale models of marine structures and of wave energy harvesters at the NOEL natural basin. This laboratory is a unique environment where experimentalists can pursue tests with the support of sensors, acquisition data center and specialized personnel established permanently in the laboratory infrastructure facing the basin (for details see www.Noel.Unirc.It).

The mission of this group is to utilize the knowledge acquired in the field of marine and civil engineering to develop novel methodologies in the analysis of the wave phenomena and of the wave climate, for wave structure interaction (floating or fixed structures). The group is also involved in the analysis of coastal structures for protection purposes (for instance caisson breakwaters), in the development of novel coastal structures hosting devices for wave energy harvesting, in the development of experimental activities for testing floating offshore wind turbine models, and in the testing of the prototype of an offshore multipurpose platform for fish farming and exploitation of wind and wave energy (Horizon 2020 project The Blue Growth Farm 774426).

Suggested skills for this research topic

Fluid mechanics

Wave mechanics

Random process theory

Dynamics of structures

Numerical analysis

Physical modelling

Algorithm coding (Fortran, Matlab, Python, etc.)

Curriculum: 3. Technology and Territory

Development of nanostructured electrolytic materials for more sustainable batteries

Reference Person: Bordiga Silvia (silvia.bordiga@unito.it)

Host University/Institute: University of Torino

Research Keywords:	Solid-state battery
	Inorganic synthesis
	Physico-chemical characterization
Reference ERCs:	PE4_8
	PE5_6
	PE3_4
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

Digital transition cannot take place without a great improvement in the technology for electricity management, in order to deeply exploit alternative energy sources and accounting for the growing demand of power. In this scenario, devices for energy storage and transfer (such as rechargeable batteries) are destined to play a predominant role, requesting more and more efforts for their optimization. As a matter of fact, even a modest increase in process efficiency is likely to result into huge environmental and economic benefits, because of their widespread application.

In particular, conventional batteries atone for the use of liquid electrolytes, typically based on flammable and toxic organic solvents, posing serious limits in terms of stability and user safety. Moreover, the introduction at the end of last century of lithium as an energy vector (recently awarded with the Nobel prize), despite having greatly increased the batteries efficiency, has led to an unexpectedly high consumption of that metal, arising some concerns about its future availability and the long-term sustainability of this technology (especially considering the so far inefficient recycling strategies).

Therefore, the research for innovative materials, whose large-scale production would be more affordable and economical, that can anyhow compete with the state-of-the-art batteries, is indispensable and cannot be postponed.

In the last decades, the biggest breakthrough in that sense has been represented by the development of solid-state batteries, where the two electrodes are connected by a solid electrolyte. Despite the great interest of the scientific community on this topic, there is still space for innovation, either by optimizing the materials already proposed for this application or by designing new ones. Such materials are mostly ceramics, where the electronic properties are determined by the redox behavior of inserted heteroatoms, the crystalline structure and the morphology of the particles.

The aim of the PhD project is the development of new inorganic solid-state electrolytes, prepared through the most common protocols of chemical synthesis (including sol-gel and solvothermal processes, chemical vapor deposition, and electrospinning), then testing them into electrochemical application to evaluate the conductivity, the potential range of stability and the cyclability in time of the charge/discharge process.

Afterwards, the most promising materials will be deeply investigated by advanced spectroscopic methods to correlate the high performances with specific structural features at a molecular level, so that some fundamental guidelines can be extrapolated and generalized.

Finally, it is worth noticing that also the synthesis itself of these materials can arise some concerns, especially because of the chemicals used as solvents and additives. Therefore, once a material (or a class of materials) will be selected, some ecofriendly solutions will be explored for the preparation, always evaluating the overall costs-profits balance of the process. For instance, it has been already demonstrated that in many cases the traditional volatile organic solvents can be effectively replaced by less expensive, easily accessible, and non-toxic deep eutectic solvents.

Research team and environment

The PhD project will develop in the frame of a collaboration between the Group of Physical Chemistry at the University of Torino and the Group for Applied Materials and Electrochemistry at the Polytechnic University of Torino (in the person of professor Claudio Gerbaldi).

The former Group has a renowned experience in the synthesis of inorganic and metalorganic materials and their characterization through spectroscopic, microscopic and diffractometric methods, whereas the latter Group is expert in the development of innovative electrolytes and their application into ecofriendly energy storage and conversion devices (as respectively testified by the above uploaded publications and funded projects).

Both Groups are well equipped for the manipulation of air-sensitive samples, through the use of glove-boxes and Schlenk lines, together with custom experimental setups for characterizing the samples in operando conditions and for testing them in commercial-like applications. Furthermore, some experiments at international large-scale facilities (such as synchrotrons and neutron sources) are prospected, upon submission of specific proposal, thanks to the long-standing experience of both Groups in these activities.

More in general, all the national and international ongoing collaborations with other academic institutes and Companies will provide the PhD student with a very dynamic environment, offering several possibilities for his/her mobility and keeping him/her in constant touch with the needs of the modern society.

Finally, the geographical proximity of the two Institutes constitutes a not negligible advantage, promoting a strong and frequent connection between the two units, thus overcoming the difficulties in the communication among the two different sectors.

Suggested skills for this research topic

The PhD candidate can be a chemist, a material scientist or a chemical engineer, he/she should have a solid knowledge of electrochemical fundamentals and processes, and good skills in chemical synthesis and in computational data processing. Most important, he/she should be well disposed towards discussion and team works.

Curriculum: 3. Technology and Territory

Highly emissive materials for energy-efficient devices, photovoltaic and photocatalytic systems

Reference Person: Brenna Stefano (stefano.brenna@uninsubria.it)

Host University/Institute: University of Insubria

Research Keywords:	Emissive materials
	Energy-efficient devices
	Photovoltaic and photocatalytic systems
Reference ERCs:	PE5_9 Coordination chemistry
	PE5_6 New materials: oxides, alloys, composite, organic-inorganic hybrid, nanoparticles
	PE4_15 Photochemistry
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 9: Industry, Innovation and Infrastructure, GOAL 11: Sustainable Cities and Communities

Description of the research topic

A promising approach to reduce energy consumption relies on the fabrication of new materials devoted to energy efficiency, especially those which exploit the interaction with light in their performances. In view of this, the search for highly emissive materials is a major objective for chemists and material scientists since they represent a key target for many lighting applications. An example of these devices are organic light-emitting diodes (OLEDs) which use red, green, and blue emitters, with the latter covering about 50% of the total pixel area of the display. While great success has been achieved in the fabrication of red and green phosphorescent OLEDs (Ph-OLEDs), many efforts are still devoted to developing a proper blue counterpart. The main objective of this PhD project is thus the search of new emissive materials to be implemented in energy-efficient devices (i.E., OLEDs) in photovoltaic or photocatalytic systems. The work will configure as a continuation of a PhD project conducted in a previous cycle, focused on the synthesis of blue emissive materials based on imidazo[1,5-a]pyridines, an interesting class of dyes characterized by large Stokes shifts, good photostability and high quantum yields. The PhD candidate will implement this class of compounds and will design and prepare new functional materials with better performances. The work will first focus on the synthesis and full characterization of the compounds, both in solution and in the solid state, to achieve information on the molecular structure of these species. The optical properties of these materials will then be thoroughly investigated in

solution, in the solid state and as thin layers when dispersed in a host polymeric matrix. Thanks to the collaboration with Prof. Klaus Meerholz, Chair for Organic Electronics Group at University of Cologne, the most promising compounds will be integrated into OLED devices and tested for their efficiency. Structure-properties relationships will be established by combining experimental data and theoretical approaches. In particular, the results obtained from DFT calculations will reveal crucial in directing the design of new molecules to be implemented in better performing materials.

Research team and environment

The research project will be conducted at the Inorganic and Organometallic Chemistry Labs of the Department of Science and High Technology, University of Insubria. The PhD candidate will operate in fully equipped labs for advanced inorganic and organometallic chemistry synthesis. He/she will have direct access to a complete list of instrumentation needed for the spectroscopic characterization of the samples (FT-IR, NMR, HPLC LC-MS, ICP-MS, GC-MS, TGA/DSC). The labs are also equipped with different UV-vis spectrophotometers and steady state and time-resolved fluorimeters, which will allow full investigation of the photophysical properties of the emissive materials, both in solution and at solid state. Additional equipment for electrochemical measurements, variable-temperature photoluminescence studies, spin coating, photocatalytic reactors are also available.

The daily work will be supervised by the reference person, with the support of all the research team, in particular Prof. Attilio Ardizzoia (expertise in synthesis and DFT calculations) and other PhDs and/or PostDocs. The established international collaborations with Prof. Bruno Therrien (University of Neuchatel, X-ray diffraction), Prof. Julien Furrer (University of Bern, advanced multinuclear NMR experiments) and Prof. Klaus Meerholz (University of Cologne, device fabrication) will allow the applicant to interact with chemists and materials scientists with multidisciplinary expertise.

Suggested skills for this research topic

A Master Degree in Chemistry is required to apply for this position. Advanced scientific and technical knowledge in all disciplines of chemistry, materials science, catalysis. Strong expertise and previous experience in inorganic and organometallic synthesis, characterization of inorganic and coordination compounds and spectroscopic examination of their reactivity are advisable. Expertise in organic synthesis will also constitute a plus. Transferable skills: research skills from fundamental to applied, critical approach to problems, capability of autonomous operations; effective time management and organizational skills to meet the deadlines; good communication skills, also in an international context.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 3. Technology and Territory

Nonlinear technologies for green energy control

Reference Person: Buscarino Arturo (arturo.buscarino@unict.it)

Host University/Institute: University of Catania

Research Keywords:	Sensors
	Networks
	Green energy optimization
Reference ERCs:	PE7_1
	PE7_12
	PE7_11
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 9: Industry, Innovation and Infrastructure, GOAL 11: Sustainable Cities and Communities

Description of the research topic

The research topic focuses on the optimal management of energy from renewable sources. The topic will cover the optimal distribution of the energy in a network as well as the use of innovative sensors and technologies to guarantee the optimal quality of the electrical power parameters, such as voltage and frequency. The main aspect of the research will hinge on the use of nonlinear technologies, and, in particular, nonlinear dynamical behavior of the components of the network, in order to enhance the energy scheduling allowing the just-in-time production and distribution of energy among more nodes (users). This is conceived by using a strategy that is controlled by chaotic signals. In fact, it has been recently proved by the reference person for a limited number of nodes that this strategy is effective. The aim is to generalize these results for a complex integrated green network with extended number of users. Moreover, each user should be guaranteed that the main parameters of the electrical quantities are effectively controlled and supervised. This will concern the second part of the research, where it will be considered a novel class of sensors based on the concept of nonlinear resonance behavior of peculiar devices able to detect the frequency drifts. Therefore, a network of such devices that can also be digitally implemented and installed in a platform based on recycled smartphones.

The main guidelines that the PhD programme will cover consists in improving the integration of renewable energy sources to conceive new control strategies and low-cost and green sensors achieving a complete optimization of the energy distribution systems. The tasks of

the research will lead also to consider the previously introduced aspects to improve the efficiency of networks devoted for power supply of recharge stations for electrical cars.

The research is, therefore, organized in the following tasks:

1. To consider green energy plants integrated in classical electrical networks, such as a complex system.

2. To adopt innovative strategies based on nonlinear technologies in order to optimize such networks, by using low-cost and green devices.

3. To use the product of the research in order to improve the quality of life in cities as regards the improvement of the local electrical networks used for sustainable mobility.

The PhD programme is therefore organized to allow the candidate, starting from the innovative results obtained by the reference person in the mentioned area, to develop the tools that can be made available to the Institutions in order to improve the quality of the environment. One of the educational aims of this project is spreading the idea that both nonlinear systems and imperfect systems, if well studied, can lead to an improvement in the global behavior of the considered networks.

Products of the research will be:

1. New control paradigms;

2. Development of green sensors and smart networks eliciting a circular economy;

3. Development of strategies devoted to transfer this knowledge not only in the area of sustainable electrical networks but also in the more general framework of networked systems.

Research team and environment

The research team consists in professors from the Dipartimento di Ingegneria Elettrica e Elettronica of the University of Catania, people involved in the Istituto Nazionale di Geofisica e Vulcanologia of Catania and from STMicroelectronics. Therefore, the various labs of the three institutions will cooperate during the PhD. Moreover, the research team will be supported by the facilities of the National Research Council (CNR) - Institute of Systems Analysis and Computer Science "A. Ruberti" and the ENEA - Frascati nuclear fusion labs. The research activities will be also developed with the involvement of the research labs at the TU Eindhoven (The Netherlands) and at the University of Cambridge (United Kingdom). The international support of the PhD project will be given by the University of Wisconsin - Madison (USA) and from MediaTek (USA).

For this scholarship a period of internship is planned at *Istituto Nazionale di Geofisica e Vulcanologia - Sezione di Catania*

Suggested skills for this research topic

Master degree in the area of Industrial, Electrical, Electronics or Computer Science Engineering.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 3. Technology and Territory

Smart zero-carbon buildings and digital twins

Reference Person: Casini Marco (marco.casini@uniroma1.it)

Host University/Institute: Sapienza University of Rome

Research Keywords:	Energy efficiency of buildings
	Smart buildings
	Digital building twins
Reference ERCs:	PE6_7 Artificial intelligence, intelligent systems, multi agent systems
	PE7_3 Simulation engineering and modelling
	PE8_3 Civil engineering, maritime/hydraulic engineering, geotechnics, waste treatment
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 7: Affordable and Clean Energy, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

Reducing carbon emissions of buildings will be critical to achieve the Glasgow climate goals and reach net zero emissions targets by 2050. It is therefore urgent for all countries to focus on how to make buildings more energy-efficient, less carbon-intensive over their full life cycle, and more sustainable.

In this picture, the integration of digital technologies in buildings can be a cost-effective solution to enable healthier and more comfortable spaces with a lower energy use and carbon impact and can also facilitate the integration of renewable energy sources in future energy systems. The ultimate goal is to achieve smart energy buildings perfectly integrated into their environment, connected to the global network and able to receive, process and take advantage of data and information to communicate with their users and share their infrastructure with that of the city and the transport systems, acting as funding elements for a wider, highly efficient urban system, delivering better quality services for citizens and accompanying benefits such as local job creation, health, and well-being. With the increasing diffusion of BIM and IoT devices, the future of both building operation and maintenance is represented by the digital twin technology, which promises to revolutionize the way buildings are managed and maintained by transforming them into a rich ecosystem of data and insights provided by AI.

Research activities shall focus on developing and testing new models, more efficient, secure and affordable technology and systems with in-built intelligence, to allow real-time smart management for new and existing buildings and districts and foster mass take-up of energy efficiency and energy saving solutions for the transition towards a net-zero carbon and circular built environment. Integration of renewable energies, electric storage, demand response and V2B technologies will be investigated, along with smart grids, smart meters, and microgrids, also considering the role of green hydrogen in decarbonization of buildings. Particular attention will be given to the new, AI-empowered advanced building control strategies based on Model Predictive Control (MPC) and Machine Learning. Applications of Digital Twin, Extended Reality (VR, AR and MR) and Robotic technology in building operation and maintenance will be also studied, evaluating the advantages in supporting management tasks and strategic decision making, along with the new tools such as building renovation passport (BRP) and digital building logbooks (DBL) to promote the buildings as material banks (BAMB) concept and the circularity of materials in construction.

The results of this investigation are expected to provide valuable insights on how digitalization and innovative technologies and systems can transform the way that infrastructure, real estate and other built assets can be operated and maintained in order to provide a more comfortable, energy efficient, sustainable, cost-effective and smart built environment.

Research team and environment

The research team is composed by an interdisciplinary group with extensive collaborative academic and industrial networks in Italy, Europe and globally, which includes, in addition to the reference person Prof. Marco Casini, the professors Livio De Santoli, Carlo Rondinini, Maurizio Barbieri, Fausto Manes, Angelo Lalli, Mariella Nocenzi, and Maurizio Muscaritoli, all members of the ""Sapienza Scientific-Technical Commitee on Sustainability"".

The research activities will be carried out in an integrated environment within the Department of Urban Planning, Design and Technology of Architecture (PDTA), of Department of Aerospace, Electrical and Energy engineering (DIAEE), and of Department Computer, Control, and Management Engineering (DIAG) and the Interdepartmental Research Center for Territory Buildings, Environment and Restoration (CITERA), of Sapienza University.

Suggested skills for this research topic

In order to perform successful research, a master's degree in a technical-scientific area is needed (Civil, Building, Environmental or IT engineering). Ideally, the successful candidate should be able to work in a multidisciplinary team and an international context and have a basic knowledge of:

-        Energy efficiency in buildings, renewable energy resources, building automation systems, smart grids, Building facility management, Digital Building Twin

- Building information modelling and computational design

- Building performance simulations tools (EnergyPlus, Modelica, LCA tools, etc.)

- Programming tools such as matlab/simulink/plecs/C sharp/python

- Big data analytics and artificial intelligence techniques (neural networks, machine learning, etc.)

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Curriculum: 3. Technology and Territory

Assessing green infrastructures' mitigation effects by geo-data and simulation

Reference Person: Causone Francesco (francesco.causone@polimi.it)

Host University/Institute: Politecnico Di Milano

Research Keywords:	Green infrastructure
	Numerical modelling
	Geo-reference data analysis
Reference ERCs:	PE8_3
	PE8_6
	PE8_11
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

Green infrastructures are often proposed as nature-based solutions viable to provide wide ecosystem services, including extreme-climate effects mitigation, especially in urban environments. However, the scientific literature lacks of quantitative information about the potential climatic effects of green infrastructures, differentiating between size, density, and typology of vegetation. Designers, thus, lack of both benchmarks and tools to design and assess potential benefits of new urban green infrastructures, to mitigate, for example, urban heat island (UHI) effects. The proposed research aims at bridging this knowledge gap by combining geo-referenced data (e.g., via Copernicus database) together with ground thermo-physical measurements, to validate numerical models (typically CFD models or hybrid multi-physics models), describing the green infrastructure. The activities will be both experimental, by using an already developed (by the host institution) wireless instrumentation, dedicated to measure all the useful thermo-physical parameters necessary to assess the outdoor climate conditions (with high time resolution), and numerical, by both investigating and using geo-data (with high space resolution) and developing numerical models (e.g., CFD models). After an adequate literature review, foreseen to both evaluated all the available database and techniques that might be used for the purpose of the work, the candidate will establish a clear methodology, that will include: (i) database investigation and data gathering; (ii) data processing; (iii) data analysis; (iv) numerical model development; (v) validation; (vi) case study application. The expected outcomes are: (i) a validated methodology to quantitatively assess the climate benefits provided by green infrastructure

to the urban environment; (ii) a tool to support designers in the performance-based design of green infrastructures; (iii) a case study, to be agreed upon by parties, analysing how different greening scenarios influence the outdoor climate conditions under different (present and future) climate scenarios (estimated using different emissions scenarios, i.e., RCP 4.5 - 8.5). The candidate will improve his/her knowledge in urban physics, including heat and mass transfer, applied thermodynamic and energy modelling of buildings and green infrastructures. He/she will furthermore gain modelling skills and critical knowledge on the usage of dynamic simulation tools (e.g., CFD), he/she will substantially improve his/her skills on data analysis and investigation of geo-data and eventually he/she will gain experience on thermo-physical measurements in field. These multidisciplinary skills will represent a huge advantage for future careers both in research and in design, furthermore they will help establishing a unique mind-set for decision makers on climate change related topics.

Research team and environment

The Buildings' Environment and Energy Systems (BEES) research group is made of 1 full professor, 4 associate professors, several post-doc fellows and Ph.D. students, all active at the Energy Department of the Politecnico di Milano. The team has a good experience on both energy and CFD analysis of single buildings and urban assemblies and its already supervising M.Sc. and Ph.D. thesis projects on related topics. The team was involved in a 2-years research project, funded by ENEA, for the development of an experimental technique to assess outdoor climate conditions in urban environments and within this framework it developed a dedicated experimental station to measure all the useful thermo-physical parameters necessary to assess the outdoor climate conditions with high time resolution. The research group is also part of the GEOLab at Politecnico di Milano, that involves several departments interested and active on the use of geo-data for different research purposes. The Lab is part of the wider Copernicus Academy Network.

The team is active in 2 EU funded research projects (Sharing Cities and NRG2peers) and is PI of a recently funded PRIN projects (URBEM), all about the modelling of complex urban environments for the creation of smart city services, including energy communities. Within the framework of these projects a substantial expertise on energy and environmental data analysis has been developed, including large database analysis via machine learning techniques.

The team also provides industrial consultancy activities, and won as Environmental Expert of the Co-inventing Doria project, the first edition of Reinventing cities contest, for the design of carbon-neutral communities.

For this scholarship a period of internship is planned at *Comune di Milano, Milano*

Suggested skills for this research topic

The candidate needs to have knowledge and skills on heat transfer and CFD modelling. Some experience with ANSYS Fluent and/or OpenFOAM is welcome. He/she needs to have some skills in data analysis, such as clustering analysis, database investigation. Some knowledge

in coding is welcome (e.g., Python, C++, R, Matlab, etc.). Attitude and interest toward sustainability and urban related climate change effects is essential.

Fluency in Italian is required, due to the tight collaboration with the technicians at the Municipality of Milan, further than fluency in English.

Type of scholarship and obligations

The type of this scholarship is: Pubblica Amministrazione (Public Administration). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 3. Technology and Territory

Photoelectrocatalytic conversion of CO2 for sustainable and resilient energy management

Reference Person: Centi Gabriele (centi@unime.it)

Host University/Institute: Università degli Studi di Messina

Research Keywords: CO2

                                Solar fuels

                                Smart energy management

Reference ERCs: PE4_10

                                PE4_12

                                PE4_4

Reference SDGs: GOAL 7: Affordable and Clean Energy, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

The thesis has the objective to develop integrated competencies for the organization and strategic direction in public administrations of the renewable energy value chain. The Doctorate aims to develop, by using a specific case example on which focus the study, knowledge, and competencies for:

1. Participation in the organization and strategic direction of public administrations (local, regional, national) to develop innovative strategies for the renewable energy value chain

2. Develop research paths to valorize management competencies, leadership, and communication skills for public organizations, including in the human resources area, in reference to the renewable energy sector

3. Reinforcement of the administration capabilities to develop public politics and decision, implementation, and evaluation tools in the energy sector.

The specific case example around which are built above competencies is a key technology to accelerate the transition to the replacement of fossil fuels and close the carbon cycle: the development of devices called artificial leaves to produce solar fuels in a distributed approach capable of integrating more effectively with the territory and its resources, enhancing its resilience, and with a direct boosted contribution to reduce the emissions of CO2 (both reusing this molecule and using solar energy for its conversion) and the territory impact on climate changes.

This objective requires a holistic system approach, which integrates fundamental knowledge of applied, engineering and industrial, and socio-economic aspects. The proposed research integrates fundamental studies on materials and mechanistic aspects, with the technological and engineering development of the devices, with analysis also of socio-economic aspects related to the use of these devices and their impact on the mitigation of CC and the replacement of fossil fuels.

The aim is thus to provide, by investigating the development of a specific critical technology, integrated by the additional competences and educational activities given both at the local and national level through the National Doctorate, both the technological and additional skills which allow promoting the human capabilities for proper management and strategic direction of the relevant area of sustainable energy.

The study will address the development of artificial leaves to produce solar fuels to be used for local renewable energy chains, a priority indicated in recent national priorities to promote the sustainability of regions in the south of Italy. Specifically, the aim is a decentralized production/storage to boost the transition to "intelligent" forms of energy generation and distribution.

Artificial leaves are devices that use solar energy to convert molecules such as H_2O, CO_2, and N_2 (widely available) into solar fuels (H_2, methanol, NH_3, respectively), acting as chemical energy storage molecules for transport and distributed use of renewable energy (solar) replacing the need of fossil fuels, therefore drastically reducing greenhouse gas emissions, with an enhancement of local renewable energy resources, overcoming the limits associated with fluctuations in demand and load imbalances in the renewable energy production.

Research team and environment

The research team where the PhD student will operate is composed of two full professors, four associate professors, three researchers, and about 15-20 PhD/post-docs on aspects related to the development of sustainable processes for chemistry and energy (are industrial chemistry and engineering), with an interdisciplinary approach combining chemistry, material science, engineering, and physics.

The research team has many running international EU projects, including an ERC Synergy, and well established international (worldwide) collaborations and networks with research centers and companies in the area of catalysis for clean energy and CO_2 conversion, sustainable processes, and technologies beyond fossil fuels.

The students will operate at the CASPE center (Laboratory of Catalysis for Sustainable Production and Energy) of the University of Messina (and reference center for the

InterUniversity Consortium INSTM on science and technology of materials, which has spaces and advanced equipment (ww2.Unime.lt/catalysis) suitable for carrying out the planned research.

The spaces available to the CASPE center, following the recent renovation, are approximately 550 m2 (in five modules, two of which are dedicated to laboratory systems for catalytic testing (including photo and electrocatalytic systems), three for the instrumental characterization of catalysts, and their synthesis. The research will deal with the development (synthesis, characterization, and testing) of the nanomaterials/electrodes for the artificial leaf device, their study, and engineering, and the assessment of the technology. PhD students will typically operate in close collaboration with other early-stage researchers, under direct supervision by one or more experienced researchers, and one professor.

Suggested skills for this research topic

Scientific/technical knowledge on: chemistry, material science, industrial chemistry and catalysis, engineering of devices, characterization of solids, testing of photo/electro materials, analysis of the mechanisms of solarinduced processes in nanomaterials, assessment methodologies.

Transferable skills: team working in an international context, a problem-solver approach and critical thinking, research skills from fundamental to applied and industrial, capability of autonomous operations and leadership, managing and report in international projects, communication skills.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 3. Technology and Territory

Biochar for Carbon Capture and Sequestration and accounting

Reference Person: Chiaramonti David (david.chiaramonti@polito.it)

Host University/Institute: Politecnico di Torino

Research Keywords:	Biochar as a tool for carbon sequestration
	Long term carbon fixation in the soils
	Carbon offsets accounting in agricultural land
Reference ERCs:	PE10_3: climatology and climate change
	PE8_11 Environmental engineering, e.G. Sustainable design, waste and water treatment, recycling, regeneration or recovery of compounds, carbon capture & storage
	SH1_12: Environmental economics; resource and energy economics; agricultural economics
Reference SDGs:	GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

This research project will contribute to the development and upscaling of a versatile and efficient negative emission technology for decarbonisation: biochar. The project aims at optimizing the carbon sequestration potential offered by biochar production, map its applications in the agricultural sector and improve the accounting of its emission offsetting potential.

The use of biochar, a carbon-rich material produced from the pyrolysis of biomass, allows for creating a stable carbon sink. The resulting "Recalcitrant Carbon" can remain in a stable form for decades, being a real, reliable carbon sink. This approach of Bio-Carbon Capture and Sequestration (BioCCS) that uses biochar as a soil amending material offers the further advantage of being easily verifiable and measured.

However, to date, the use of biochar for emission offsetting is still in its infancy, despite its highly promising features, due to the need for further technological testing and advancements, and because of a lack of a clear framework to transparently account for its use.

The planned activities for the PhD research encompass experimentations and analysis at a pilot level, for the production of biochar. The production of biochar can rely on different advanced feedstock, for instance recovering the organic fraction of wastes, or other organic

materials and/or residual lignocellulosic streams. Different feedstock will be tested in the project, and the resulting product characterized for possible applications.

The research will also address existing and innovative methodologies for the generation and accounting of carbon credits, starting from a review of existing practices. Currently, the process of certifying emission offsets as stable carbon in the soil in the form of biochar is not clearly articulated in any legislative framework. Country governments and companies are highly interested in this application to achieve their decarbonization commitments, but for now the accounting of emission reductions through this pathway remains ambiguous. The project will develop new methods of accounting for emissions in production, distribution and consumption activities and models of knowledge, measurement and monitoring of the effectiveness of the actions. The research will be of paramount importance to create a sound scientific background for adopting biochar as a negative emission technology at the policy and legislative level, as well as for corporate use.

Overall, the research will contribute to the definition of actions to mitigate the impacts of climate change and to promote of sustainable development, as a contribution to the green recovery and to overcoming the effects of the crisis in the context of the COVID-19 pandemic. The research is in line with the provisions of the National Research Program, in the field of research and innovation ""Climate, energy and sustainable mobility"", and will provide concrete instruments to create a more resilient and circular economy.

Research team and environment

The study requires an interdisciplinary approach and thus the PhD student will need to be supported by a diverse team. The current group collaborating with Prof. Chiarmonti encompasses all the required skills, with internationally recognized experts on thermochemical conversion processes, catalyst development, bioenergy and sustainability analysis. Currently the group consists of a senior researcher, 3 PhD students and works in strong collaboration with the Chemistry Dept. Of POLITO.

Prof. Chiaramonti is also president of the no-profit research body RE-CORD, which owns several unique pilot-scale reactors, a chemical lab fully dedicated to bioenergy and a group of experts.

Moreover, the existing collaboration with the socio-economic experts' group led by Prof. Cambini will effectively complement the existing skillset, offering to the PhD student a wide and simulating environment, in which to develop his/her researcher.

Suggested skills for this research topic

The ideal candidate should:

-        have to a sufficient background on renewable energy technologies, and specifically on thermochemical biomass conversion;

- have a sufficient background on the environmental impact of energy production and use,

- be knowledgeable specifically about GHG emissions, with a clear vision of the main on-going actions for promoting economy-wide decarbonization, both at the country and EU level;

- be highly proactive and able to work autonomously;

- have good personal/relation skills and be keen to work in team;

- show a strong motivation in working on the topic and performing research activities.

Curriculum: 3. Technology and Territory

Sustainable manufacturing and smartness

Reference Person: Dassisti Michele (michele.dassisti@poliba.it)

Host University/Institute: POlytecnical University of Bari

Research Keywords: Sustaibable manufacturing

Smart manufacturing

Industry 4.0

Reference ERCs: PE8_9

PE8_11

PE8_8

Reference SDGs: GOAL 12: Responsible Consumption and Production

Description of the research topic

Manufacturing organizations are facing the urge to adopt new strategies like sustainability to be able to respond to the market and customer's demand for sustainable products due to the scarcity of the natural resources or government policies. To serve this purpose, several approaches have been explored so far, from optimisation strategies up to smart manufacturing. Provided there is not still a clear view or even a solution so far to this big issue.

Research team and environment

Michele DAssisti – full professor

Fulvio Lavecchia – associate professor

Dr. Ing. Concetta Semeraro - Sharjah University (cooperation)

Suggested skills for this research topic

Manufacturing technologies

Engineering

Curriculum: 3. Technology and Territory

Circular economy as a driver for territorial development

Reference Person: De Chiara Alessandra (adechiara@unior.it)

Host University/Institute: University of Naples L'Orientale

Research Keywords:	Circular economy
	Sustainability innovation
	Green transition for territorial development
Reference ERCs:	SH1_10 Management; strategy; organisational behaviour
	SH1_3 Development economics; structural change; political economy of development
Reference SDGs:	GOAL 9: Industry, Innovation and Infrastructure, GOAL 11: Sustainable Cities and Communities, GOAL 12: Responsible Consumption and Production

Description of the research topic

The research proposes the green transition and the development of circular economy initiatives as a driving force for territorial development.

The industrial symbiosis and social capital frameworks represent the theoretical basis for the investigation of the territorial development that starts from the support for circular economy initiatives that, from the very specificities of the territories - resources and industrial culture - can identify opportunities for business (in particular for micro-enterprises operating on the national territory) and play the role of a multiplier for the birth of an economic system that adopts the principles of "closing the circle".

The identification of the drivers of circular entrepreneurship, the identification of local specificities and the rediscovery of shared values between the socio-economic and institutional subjects, can guide policies in supporting the development of circular economy initiatives, enhancing, thanks to solid networks of relationships, the local specificities and creating new opportunities for economic and social growth. Therefore the research will have theoretical, managerial and policy implications.

The research will be carried on with the support of external partner both research partners - as universities and other research centers - and business partners - as organizations involved in circular economy initiatives the will bring know-how and expertise suitable for identifying new sustainable supply chains, within and outside the national territory, and to outline new

horizons for territorial development. In addition, the research partners can contribute to the identification of best practices.

Research team and environment

The research team includes the phd student who will interact with researchers, within the doctoral college and the university partner, and actors belonging to the local system.

The research project will create a network of researchers in order to study and individuate the theoretical background, enhancing the green research themes within the doctoral studies.

The research project will enable a network of actors to implement circular business and system models and will favor the development of relations within the institutional environment in order to plan and implement policies for green transition for territorial development.

For this scholarship a period of internship is planned at *Lavandula, Castelcivita (SA)*

Suggested skills for this research topic

The candidate must be in possession of a master's degree or a suitable qualification obtained abroad.

In the selection of the candidate will be taking into account specific comptences on sustainable development and sustainable innovation in companies.

Type of scholarship and obligations

The type of this scholarship is: Pubblica Amministrazione (Public Administration). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 3. Technology and Territory

Innovative power cycles and working fluids for the energy transition

Reference Person: Di Marcoberardino Gioele (gioele.dimarcoberardino@unibs.it)

Host University/Institute: Università degli Studi di Brescia

Research Keywords:	Closed thermodynamic cycles
renewable energies	Renewable energy conversion and biofuels production from
	Thermodynamic and transport properties of fluids
Reference ERCs:	PE8_6 Energy processes engineering
	PE8_2 Chemical engineering, technical chemistry
	PE11_2 Engineering of metals and alloys
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 9: Industry, Innovation and Infrastructure

Description of the research topic

Nowadays, the energy scenario is rapidly evolving towards new and efficient methodologies for the conversion of "primary" renewable energy sources into mechanical energy, electricity and thermal/refrigeration energy, a decisive role is played by heat engines that adopt different working fluids or mixtures, operating in closed thermodynamic cycles, such as the Rankine cycle or the Joule-Brayton cycle.

As a matter of fact, closed thermodynamic cycles can convert heat from any source (waste heat from industrial processes, renewable sources, nuclear, etc.): they can therefore be adapted to different and varied applications exploring different configurations to solve design and optimisation issues.

For example, (1) recoverable heat from industrial processes is not always continuously available; (2) the widespread use of renewable energy sources (also with systems of very different power sizes) requires the development of flexible, remotely controllable systems, in general with the integration of a storage system for the produced excess energy.

Within this framework, the proposed research concerns the development and study of efficient, versatile, flexible and economically sustainable systems to convert renewable energy sources into their possible final use (i.E. Electricity, heat etc.) as well as into decarbonised energy carries such as hydrogen and biofuels.

The use of innovative thermodynamic cycles (with innovative working fluids and configurations) also involves the necessity to identify the most effective working fluids or mixtures for any specific application, in consideration of the relevant thermodynamic properties, and their thermal stability limit (the maximum temperature at which the fluid can operate), which is general evaluated experimentally. Additional experimental analysis are required to assess the compatibility between different materials and working fluids, aiming at identifying the most cost-effective materials to adopt, particularly in the high temperature sections of the power cycle. Finally, the study of the performance and the design of key components (heat exchangers, turbomachinery, electrolysers) is also based on the theoretical and experimental evaluation of the thermodynamic transport properties (i.E. Thermal conductivity and viscosity) of the working fluid.

The objectives mentioned above are demanding from both a technical and scientific point of view and certainly relevant for a Phd course that aims at providing a concrete contribution to the knowledge in the context of the energy transition.

Research team and environment

The support to the research activities will be provided by the Energy Technology Group (ERGO), in the Department of Mechanical and Industrial Engineering.

ERGO's main research activities focuses on the study, analysis, and design of components involved in all the aspects of energy conversion, particularly in case of power plant operating with non-conventional working fluids (ORCs, closed gas cycles, Stirling engines). The main experimental activity of the Group is the assessment of the thermal stability of working fluids for closed cycle engines. This task is carried out in the Fluid Test Laboratory.

The research team, is presently composed by (permanent personnel):

- Paolo Iora, full professor of "Energy and Environmental Systems"

- Costante Invernizzi, full professor of "Fluid Machinery and Energy Conversion Systems"

- Gioele Di Marcoberardino, senior researcher of "Energy and Environmental Systems"

- Modestino Savoia: technician in the Fluid Test Laboratory.

The group actively collaborates with universities and industries (domestic and foreign) also in the context of some international research projects funded by EU.

Suggested skills for this research topic

The ideal candidate should have a background in mechanical engineering, a solid engineering thermodynamics basis, and a basic knowledge of chemical thermodynamics.

The candidate should have a strong interest in processes modelling by specific software and a good familiarity with programming tool such as Matlab, Fortran or similar. A strong interest in experimental activity, starting from the test bench design, project of experimental measurements and analysis of the results, is desirable.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 3. Technology and Territory

Artificial Intelligence for Precision Livestock Farming: Supporting Sustainable Production and Improving Animal Welfare

Reference Person: Distante Damiano (damiano.distante@unitelmasapienza.it)

Host University/Institute: University of Rome UnitelmaSapienza, Italy

Research Keywords: Artificial Intelligence

Precision Livestock Farming

Optimization of natural resource usage, animal welfare improvement and resilience to climate transition, reduction of climate altering agents emission and antibiotics usage in animal husbandry

Reference ERCs: PE6_7

PE6_11

LS9_3

Reference SDGs: GOAL 3: Good Health and Well-being, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

The new EU common agricultural policy (CAP)[1] has defined the policies for the climate, the environment and animal welfare, which will apply for the period 2023-2027.

To address societal needs about foods and health, the CAP strategic plan [2] supports actions towards the climate transition, sustainable production, animal welfare and environment.

Specifically, the CAP promotes sustainable agroforestry practices, such as: biological agriculture, integrated production, agro-ecology, agroforestry and precision farming.

Additionally, according to the sustainable development goals of the Agenda 2030 [3], the EU Council also promotes the activities devoted to the general improvement of the animal welfare and to fight the antimicrobial resistance.

Precision livestock farming (PLF) is defined as the individual animal management by continuous real-time monitoring of health, welfare, production/reproduction, and environmental impact [4,5,6]. The use of sensors to collect data on animals' behavior and livestock farming production in PLF has several potentials, including: i) the early detection of diseases and other animal welfare issues; ii) the improvement of production performances;

iii) the optimization of available resources usages; iv) the minimization of environmental impact; and v) the increase of livestock farming societal acceptance.

Moreover, the development of new technological tools (e.G., RFID, ruminal bolus, activometers, thermographic cameras) has provided new and significant opportunities to collect fine phenotypes and improve welfare, productivity and sustainability in the livestock sector.

As a result, it is evident that PLF has a great potential to facilitate sustainable production.

The proposed research project is aimed at applying artificial intelligence (AI) techniques and methodologies to data collected in real PLF scenarios to experimentally support the achievement of PLF objectives and potentials.

Specifically, our research goal is to find the tradeoff between livestock productivity and animal welfare, while (among others): i) reducing the usage of antibiotics on animals and in food production; ii) improving the food quality (security and safety); iii) optimizing the use of resources; and Iv) favoring the adaptation and mitigation to climate change.

Historical and new data collected in PLF systems will be analyzed by means of AI techniques and methodologies, with the aim of developing data analysis and prediction models able to: i) determine the best balance between animal nutrition, emission of climate-altering substances and sustainable production requirements; ii) optimize the ecosystem services provided by sustainable intensive livestock farming; iii) identify animal population most resilient to climate change to be involved in an intra-breeding campaign for genetic improvement.

In this field of research, one of the most difficult challenges is related to the need to combine and analyze heterogeneous data coming from different sensor systems.

We plan to combine and process existing historical time series of precision milk data recording (milking ability: speed and yield), animal activity (movement, feeding behavior, rumination time), precision NIR, enteric methane emissions and environmental recording collected from a population of experimental subjects.

In this research, other phenotypes may also be leveraged, including data on the quality of milk and derived products, such as milk coagulation properties (r, K20, a30, Dairy Aptitude Index), spectroscopic profiles, somatic cell values, temperatures on qualifying points of the animal (i.E. Udder, ocular orbit, abdomen, etc.), biochemical important parameters in the animal welfare assessment, such as urea, beta-Hydroxybutyrate, acetone, etc.

This research project will be articulated along the following research lines:

Design and learning of predictive AI models to be applied on heterogeneous data collected in PLF scenarios to support decisions on actions to take towards the mitigation of climate-altering substances emission while preserving the animal welfare and production performances.

Use of statistical and machine learning features analysis techniques to identify the correlation and tradeoff between the dietary animal administration and the emission of climate-altering substances and impact on production performances.

Conducting experimental research aiming at boosting the performances of the learned models.

Applying effective methodologies for the reconstruction of missing data on time series collected by means of digital agriculture technologies.

Design and development of software systems to support the sensor monitor activities.

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[6] David Meo Zilio, Roberto Steri, Miriam Iacurto, Gennaro Catillo, Vittoria Barile, Antonella Chiariotti, Francesco Cenci , Maria Chiara La Mantia and Luca Buttazzoni. 2022. Precision Livestock Farming For Mediterranean Water: Some Applications And Opportunities From The Agridigit Project. In Book: Safety, Health and Welfare in Agriculture and Agro-food Systems. DOI: 10.1007/978-3-030-98092-4_5.

Research team and environment

Research at UnitelmaSapienza (a young online & distance learning University scity directly linked to Sapienza University of Rome) is carried out in various laboratories, research centers by various research groups.

The Intelligent Information Mining research group (IIM - http://iim.Di.Uniroma1.It) involves researchers from UnitelmaSapienza and Sapienza University of Rome that collaborate in investigating research topics in the following research areas: Machine Learning and Data Mining, Knowledge Based Systems, E-Health and Network medicine, Social Media Analysis and Recommender Systems, Human-Computer Interaction and Web Engineering, E-Learning and Educational Data Mining.

The proposed research will be supervised by

- Prof. Eng. Damiano Distante, PhD (SSD INF/01, ERC: PE6_7, PE6_10, PE6_11), Department of Law and Economics, University of Rome UnitelmaSapienza, Italy, Advisory member of the IIM research group (https://iim.Di.Uniroma1.It)

In collaboration with:

- Prof. Stefano Faralli, PhD, Computer Science Department, Sapienza University of Rome, Italy (s.S.D.:INF/01, ERC: PE6_7, PE6_10, PE6_11), member of the IIM research group;

- Dr. Miriam Iacurto, (SSD AGR/19, ERC: LS9_3), Dr. Roberto Steri (SSD AGR/17, ERC: LS9_3) and Dr. David Meo Zilio (SSD AGR/17, ERC: LS9_3), Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria (CREA), Italy (agreement to be established between UnitelmaSapienza and CREA - Centro Zootecnia e Acquacoltura - ZA).

Suggested skills for this research topic

- Knowledge of machine learning and deep learning algorithms and techniques for the supervised and unsupervised learning of predictive models on heterogeneous, sparse and noisy data, including data in the form of time series.

- Programming skills with python and AI suites.

- Experience with DBMS, SQL, NoSQL and Web programming.

- Propensity to team working and interdisciplinary research.

The preferred candidate should also have knowledge of PLF methodologies and technologies.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 3. Technology and Territory

Decarbonisation of industry and cross-sectoral implications on the energy system

Reference Person: Fattori Fabrizio (fabrizio.fattori@polimi.it)

Host University/Institute: Politecnico di Milano

Research Keywords:	Climate change mitigation
	Industry
	Sector coupling
Reference ERCs:	PE8_9 Production technology, process engineering
	PE8_10 Manufacturing engineering and industrial design
	SH7_5 Sustainability sciences, environment and resources
Reference SDGs:	GOAL 9: Industry, Innovation and Infrastructure, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

Industry is a key and critical sector for decarbonisation of the economy. On the one hand, the industrial sector is responsible for an important amount of green-house gases emission; on the other hand, new or different technologies and materials must be mass-produced in order to decarbonise other sectors (e.g. insulation materials, heat pumps, electrolysers, batteries). Industry is in general very much connected to other segments of the energy system, such as transport (e.g. transport of goods), power generation (e.g. industrial combined heat and power plants may produce excess power), space heating (e.g. waste heat may be used in district heating networks). The decarbonisation of industry is thus going to bring in several cross-sectoral implications that must be assessed from a systemic point of view.

Industry is a set of very different subsectors (cement, steel, paper, glass, etc.) with a broad variety of processes and temperatures (cooling, drying, cleaning, firing, etc.) and a different impact in terms of consumptions and emissions (the latter can be both from combustion or from processes). The path towards decarbonisation is thus specific for almost each process in each subsector.

The goal of this doctoral research is improving the knowledge about the possible path for the decarbonisation of industry and understanding the systemic implications of such path. The focus is on the main subsectors and processes within the Italian and European industry, in the near and long term. The research activities should focus first of all on the estimation of

the demand of goods and on its evolution, also considering the political framework (e.g. carbon adjustment mechanism). The second step would deal with the analysis of the possible decarbonisation paths in each of the main subsectors, i.e. the analysis of possible technological (e.g. fuel switch) and non-technological (e.g. circular economy) solutions. The third step would be understanding the most likely or most convenient scenarios and estimating the possible consumption of electricity or other fuels (especially e-fuels) in time and space. Based on the previous three steps, the final part would analyse the possible implications of such scenarios on the energy system, for example in terms of: (i) industrial districts with local e-fuels generation and consumption, and CO2 capture; (ii) industrial combined heat and power generation; (iii) availability of waste heat and (iv) freight transport.

Research team and environment

The activities will be carried out entirely or mostly at the Department of Energy of Politecnico di Milano, in close collaboration with the division of emission projections, integrated modelling and indicators of ISPRA. In particular, the candidate will work within the energy scenarios area of the RELAB group, currently made up of three junior researchers, two PhD candidates and two senior researchers with different backgrounds. The area analyses possible evolution of energy systems over medium to long-term time horizons by using and developing energy system models and hourly simulation tools and by performing data analyses. It studies critical issues such as the integration of large shares of renewables into future energy systems, the role of more efficient technologies and innovative conversion processes, possible developments in end-use electrification and their systemic implications (e.g. electric vehicles, heat pumps). The analyses aim at providing indications on how to achieve national and international strategic targets, such as the reduction of greenhouse gas emissions.

The working group collaborates and interacts with important stakeholders (private actors, research bodies, public institutions) involved in the sustainable energy transition at national level.

Suggested skills for this research topic

The ideal candidate should preferably have a good knowledge of the interrelated dynamics of energy systems and a good knowledge of the industrial sector and its processes. He/she should be familiar with the analysis of literature and datasets to detect relevant information in the field.

Curriculum: 3. Technology and Territory

ABEs for mitigating and contrasting climate change in buildings

Reference Person: Favoino Fabio (fabio.favoino@polito.it)

Host University/Institute: Politecnico di Torino

Research Keywords:	Advanced Building Envelope systems
	Building Resiliency
	Energy and Comfort in Buildings
Reference ERCs:	PE8_3
	PE8_6
	PE8_11
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 12: Responsible Consumption and Production

Description of the research topic

The trend of global warming of last century (0.56¬∞C to 0.92¬∞C increase between 1906–2005) will be reaching a temperature increase between 1.1¬∞C and 6.4¬∞C for the end of this century (depending on the scenario), compared to the period 1980-1999. This average trend produces an increasing number of local extreme events, such as heat waves, increased bushfire risk, extreme storms etc. Considering all the global and local effects of global warming, whether these are chronic slowly changing climate trends or sudden extreme events, it appears fundamental to understand how this context might impact on the way we design and operate buildings. Particularly on how we can support design decision making of building enclosures that could be able (i) on one side to reduce and mitigate the risks related to climate change scenarios (such as energy poverty, passive survivability, heat and cold stress risks etc.), (ii) while on the other to contrast and positively impact on phenomena that are inducing such risks, like Urban Heat Island effect, carbon emissions etc.

In fact the facade is not only a spatial location separating the outdoor form the indoor environment, but a functional system that ensure the performance and the operation of a building, mediating between a changing external environment and the continuity of operations and performance needed for human health, comfort and activities. In the last decade, innovation in building envelope materials and building envelope systems is presenting unprecedented opportunities to control energy and mass flow between indoor and outdoor environment in a dynamic way. This can overcome the limitations concerned to climate change mitigation of the "energy conservation approach", which was a necessary initial step towards space heating and cooling reductions, but could mean in the future a less

prepared built environment towards a changing climate. Advanced Building Envelope systems (ABEs) are innovative facade systems providing flexible and efficient energy management solutions by integrating (i) solar energy conversion systems, (ii) decentralized HVAC elements, (iii) materials capable of actively and selectively managing the energy and mass transfer through building envelopes (adaptive or dynamic), including for example thermochromic opaque and transparent materials, electrochromic films, phase change materials etc. These allow to conceive the façade as a "selective filter", so to adapt to everchanging climate, being able to find trade-offs or solutions that are able to minimize at the same time carbon emission / energy use, overheating and overcooling, solar control and urban heat island effect. The aim of the research is to:

(i)   develop a quantitative evaluation framework to support decision making for building envelope design and building material development, in the context of climate change, with the aim to mitigate and contrast its effects in the built environment;

(ii)   provide a quantitative evaluation of different innovative building envelope technologies in different building use scenarios in the context of climate change;

(iii)   select promising ABEs solutions that can be integrated in different climate change / building use scenarios in order to guide and inform policy makers.

Research team and environment

The PhD student will be integrated into a multi-disciplinary building physics research group TEBE at the Department of Energy, of about 50 members, focusing on aspects from energy use and production in buildings and communities, to different aspects of indoor/outdoor environmental quality (thermal, visual, acoustic, indoor air quality). The integration in such an environment will strongly facilitate the candidate in understanding both vertical and horizontal aspects of its PhD project, developing collaborations and providing great opportunity for growth and cross-fertilization. Within this larger group, the PhD student will work on a daily basis in the research unit related to building envelopes.

In the last 10 years the TEBE research group has managed about 20 EU funded projects, the Building Envelope (BE) research unit can claim a specific expertise and know-how on smart and multifunctional façade systems, embedding smart materials, building performance assessment as far as all the aspects related to thermophysics, acoustics and lighting and to energy optimisation in a LCC perspective, are concerned. As a plus, to the guidance and knowledge sharing, the student can benefit from the international academic contacts, industrial contacts and experience on real world application developed by the group in the framework of the several EU and national projects on such topics.

Last but not least, the BE research unit benefit of numerous experimental facilities for materials and building envelope systems properties and performance characterization, as well as outdoor test facilities for real world implementation, enabling models validation and calibration, full scale performance characterization and real world demonstration.

For this scholarship a period of internship is planned at *EURAC, Bolzano*

Suggested skills for this research topic

The candidate must hold a MSc in an energy engineering, civil engineering, building engineering or architecture. During the BSc and MSc, he/she should have passed different building physics exams (at least two), demonstrating knowledge of basic and advanced building physics and building performance, indoor environmental quality aspects (such as thermal and visual comfort).

The candidate should have proven experience with building performance simulation tools (i.E. Energyplus, Radiance etc.), and with scripting and programming in Python and/or Matlab.

It is highly appreciated experience of experimental work and building physics measurements.

The candidate should have experience with MS Office package (mastering Excel), with CAD and some experience with 3D BIM software (i.E. REVIT).

The candidate should have excellent English language skills, analytical skills, and most importantly curious, independent, and proactive.

Type of scholarship and obligations

The type of this scholarship is: Dottorati Innovativi (Innovative PhD courses). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 3. Technology and Territory

Innovative Catalysis for Sustainable Synthesis of Active Pharmaceutical Ingredient

Reference Person: Fini Francesco (francesco.fini@unimore.it)

Host University/Institute: Università degli Studi di Modena e Reggio Emilia

Research Keywords:	Asymmetric Organocatalysis
	Supramolecular- and photo-catalysis
	Sustainable synthesis of Active Pharmaceutical Ingredients
Reference ERCs:	PE5_13 homogeneous catalysis
	PE5_17 organic chemistry
	PE5_16 supramolecular chemistry
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 9: Industry, Innovation and Infrastructure, GOAL 12: Responsible Consumption and Production

Description of the research topic

Catalysis is recognized as one of the most renowned sustainable methodology in organic synthesis for the production of bioactive molecule. In the last twenty years organocatalysis (small-organic molecule metal-free catalysis) has been defined as the third pillar of catalysis by D.W.C. MacMillan and B. List. The Royal Swedish Academy of Science selected them as Nobel Prize of Chemistry recipients for the great advancement in Science and Society. The academic community start to develop novel modes of activation of substrates and to revisit traditional organic reactions with the new paradigm. Tremendous development in terms of sustainable and green chemistry has been attained, but the industry has been reluctant to apply the novel catalysis to the syntheses of active pharmaceutical ingredients(API). Still, few organocatalytic processes developed by industry have been disclosed, showing that organocatalysis and in general innovative catalysis are the tools of choice for a green and bright future in the field of chemistry and in general for humanity.

The research topic will be focused for the development of innovative catalysis for the synthesis of building block in organic synthesis and medicinal chemistry. The development of sustainable green processes for the synthesis of API or even applying novel methodology for the synthesis of patent-expired active principles (generic) will be on paramount importance to make medication as affordable as possible, eventually changing the pharmaceutical

market. In this regard avoiding the use of expensive and impactful heavy metal, towards small organic molecule from the Natural pool will be the key to move on more renewable resources.

Organocatalyst or photocatalyst could be used individually as green catalyst applied to organic synthesis. Then, a synergistic approach might be taken in consideration where more than one catalytic species activate several reaction partners for the synthesis of the products. In addition, at the edge of organocatalysis lies the supramolecular catalysis, where a small organic molecule self-aggregates into supramolecular structure in an orderly fashion taking the activation of substrates to a level never seen before.

Careful attention will be devoted for the application of innovative catalysis to traditional organic reaction. In this regard multicomponent reactions (MCR) are among the most wanted process: by mixing more than two substrates and reagents the synthesis of complex molecules is achieved without further human intervention, eliminating purification process and energy. Great examples are represented by the Passerini and Ugi reactions, or Mannich and Strecker reactions.

The results obtained will be disseminated at national and international scientific meetings, and published in top-tier international scientific journals. The aim is also to raise public awareness on the importance of research and innovation. Specific training to the researchers engaged in the project to manage social media profiles and to public speaking and dissemination.

Research team and environment

The PhD candidate will be part of a young and growing research group working on innovative catalysis in particular on photo-, supramolecular- and organocatalysis where novel sustainable methodologies are developed with the aim to change the world.

Group members and the candidate will interact with diverse science and be exposed to a multidisciplinary environment; besides participating in international conferences and meetings. They will be encouraged to undertake personal development and professional courses, and to develop soft skills.

The reference person has approximately 30 square meter of lab space at the Department of Life Sciences, Università di Modena e Reggio Emilia. The lab is fully equipped with fume hoods, rotary evaporators, UV lamps and several high vacuum and inert-gas lines for the most challenging organic synthesis procedures. The group has access to 100 square meter common laboratory where are placed an in-house HPLC apparatus for organic and chiral compounds separations with PC interface and Polarimeter for chiral compounds characterization. The lab space can accommodate three to four researchers. The group members have access to the CIGS (Interdepartmental center for Large Instrumentations), a facility where are placed two NMR spectrometers (400 and 600 MHz) together with Mass

Spectrometry analyzers (UHPLC coupled with Q Exactive, Ñ¢ Hybrid Quadrupole-Orbitrap, Ñ¢ Mass Spectrometer, ion Trap LC/MS).

Suggested skills for this research topic

The candidate should be able to teamwork in a multidisciplinary environment, thriving for knowledge and thinking outside of the box. It should have the desire to explore novel chemistry without dogma driving the research towards the expected and the unexpected.

Solid foundation of organic chemistry is of paramount importance, proficiencies in catalysis will be preferred, together with strong communication skills in an international environment.

Curriculum: 3. Technology and Territory

Impact of climate change on the renewable energy sector in Italy

Reference Person: Fosser Giorgia (giorgia.fosser@iusspavia.it)

Host University/Institute: IUSS Pavia

Research Keywords:	Renewable energy
	Climate change
	Impacts
Reference ERCs:	PE10_3
	PE8_6
	SH7_5
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

The renewable energy sector is strongly tied with climate since the availability of renewable sources, like hydro, solar and wind power, very much depend on rain, radiation, and wind patterns. In a context of decarbonisation of the energy system, it becomes crucial to determine how the whole sector will be affected by climate change. Changes in cloud cover could impact on a solar panel productivity, while systematic changes in wind pattern could reduce the energy production of a wind farm. Meantime the projected reduction in mean precipitation could reduce considerably the energy produced by a hydroelectric power plant.

Regional climate models (RCMs) are been proven to be an important tool in climate research and often used to drive impact models. However, RCMs tend to overestimate cloud cover while underestimating wind speed and precipitation extremes on current climate, thus reducing the confidence in their projections. In contrast, km-scale models, called Convection-Permitting Models (CPMs), substantially improve, especially at the sub-daily time scale, the representation of both precipitation and wind field thanks to the possibility to switch off the parameterisation of convection and to their substantially higher spatial resolution.

This research topic aims to determine the impact of climate change on the renewable energy sector over the Italian peninsula. In particular, the focus will be on radiation, the wind pattern and speed, cloudiness and precipitation. Climate variables will be extracted from observational and reanalysis dataset, and from state-of-the-art climate simulations, like RCMs from the CORDEX dataset and CPMs from the CORDEX-FPS CONV initiative, for the

historical, near and future climate. The analysis of climate data will provide an assessment of the changes expected to impact the energy sector.

Climate analysis will be then integrated into energy system models developed and used within the A2A group. In particular, the results of climate analysis will the basis of the estimation of the electricity production from renewable sources over the Italian territory in the long-term horizon (next 30-40 years). The main goal will be to identify potential trends of producibility in a spatial-temporal framework and, subsequently, to estimate the tendency of generation volumes of existing and future renewable plants in Italy. The probability of extreme climate events that may statistically limit the producibility of the renewable power assets will also be analyzed. In addition, a geographical analysis aimed to identify and categorize the investment attractiveness of Italian regions/areas may be conducted.

Research team and environment

IUSS mission is to provide advanced education to undergraduate and graduate students, as well as fundamental and applied research in the fields of Science, Technology, Engineering and Mathematics (STEM), and Human, Social and Life Sciences. At IUSS, PhD candidates will find an open multidisciplinary environment offering real opportunities for developing academic and professional tools for facing the challenges arising from increasing complexity and fast changes in the society and the environment. IUSS is always and actively committed towards internationalisation, inclusion and diversity. The selected candidate will join the research centre on Climate change impAct studies for RISk MAnagement (CARISMA). The CARISMA team is composed by STEM and Social scientists working in the prism of climate change on: data analysis and modelling of Earth system and economic system processes; impact assessment of extreme natural events and anthropogenic activities on human and natural environments; risk management of natural and anthropogenic hazards; formulation and proposal of new economic, political and legal models of sustainable development.

A2A is an Italian multiutility active in several fields: generation of electricity from different sources, distribution and sale of electricity and natural gas, district heating, waste collection and treatment, electric mobility, public lighting, water service. The mission of A2A is to increase the life quality of clients, citizens and employees, taking care of next generations and future of the planet. A2A has recently published a 10-years industrial plan based on two main pillars: 1) Energy Transition, aimed at sustaining the decarbonization process by developing the electricity production from renewables, the energy efficiency and the electrification of consumptions; 2) Circular Economy: aimed to promote the protection of the environment by the increase of waste reduction, reutilization and recycling. Key company figures in 2021 follows: 11.5 B, Ç¨ of revenues, 500 M, Ç¨ of EBITDA, 13.300 employees.

The analysis of meteorologic and climatic phenomena is of great importance for A2A, as they directly impact many aspects of the business, especially in electricity generation and

consumption, energy trading, distribution grids management and control, investment planning.

For this scholarship a period of internship is planned at *A2A SpA, Milano*

Suggested skills for this research topic

The ideal candidate should have a strong background in data analysis and statistics (analysis of probability distribution functions, uncertainties, etc.) and be familiar with the management of large datasets. He/she should preferably have knowledge of the energy system and its sectors, as well as its possible interactions with weather and climate.

Type of scholarship and obligations

The type of this scholarship is: Dottorati Innovativi (Innovative PhD courses). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 3. Technology and Territory

The impact of climate change on the future energy system

Reference Person: Gaetani Marco (marco.gaetani@iusspavia.it)

Host University/Institute: IUSS Pavia

Research Keywords:	Climate change impact
	Future energy system
	Availability of energy resources
Reference ERCs:	PE8_6
	SH7_5
	SH7_9
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

Climate is a major driver for many dynamics of the energy system: the availability of renewable sources, such as hydro, solar and wind, very much depend on rain, radiation, and wind patterns; demand for space cooling and heating is related to temperatures, among others; the availability of waste biomass from agriculture depends on crop yields; moreover, efficiency of several technologies, e.g. heat pumps, batteries and power networks, varies with temperature. In such a context, analysing the impact of a changing climate on the energy system can be key for planning the path towards the decarbonisation of the energy system. Such planning process is usually based on models of the whole energy system that rely on past trends and correlations in historical climate data series.

This research topic thus deals with the analysis of the implications of climate change on demands, resources and efficiencies, as well as other potentially affected segments of the future energy system. The analysis should provide insights on the impact not only of global aspects of climate change (e.g. higher temperature), but also of compound climate events that could have much worse cumulative implication for the energy sector (e.g. a dry winter followed by a hot summer is likely to lead to high cooling demand and low sources for hydro power plants to cover peak loads). The analysis should also consider the spatial dimension of the problem to properly take into account the energy connections between geographical areas characterised by different present and future climate conditions (e.g. high demand of power in the North bidding zone and high availability of renewable resources in the South bidding zone). The geographical scope of the analysis focuses on Italy, however the

assessment of the implications of the results at the regional and global scale is also encouraged.

The research crosscuts two different fields of knowledge: climate science on the one hand, and the energy system analysis and modelling on the other hand. Climate variables related to the energy sector will be extracted from observational and reanalysis dataset, and state-of-the-art climate model simulations, such as the CORDEX regional climate models and the CORDEX-FPS CONV convection-permitting models, for historical and future climate. The analysis of climate data will provide an assessment of the changes expected to impact the energy system (e.g. heat waves and cold spells occurrence, intense precipitation and droughts as well as compound events). Climate analysis will be then integrated into energy system models developed and used by the RELAB group of Politecnico di Milano. Non-climate related data and assumptions of these models should be set according to national and international policy scenarios (e.g. Integrated National Energy and Climate Plan and Long-term strategy).

Research team and environment

The activities will be carried out mostly in the energy scenarios area of the RELAB group at the Department of Energy of Politecnico di Milano, in close collaboration with the climate scientists of the CARISMA group at IUSS Pavia.

The energy scenarios area analyses the possible evolution of energy systems over medium to long-term time horizons by using and developing energy system models and hourly simulation tools and by performing data analyses. It studies critical issues such as the integration of large shares of renewables into future energy systems, the role of more efficient technologies and innovative conversion processes, possible developments in end-use electrification and their systemic implications (e.G. Electric vehicles, heat pumps). The analyses aim at providing indications on how to achieve national and international strategic targets, such as the reduction of greenhouse gas emissions. The working group collaborates and interacts with important stakeholders (private actors, research bodies, public institutions) involved in the sustainable energy transition at national level.

The CARISMA team is composed by STEM and Social scientists working in the prism of climate change on: data analysis and modelling of Earth system and economic system processes; impact assessment of extreme natural events and anthropogenic activities on human and natural environments; risk management of natural and anthropogenic hazards; formulation and proposal of new economic, political and legal models of sustainable development.

IUSS and Politecnico di Milano are actively committed towards internationalisation, inclusion and diversity.

Suggested skills for this research topic

The ideal candidate should have a strong background in data analysis and statistics (analysis of probability distribution functions, uncertainties, etc.) and be familiar with the management of large datasets. He/she should preferably have basic knowledge of the energy system and its sectors, as well as its possible interactions with weather and climate.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 3. Technology and Territory

Exploiting nonlinear dynamics for the design of innovative solutions of vibration energy harvesters

Reference Person: Gatti Gianluca (gianluca.gatti@unical.it)

Host University/Institute: University of Calabria

Research Keywords:	Energy Harvesting
	Nonlinear Dynamics
	Nonlinear Vibration
Reference ERCs:	PE8_7 Mechanical engineering
	PE8_1 Aerospace engineering
	PE7_2 Electrical engineering: power components and/or systems
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 9: Industry, Innovation and Infrastructure, GOAL 11: Sustainable Cities and Communities

Description of the research topic

Vibration energy harvesting from otherwise dissipated kinetic energy in the environment has attracted intense research effort in the past decades, as it can be a sustainable way to reduce the use (and subsequent disposal) of batteries or the need of cables. This is particularly relevant in remote or hostile environments. For harmonic excitation, the best energy harvester is a tuned linear spring-mass-damper oscillator. However, when excitation consists of a wide spectrum, the performance of a linear device drastically decreases and nonlinear stiffness has been proposed to enlarge its bandwidth. One first critical issue is the appearance of multi-stable amplitudes of oscillation, with different energy levels. For energy harvesting purposes, it is desirable for the device to oscillate at one of the highest amplitudes, and several active control strategies have been proposed to steer the oscillation as desired. They however detract energy from the harvested one. A second critical issue manifests when it is of interest to harvest energy at very low frequency (e.g. by wind, passing trains, walking persons, or sea waves) using a linear device. This requires a suspension spring with extremely low stiffness and very large static deflection. A relatively long elastic element, however, can introduce undesired dynamics. From the electrical point of view, signal rectification and AC-DC conversion with high-efficiency are also critical issues.

This research aims at studying the fundamental benefits of exploiting nonlinear dynamics and design efficient energy harvesting systems, addressing the limitations mentioned above. The state of the art in modeling energy harvesters will be analyzed. Innovative solutions will be investigated using a multidisciplinary mechatronic approach. Prototype devices will be constructed to perform experimental tests and validate the theoretical expectations.

Research team and environment

The research activity will be carried out at the Mechanical Engineering Lab - Mechatronic Division of the University of Calabria in collaboration with the Measurements of Optical and Electronic Systems Lab of the Polytechnic Milan, and with the Integrated Microsystem and Sensor Lab of the University of Pavia. The overall research group consists of 3 Full professors, 2 Associate professors, 2 Researcher, 3 Post-doc fellows, and several PHD students. The team has recognized expertise in nonlinear dynamics, vibrations, mechatronics, electronic measurements and power electronics, with both theoretical and experimental skills. It has fruitful collaborations with several Universities and Research Centers abroad, e.g. UNESP (Brasil), ISVR (UK), INP-Toulouse (France), IMEC (Belgium), as well as international industrial partners, e.g. STMicroelectronics, Infineon. It is thus expected that part of the research work will be spent abroad in at least one of these Institutions.

Suggested skills for this research topic

Good background in mechanical engineering, with electronics, measurements, data analysis and programming skills (MATLAB) are required. Candidates with good knowledge in mechanical vibrations and nonlinear dynamics are encouraged. Working enthusiasm, creativity and attitude to problem solving are welcome.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 3. Technology and Territory

Nature Based Solutions for the Sustainable Smart Cities of the Future

Reference Person: Lombardi Patrizia (patrizia.lombardi@polito.it)

Host University/Institute: Politecnico di Torino

Research Keywords:	Nature based Solutions (NBS)
	Sustainable Smart Cities Planning
	Digital Transformation
Reference ERCs:	SH7_6 Environmental and climate change, societal impact and policy
	SH7_7 Cities; urban, regional and rural studies
	SH7_5 Sustainability sciences, environment and resources
Reference SDGs:	GOAL 9: Industry, Innovation and Infrastructure, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

The consequences of global climate change are already being felt on every continent in the world. Global warming is bound to have a multitude of negative consequences, including the exacerbation of the intensity and occurrence of natural disasters. Having dealt with the COVID-19 pandemic crisis and being aware of the need to cope with climate change adaptation and mitigation, cities are promoting new ideas, striving to implement inclusive co-design processes in Visionary Solutions (VS) planning and design, and rethinking urban spaces in a healthier and greener way.

In response to systemic shocks and the global dynamics of change and vulnerability of territories, this PhD research will explore the use of Nature-based Solutions (NBS) for spatial and urban planning from an ecosystem resilience perspective, considering multiple criteria. The European Commission has defined NBS as solutions inspired and supported by nature that provide multiple benefits toward resilient development. On the other hand, another concept that has emerged is the Sustainable Smart City, defined as a place where traditional networks and services are made more efficient by the use of innovative technologies, digitisation of systems. In this context, the VSs based on urban digital transformation and nature-based actions, are proposed by an ongoing H2020 project, named VARCITIES – Future cities (https://www.Varcities.Eu). It aims at implementing the definition of NBS, proposing

the resolution of well-known local urban issues by addressing them from a new perspective capable of combining technologies and experimenting innovative approaches.

This PhD research will be partially conducted in the context of VARCITIES, for which EURAC is one the involved partner and the data collected of its relative pilot cities will be the basis of the research analysis. In fact, these pilots could be investigated to explore NBS which are innovative either in their functional scope, socio-economic reach, integrative approaches or application in new settings.

The objectives of this research are: (i) Analyse the effect of VSs integrated and designed in the citizens wellbeing employing a participatory co-design process involving local stakeholders and assuming multiple criteria; (ii) Shift towards the combined use of NBS and innovative technological solutions to restructure the cities governance practices; (iii) Provide appropriate approaches based on citizen science, artificial intelligence tools to better communicate the science of NBS and promote citizen engagement in the co-creation and co-implementation of NBS.

Indeed, the implementation of VSs requires not only technical know-how, but also the mobilisation of competences and skills from all institutional sectors, in particular during the co-design phase. Into this, the proposed interdisciplinary methodology starts by conducting a comprehensive and systematic literature review. Afterwards, the technical and social methods and models will be integrated and created. Finally, the application and validation of the proposed model will be implemented on different pilot studies.

This PhD research intends further to contribute as a basis for future EU projects and to the New European Bauhaus initiative by supporting the digital transitions in communities' living environments through merging sustainability, innovation and inclusiveness.

Research team and environment

The PhD activities will be a joint research activities between Politecnico di Torino (https://www.Dist.Polito.It/) and EURAC research center (https://www.Eurac.Edu/en). The activity will mostly take place in the (S3+Lab) "Urban Sustainability & Security Laboratory for Social Challenges" laboratory which is part of the SDG11Lab of the Interuniversity Department of Regional and Urban Studies and Planning, Politecnico di Torino, which integrates all existing relevant platforms and operating solutions for providing an infrastructure with a horizontal component, able to guarantee efficient access to general and reference data sources, and to host a variable number of vertical domains that require specific data and dedicated analysis tools. Being also a part of an EURAC Research project, the PhD candidate will spend at least 6 months at this research institute. The PhDs daily activities will be supervised by the main tutor (prof. Patrizia Lombardi) with the contribution of the full environment of the laboratory and in particular of Dr. Sara Torabi Moghadam (Polito) and Dr. Adriano Bisello (EURAC).

Suggested skills for this research topic

PhD candidate to be involved in this project is expected to have interest in theoretical perspective on Nature Based Solution (NBS) and spatial analytical tools for Sustainable Smart urban planning, competencies in LCA methodologies and GIS mapping for environmental evaluation. Moreover, the candidate should be familiar with the social research methodologies to provide appropriate approaches to engage citizen in the co-creation design of NBS.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Curriculum: 3. Technology and Territory

Paradigm capsized: planning with tangible, manageable and measurable NbS

Reference Person: Marignani Michela (MARIGNANI@UNICA.IT)

Host University/Institute: University of Cagliari

Research Keywords:	NbS multiple benefits
	Urban biodiversity
	Mediterranean coastal areas
Reference ERCs:	LS8_1 Ecosystem and community ecology, macroecology
	SH7_5 Sustainability sciences, environment and resources
	PE10_4 Terrestrial ecology, land cover change
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

In the last decades, human pressure along the coastal zones increased worldwide, with several impacts on natural ecosystems: a third of the Mediterranean population lives in coastal regions, which will be the most affected by climate change and extreme events, thus making urgent to find adaptation and mitigation solutions, aiming at enhancing their resilience.

In this context, coastal cities represent a priority challenge, with a key role in supporting sustainable development and, at the same time, reducing pressures on natural ecosystems.

Nature-based Solution (NbS) have been recognized as an effective way to address such challenges by achieving ecosystem restoration and conservation, and simultaneously ensuring the sustainability of social and economic dimensions. The implementation of NbS in cities can enable urban and peri-urban areas to deliver multiple benefits and vital ecosystem services (ES), empowering them to address biodiversity loss, restore degraded land, increase resilience, mitigate and adapt to climate change. Nevertheless, while NbS approach, potentially provides a conceptual and operational framework that links multiple benefits with the protection of the natural capital, a lack of comprehensive evidence remains on NbS reversibility, flexibility, cost effectiveness and long-term feasibility and/or sustainability compared to gray approaches, especially in Mediterranean areas.

Main objective of the research proposal is to generate scientifically robust NbS monitoring and evaluation data, aiming at facilitating a full NbS integration into planning and design of urban coastal Mediterranean areas. Those data will offer examples of the positive chances that the NbS integration into decision-making can provide in strategic urban planning processes, providing evidence to support NbS efficiency and cost- effectiveness in comparison with traditional grey approaches

After the theoretical conceptualization, the research will investigate a specific case study, located in Sardinia, focusing on:

-Study area analysis: consultation of relevant plans and programs, urban trends, analysis of environmental, social and economic components.

-Identification and evaluation of the existing key components of the green infrastructure network: definition of natural components (e.G. Ecological corridors, trees outside the forest, protected areas) and assessment in terms of ecological processes and functions.

-Identification and evaluation of NbS: proposal for the implementation of the ecological network through urban regeneration actions and NbS (e.G. Green areas, ponds, woods fragments) to enhance the resilience of the study area to climate change. All the proposed solutions will be evaluated, as well as their trade-offs and synergies, according to the criteria and sub-indicators proposed for the standard framework for NbS design and assessment defined by the IUCN (2020).

-Development of tools for assessing and monitoring the cost- effectiveness in comparison with traditional grey approaches (e.G. Indicators, collaborative GIS).

The proposed approach will allow to prioritize sustainable management options, reducing conflicts of use and minimizing impacts on ecological integrity. In addition to offering concrete solutions for the case study, the project will also bring advances in the current debate on the lack of harmonization and operationalization of the integration of NbS into decision-making and strategic urban planning.

Research team and environment

The scholarship will work within the framework of the Department of Life and Environmental Sciences - Botany division of University of Cagliari. The researcher will have the possibility to work in a multidisciplinary team, under the responsibility of Prof. Michela Marignani. Main scientific interests focus on landscape ecology, with studies on the effects of habitat fragmentation on multi-taxonomical diversity, the definition of ecological networks at different scales and spatial planning in urban and peri-urban environments. The team performs multidisciplinary research activities, thanks to the collaboration with environmental engineers, urban planners, zoologist, geologist and ecologists.

Suggested skills for this research topic

We are looking for candidates with a good knowledge of ecology and ecological processes, as well as in natural resource planning and human dimension integration. The ideal candidate has a Master's degree related to sustainability science, natural and environmental sciences, ecology, biology or similar. Experience with statistics, spatial planning, environmental impact assessment and ecosystem services evaluation will be welcomed.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 3. Technology and Territory

Multi-criteria decarbonisation analysis for remote and rural areas

Reference Person: Mattiazzo Giuliana (giuliana.mattiazzo@polito.it)

Host University/Institute: Politecnico di Torino

Research Keywords:	Energy scenario making and analysis
	Local energy planning
	Energy systems operation and management
Reference ERCs:	PE8_7 Mechanical Engineering
	SH7_9 Energy, transportation and mobility
	SH7_6 Environmental and climate change, societal impact and policy
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

The decarbonisation targets set by the international community can be achieved by adopting an effective medium to long term energy planning strategy that can support local authorities' decision-making processes.

The sustainable development of social contexts is a three-dimensional problem involving different environmental, social, and economic levels. Consequently, detailed energy planning must consider a high penetration of RES in the energy system and the economic feasibility and social impacts on the host community. The latter cannot be evaluated only in terms of employment effects but also social acceptability. The abovementioned becomes even more true if the contexts considered are rural and remote areas, which make extensive use of fossil fuels, and local communities are more cohesive.

The decarbonisation of local energy systems should be pursued by evaluating the high-RES penetration and the environmental cost of deployment, maintenance and decommissioning. Following the three-dimensional nature of sustainable development, a successful plan must consider the socio-economic and financial sustainability of proposed solutions and spillover effects on citizenship, offering strategies to increase social acceptability.

The PhD aims to develop a multi-criteria analysis methodology, adopting scoring systems (es. GHG, ESG) to evaluate the performances of provided solutions in the framework of sustainable decarbonisation pathways for remote and rural areas. Moreover, the research

aims at building scenario analysis tools to support the sustainable development decision-making processes.

Research team and environment

The PhD activities will be mostly at Politecnico di Torino at the Marine Offshore Energy Lab (MORE) a highly multidisciplinary research center, part of the Department of Mechanical and Aerospace Engineer (DIMEAS). The group is currently composed of 2 full-time professors, four post-doctoral research fellows (2 under the H2020-MSCA-IF programme), 12 PhD students, 8 post-master research fellows, and various under-graduate interns and thesis students. The group's expertise is centered on all aspects of offshore renewable energy, especially focusing on the conception, design, testing, and deployment of novel wave energy converter technologies and floating offshore wind turbines. In particular, the major and tangible result of the group is the Inertial Sea Wave Energy Converter (ISWEC), which has been tested in wave tanks at different prototype scales, in dry-test hardware-in-the-loop (HIL) facilities, and deployed offshore in both half-and full scale, respectively in the Adriatic Sea and the Strait of Sicily (Mediterranean Sea). Other relevant lines of research and innovation comprise of a point absorber wave energy converter, a pendulum wave energy converter (PeWEC), innovative floating substructure for floating offshore wind turbines, and energy system modelling for small islands enabling the energy transition, also being the national representative within the Clean Energy for EU Islands Secretariat.

Suggested skills for this research topic

The candidate should preferably be enthusiastic about the subject proposed. He should have the ability to present a scientific work both in oral and written form and have proactivity and parallel thinking. To carry out the PhD research goals, the candidate should have a background in:

- Energy system modelling

- Knowledge of RES plants design

- Good programming skills (e.G. Python, Matlab) and good knowledge of GIS software.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Curriculum: 3. Technology and Territory

Holistic stochastic approach for sustainable energy transition of alpine cities

Reference Person: Menapace Andrea (andrea.menapace@unibz.it)

Host University/Institute: Free University of Bozen-Bolzano

Research Keywords:	Renewable Energy Transition
	Climate Neutral Cities
	Stochastic Energy Scenarios Modelling
Reference ERCs:	SH7_7 Cities; urban, regional and rural studies
	PE10_17 Hydrology, hydrogeology, engineering and environmental geology, water and soil pollution
	PE6_11 Machine learning, statistical data processing and applications using signal processing (e.g., Speech, image, video)
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

The proposed PhD project regards the development of an innovative methodology for sustainable energy planning aiming at supporting the energy transition of alpine cities from current fossil fuel-based energy systems to future smart and renewable ones. The focus of this work will be therefore put on the optimal planning procedure that will be based on a holistic modelling of the energy systems and a stochastic approach for the analysis of the various scenarios. The design criteria based on this techno-economic methodology are identified in the sustainable use of renewable and local resources (e.g., biomass and hydropower plants), the implementation of smart grids and storage, and the decentralisation of energy generation and recovery.

The main activities to be carried out are listed hereafter.

- Collection and validation of the demand and production of the different energy vectors and technologies in annual aggregated and hourly time-series format. Gathering of information about the business-as-usual energy systems and the potential local resources.

- Modelling of the energies systems by means of proper advanced energy system analysis software to reproduce the current energy scenario. Using a holistic approach several sustainable alternative systems will be investigated including several cutting-edge

technologies, complex interaction among the energy vectors (e.g., heating, cooling, electricity and transport), renewable energy sources and smart grids (e.g., district heating and cooling, and hydropower systems).

- The input data of the energy model, comprising the energy demand and the renewable production, will be modelled through proper statistical methods that also evaluate the long-term climate change projection. Particular attention will be done on the modelling of the district scale that will be crucial for a reliable analysis of some innovative options, such as prosumers, district heating and energy communities.

- Merging the holistic energy modelling approach with the statistical inputs modelled the candidate will perform the final statistical analysis about the different long-term scenarios.

- The optimal planning alternatives will be finally figured out through a multiple criteria decision analysis.

- The analysis and comparison of the applications in different cities will be performed with the final aim to achieve useful information for sustainable energy planning into the alpine region.

Thus, a holistic-stochastic energy planning methodology will be obtained by coupling robust hourly energy simulations and stochastic modelling of the systems scenarios with a flexible multiple criteria decision analysis to identify the best scenarios. The methodology will be tested on a few alpine towns characterised by different features in order to define some long-term sustainable scenarios able to meet the climate change mitigation targets. The results of the test cases will be analysed and compared to seek the general trends useful for energy design guidelines of the alpine regions.

The main practical implication of this work should be to provide a reliable planning procedure suitable for small urban centres in the alpine region. This methodology should be able to support the decision-making process of local public administrations in the optimize long-term investments for reducing greenhouse emissions and increasing the share of renewables.

Research team and environment

The development of the proposed research project needs a wide range of knowledge comprising urban energy planning, sustainable energy resources evaluation, energy system modelling, statistical energy data analysis, optimization algorithms, smart energy district implementation, climate change projection, and econometrics. Therefore, the candidate will collaborate with a multidisciplinary group of professors and researchers including the Faculty of Science and Technology, Faculty of Economics and Management and Faculty of Computer Science of the Free University of Bozen-Bolzano. In addition, the candidate will have the opportunity to collaborate with the extensive network of partnerships, which comprises for instance the Department of Planning of the Aalborg University. The candidate will be involved in the activities of the presented above research group for the sustainable development of

smart and renewable-based urban energy systems aimed at talking about climate change. The alpine context will be deeply analysed in order to properly figure out the most suitable energy resources, technologies and solutions. The main findings will be shared with local public administrations to support the decision-making process of urban energy planning and policy definition.

Suggested skills for this research topic

The candidate should possibly be highly interested in the research topic, enthusiastic to work in a multi-disciplinary team but also inclined to solve problems independently, ambitious and not afraid to share any ideas. In addition, the candidate should have the problem-solving capability, be hungry for new knowledge and be willing to overcome her/his limits. The candidate should have the ability to organise and plan work, schedule tasks and meet deadlines.

At the same time, a master degree in a technical-scientific area is required, such as Energy, Civil or Environmental engineering. Good knowledge of energy systems modelling, energy demand analysis, energy production systems, renewable energy sources, cutting-edge energy technologies, smart energy grids and communities, energy storage, energy economics and energy policies are strongly recommended. The following technical skills are advisable: software tools for energy systems analysis (e.g., EnergyPLAN) and geographical information systems (e.g., QGIS), and programming language for calculation, statistical analysis and graphics (e.g., R, Python or Matlab).

Curriculum: 3. Technology and Territory

Flexible buildings as thermal storages for RES integration and smart cities/territories

Reference Person: Pagliano Lorenzo (lorenzo.pagliano@polimi.it)

Host University/Institute: Politecnico di Milano

Research Keywords:	Flexibility
	Energy storage
	Flexibility services
Reference ERCs:	PE8_3 Civil engineering, architecture, offshore construction, lightweight construction, geotechnics
	PE1_20 Control theory, optimisation and operational research
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 9: Industry, Innovation and Infrastructure, GOAL 11: Sustainable Cities and Communities

Description of the research topic

The expected increasing penetration of variable renewables in the energy mix and electrification of thermal uses in buildings and mobility, will create challenges for the electricity system and require large land takes for collection and storage of energy. Increased extraction of needed materials will also put pressure on territories and communities.

Reducing energy needs and making flexible the time of demand is essential to reduce size of collection, storage and transport infrastructure and its environmental impacts and overall costs.

Presently most buildings are extremely rigid in terms of time of energy demand. E.g. Heating systems are turned on early morning in winter in the nearly the entire building stock to recover from the drop in temperature overnight due to the high thermal losses via envelope and ventilation. In this situation, substitution of gas boilers with electric heat pumps would create an extremely challenging electric peak demand at the time of early morning recovery from night thermostat set-back. Buildings have the potential to act as thermal batteries but presently are in majority short-circuited to external cold sinks. By retrofitting buildings with thick external insulation layers, high performance fenestration, external solar protections and mechanical ventilation with heat recovery, their energy needs for heating and cooling may be reduced to very low levels. Much less explored, to the point of not being present in the Smart Readiness Indicator EU framework, is the effect of such retrofits on the flexibility of

demand. The thermal capacity of typical building typologies in Italy and Europe is high and, when protected from quick discharge, may enable buildings to remain in the thermal comfort range (as reported in EN 16798 and ASHRAE 55) up to several days without any active energy input.

This would allow:

- matching the building hourly demand profile with the supply of local energy (renewable or recovered energy) on a scale from few hours to a few days

- storing renewable or recovered waste energy when overabundant on the grid(s)

- managing conditions of energy supply shortage / high costs on the grids by modulating the demand profile over time (demand response, peak shaving, potential participation in the capacity market)

- protecting occupants during extreme weather events which may disrupt supply of electricity and fuel for a number of days.

This research will:

- develop Model Predictive Control (MPC) algorithms for flexibility services (e.g. The charging and discharging of energy in the thermal capacity of building structures, while maintaining comfort; the charging and discharging of added thermal capacity as water tanks,, ...) that would enable buildings to actually act as elements of smart grids and energy communities and respond to dynamic conditions of weather and grid state.

- test those MPCs via calibrated simulation models (e.g. Energyplus + Python) and tune them to optimise a series of chosen flexibility indicators within given energy and comfort constraints

- test the optimised MPCs in real, occupied buildings, with a special interest on commercial buildings

- assess of the impacts of dynamic exploitation of flexibility at building, district and national energy system level (e.g. Participation of building aggregations to the capacity market, adding flexibility and hence increased options for RES integration to new energy communities, reduction of land-take in line with UN-SDGs goals and EU parliament - "no land degradation" by 2030 and "no net land take" by 2050 at the latest -)

- feedback to EU Smart Readiness Indicator methodology, presently under test and potentially open to evolution.

Research team and environment

The research team is the end-use Efficiency Research Group (www.EERG.Polimi.It), active at Polimi since 1996 under the direction of Prof. Pagliano, with collaboration with a number of European Universities, Fraunhofer Institute, Lawrence Berkeley National Laboratory, California University, ...

EERG has participated in, promoted and directed more than 50 research projects and studies funded by public (e.G. European Union, Regional Governments, National Ministries, ENEA,) and private bodies (e.G. Electric Companies) on various aspects of buildings analysis and simulation, buildings monitoring, comfort surveys and energy economics and planning, with a special focus on end use efficient technologies and programmes. We have participated and currently participate in activities of Energy in Buildings and Communities Programme

Of the International Energy Agency, such as: IEA ECBCS Annex 5 - ""Air Infiltration and Ventilation Centre; IEA EBC Annex 58 - ""Reliable Building Energy Performance Characterization Based on Full Scale Dynamic Measurements""; IEA SHC Task 40 / ECBCS Annex 52 - ""Towards Net Zero Energy Solar Buildings""

For this scholarship a period of internship is planned at *Comune di Milano, Milano*

Suggested skills for this research topic

The ideal candidate should have good foundations in building physics and control methods, being acquainted with measurement procedures in buildings, being able of critical and evolutive use of building simulation. Good knowledge of English language, interest in scientific communication both at conferences and via peer reviewed journal papers. Ability or interest to learn and communicate in Italian language is also appreciated, for communication with Italian actors.

Type of scholarship and obligations

The type of this scholarship is: Pubblica Amministrazione (Public Administration). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 3. Technology and Territory

Simulation and optimisation of energy community energy flows by computational intelligence

Reference Person: Poggio Alberto (alberto.poggio@polito.it)

Host University/Institute: Politecnico Di Torino

Research Keywords:	Decarbonization
	Energy transition
	Renewable energy communities
Reference ERCs:	PE7_2 - Electrical engineering: power components and/or systems
	SH7_5 Sustainability sciences, environment and resources
	SH7_10 GIS, spatial analysis; big data in geographical studies
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

The European Green Deal aims to reduce net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels. Renewable energy policies must make an important contribution to achieving this challenging objective. In the ongoing revision of the Renewable Energy Directive (RED), it is proposed to increase the overall share of renewables to 40%.

Buildings and transport will drive the energy transition; in both these end-use sectors, progressive electrification is expected:

- in transport, with an increase in vehicle charging consumption and new opportunities for short-term grid balancing and storage services;

- in buildings, with a growing role of heat pumps and new issues of coupling of the heat and electricity demand profiles.

To face this strong increase in electricity demand, a high penetration of renewables is needed.

Currently the generation and use of renewable electricity is based on two main configurations: i) large plants that feed into the grid; ii) small plants for the self-consumption of single users. Both approaches have structural limitations. The concentration of generation in large plants can lead to significant environmental and land consumption impacts. In

addition, centralized generation processes can be inefficient with respect to the localization and the dynamics of energy demand. Distributed generation of individual users avoid the main part of impacts issues. Typically, the design criteria of small plants is optimized on the real energy needs of single users. But, from another point of view, the size of individual plants is often smaller than the onsite available installation capability. In this way, much of the renewable potential is untapped.
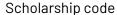
Sharing energy is the key practice to overcome these limitations in and to enable further developments of renewable generation. According to definitions of RED, local energy communities are the main instrument to allow energy sharing and value exchange between different users. The concept of energy community is evolving rapidly: from small associations for photovoltaic generation and self-consumption to complex energy systems containing different energy sources in a wide territorial extension.

The PhD research will focus on the development of simulation and optimization techniques to maximize energy, environmental and economic performance of energy communities. Multiplayer systems will be considered, in which different actors interact to optimize the exploitation of renewable sources such as energy communities and systems with energy storage of different forms (thermal, electrochemical, hydrogen, etc.). Data analysis techniques will be involved, such as clustering techniques and Machine Learning methods, such as linear regression, Support Vector Regression and artificial neural networks. The application of these techniques in the energy fields (energy demand prevision, user needs analysis etc.) has already provided good results in terms of accuracy and computational efficiency if compared to the techniques of more traditional simulations and has now reached a degree of development that can be applied in real energy systems. Therefore, this approach will be applied to the study of the design and operation of energy communities based on real case studies.

Research team and environment

Politecnico di Torino carries out education, research, technological transfer and services in all sectors of architecture and engineering. The Department of Energy is the point of reference in Politecnico di Torino for the areas of knowledge concerned with energy and sustainable development. The candidate will join the Sustainable Energy Analysis (SEA) and to Computer Aided Design of ElectroMagnetic Apparatuses (CADEMA) research groups that works on local energy planning and on optimization procedures to energy management and network systems.

SEA research group is coordinated by prof. Alberto Poggio. Main research topics addressed concern: energy transition at urban and regional scale, energy analysis of industrial processes and cogeneration plants, sustainable supply chains for wood biomass energy, renewable heat for district heating. SEA team integrates a knowledge of energy technologies with multi-scale analysis, from the individual user or plant up to an entire territory, and a multidisciplinary approach, including issues related to climate change, air quality, territorial management, local development.

CADEMA research group is coordinated by prof. Maurizio Repetto and groups professors and researchers mainly belonging to the scientific sector of "Principle of Electrical Engineering" with competences in simulation and optimization of complex system by means of evolutionary and neural computation. Analysis tools have been developed for hybrid energy systems and for multi-agent sharing structures as the one of energy community.

Suggested skills for this research topic

Good knowledge on: energy systems modelling, energy data analysis, energy generation and distribution, cogeneration, district heating, energy self-production at user scale (prosumer), renewable energy resources, technologies and supply chains (e.G. Wood biomass, solar thermal and photovoltaic, hydrothermal and aerothermal by heat pumps). Base knowledge on: data processing, data analysis and spatial representation software (e.G. Excel, Matlab, R studio, GIS).

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research).This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 3. Technology and Territory

Implementation of local energy communities: hardware infrastructures and software logic

Reference Person: Poggio Alberto (alberto.poggio@polito.it)

Host University/Institute: Politecnico di Torino

Research Keywords:	Energy Communities
	Hardware infrastructure
	Data analysis
Reference ERCs:	PE7_2 Electrical engineering: power components and/or systems
	SH7_5 Sustainability sciences, environment and resources
	PE7_8 Networks, e.G. Communication networks and nodes, Internet of Things, sensor networks, networks of robots
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

The European Climate Act and the Fit for 55 EU directive have set increasingly challenging targets to reduce emissions and increase the development of renewable energy sources.

To achieve these goals, distributed generation from renewable electricity will have the greatest prospect of growth, both to cover civil and industrial electricity needs, and as part of the electrification process of the transport sector, also through the development of energy communities.

The 'Green Revolution and Ecological Transition' and 'Infrastructure for Sustainable Mobility' are in fact two of the six key themes of the PNRR, themes within which the following proposal fits to support the sustainable development and use of local resources. (Mission M2C2 - Renewable Energy, Hydrogen, Grid and Sustainable Mobility | Investment 1.2: Promoting Renewables for Energy Communities and Self-Consumption; Investment 2.1: Strengthening the Smart Grid. Mission M2C1.3 Develop integrated projects | Investment 3.2: Green communities).

The doctoral research will focus on the development of simulation and optimisation techniques to maximise the energy, environmental and economic performance of local energy communities and prosumers, and hardware devices to support smart grids.

Optimisation systems will be implemented based on deterministic techniques, such as Mixed-Integer Linear Programming systems, and stochastic methods such as artificial immune networks. In addition, the research will apply game-theoretic and agent-based model methods, where different actors interact to optimise the exploitation of renewable energy sources such as energy communities and energy storage systems.

Data analysis techniques such as clustering techniques and machine learning methods (linear regression, support vector regression and artificial neural networks) will be involved. The application of these techniques in the energy sector (energy demand forecasting, user needs analysis, etc.) has already provided good results in terms of accuracy and computational efficiency compared to more traditional simulation techniques and has now reached a degree of development that can be applied to real energy systems.

The hardware infrastructure and the software platforms for the implementation of the identified solutions will then be defined, also in the context of the current energy market and its evolution, and their application on pilot cases developed in collaboration with local energy operators.

Research team and environment

Politecnico di Torino carries out education, research, technological transfer, and services in all sectors of architecture and engineering. The Department of Energy is the point of reference in Politecnico di Torino for the areas of knowledge concerned with energy and sustainable development. The candidate will join the Sustainable Energy Analysis (SEA) and the Computer Aided Design of ElectroMagnetic Apparatuses (CADEMA) research groups that works on local energy planning and on optimization procedures to energy management and network systems.

SEA research group is coordinated by prof. Alberto Poggio. Main research topics addressed concern: energy transition at urban and regional scale, energy analysis of industrial processes and cogeneration plants, sustainable supply chains for wood biomass energy, renewable heat for district heating. SEA team integrates a knowledge of energy technologies with multi-scale analysis, from the individual user or plant up to an entire territory, and a multidisciplinary approach, including issues related to climate change, air quality, territorial management, local development.

CADEMA research group is coordinated by prof. Maurizio Repetto and groups professors and researchers mainly belonging to the scientific sector of "Principle of Electrical Engineering" with competences in simulation and optimization of complex system by means of evolutionary and neural computation. Analysis tools have been developed for hybrid energy systems and for multi-agent sharing structures as the one of energy community.

For this scholarship a period of internship is planned at *URMET Telecomunicazioni, Torino*

Suggested skills for this research topic

Good knowledge on: energy systems modelling, energy data analysis, energy generation and distribution, energy self-production at user scale (prosumer), renewable energy resources. Base knowledge on: data processing, data analysis and spatial representation software (e.G. Excel, Matlab, R studio, GIS).

Type of scholarship and obligations

The type of this scholarship is: Dottorati Innovativi (Innovative PhD courses). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 3. Technology and Territory

Biocatalytic transformations in unconventional green solvents

Reference Person: Prandi Cristina (cristina.prandi@unito.it)

Host University/Institute: University of Turin

Research Keywords:	Biocatalysis
	Green processes
	Fine chemicals
Reference ERCs:	PE5_17
	LS1_2
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 4: Quality Education, GOAL 5: Gender Equality, GOAL 6: Clean Water and Sanitation, GOAL 7: Affordable and Clean Energy, GOAL 9: Industry, Innovation and Infrastructure, GOAL 11: Sustainable Cities and Communities

Description of the research topic

Biocatalysis has become a valuable method for manufacturing chiral synthons for agrochemicals and pharmaceuticals due to its high intrinsic regio-, chemo- and stereoselectivity. Furthermore, as biocatalysts operate under mild (physiological) conditions they are often compatible with each other rendering them suitable for multi-step cascade processes in one pot. Cascade reactions are very attractive as yield-reducing intermediate product isolation is not necessary. Additionally, improved step- and atom economy translate into significant economic and environmental benefits. Apart from a few exceptions, enzymes display the highest activity in buffered systems; however, most of the industrially relevant substrates are hydrophobic and hence hardly soluble in aqueous buffers. If emulsions or two-phase systems are not suitable for the respective biocatalyst, overall productivity of these biotransformations is limited. Inactivation can be circumvented when enzymes are operated as whole cells. Here, the implementation of living cells, resting cells or even lyophilised cells is an option. The cell envelope may protect the enzyme from the organic exterior by providing an environment closer to nature. Often the application of organic solvent also facilitates product isolation as tedious product extraction from an aqueous phase can be omitted. Hence, biocatalytic cascades using whole cells in organic media offer a highly potent alternative to standard chemical syntheses to establish cheap, selective and efficient production processes.

In this PhD project, biocatalysts as isolated enzymes or as whole cells will be used in unconventional green solvents, mainly Deep Eutectic Solvents to promote chemo-. Regio- and stereocontrolled transformations leading to target compounds as fine chemicals of pharmaceutical or agrochemical interests.

Research team and environment

The research team is composed by myself (full professor in organic chemistry) and:

2 associate professors

1 post doc

3 PhD students

2 graduate students

5 thesis students

Suggested skills for this research topic

The candidate should be familiar with:

Organic synthesis and basic principles of catalysis

Green chemistry

Enzymes

Protein structures and biocatalytic mode of actions

Whole cells catalysis

![PhD SDC - Sustainable Development and Climate Change logo]

Curriculum: 3. Technology and Territory

Sustainable Energy Communities

Reference Person: Raugi Marco (marco.raugi@unipi.it)

Host University/Institute: University of Pisa

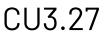|	
Research Keywords:	Sustainable energy
	Energy Communities
	Data Analytics
Reference ERCs:	PE8_6
	PE7_3
	PE6_11
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 9: Industry, Innovation and Infrastructure, GOAL 11: Sustainable Cities and Communities

Description of the research topic

The object of the research is the identification of solutions of complete self-sufficiency for energy communities through innovative methods for the integration of electrical and thermal systems, powered only by renewable sources produced locally (solar, wind, geothermal, biomass, etc.). ICT technologies and artificial intelligence will be adopted. Future scenarios are studied in which it is not sustainable to use the electricity and gas grid and the energy needs of civil, industrial and agricultural buildings must be satisfied with only renewable sources to be produced on site. In this scenario, it is necessary to study a completely innovative case in which it will be necessary to adapt the energy demands of users (negotiating consumption for civil uses with those for industrial use) with the energy available in terms of both overall consumption and hourly distribution. This perspective induces a radical change in current habits and lifestyles in terms of citizens' consumption and productive activities. Specific research topics are: integration of storage systems, renewable sources, utilities with ICT technologies and electronic platforms to maximize sustainability and energy efficiency. Development of artificial intelligence systems based on the monitoring of energy consumption and climatic conditions of buildings and plants to provide an information system to aid decisions. Socio-economic investigation, also through gamification techniques, to obtain profiles of energy needs in the prefigured context and understand their social acceptability.

Research team and environment

The research team is composed by professors of the Department of Energy Systems Constrction and Technology Engineering, in particular Prof. Daniele Testi, Prof. Marco Raugi and Prof. Mauro Tucci. The candidate will also operates in the very stimulating framework of the Interdipartmental Research Centre on Energy for Sustainable Development https://ciress.lt/ where many experts on Electric Engineering, Electronic Engineering, Computer Science, Thermal Engineering etc etc will dialogue, help and guide the student activities.

Suggested skills for this research topic

The candidate should have a good mathematical background and computer programming skills.

Energy systems and energy systems integration knowledge and understanding will be considered as preference

Titles. If necessary the candidate will be formed on these topics during the first year.

Computer programming skills are necessary. Big data analytics and artificial intelligence methods (neural

Network, machine learning etc) will be considered as preference titles. If necessary the candidate will be formed

On these topics during the first year.

The candidate should be open minded and able to dialogue with colleagues with socio economic skills in order

To undestand the socio-economic interactions into an Energy Community

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 3. Technology and Territory

Sustainable and Circular Manufacturing in the Digital Era

Reference Person: Rosa Paolo (paolo1.rosa@polimi.it)

Host University/Institute: Politecnico di Milano

Research Keywords:	Circular Economy
	Industry 4.0
	Twin Transition
Reference ERCs:	PE8_9
Reference SDGs:	GOAL 12: Responsible Consumption and Production

Description of the research topic

Given the direct exploitation of materials and natural resources, the manufacturing sector is on the forefront of sustainability and circular economy. This way, the negative impact of this sector in terms of sustainable development and climate changes must be adequately monitored and reduced. During the last decade, both circular economy and Industry 4.0 approaches have been adopted by manufacturing companies in order to cope with environmental issues and technological advances. However, current researches are showing that digital technologies could support and enable even more sustainable practices if adequately integrated and managed. The intent of this research is to establish new ways to do it in practice and support companies during the transition from linear to circular behaviours.

Research team and environment

The research team will be constituted by Paolo Rosa (PhD in Economics and Management of Technology got @ University of Pavia in 2018) as main reference person, and Luca Fumagalli. Professors Marco Taisch and Sergio Terzi of the Manufacturing Group of the School of Management POLIMI will also be involved. The research activity will consider also the collaboration with other POLIMI's PhD students and post-doc operating in the Manufacturing Group, like Roberto Rocca, Federica Acerbi and Marco Spaltini. This will create a stimulating environment for the new PhD candidate. One main idea of the research team is to create cooperation with the MADE Competence Centre Scarl (where University of Pavia and Politecnico di Milano are academic partners). Given the current role of Paolo Rosa at MADE (as sustainability focal point), he will act as facilitator between the Manufacturing Group and MADE, by supporting the PhD candidate's activities. Some of these activities will be also implemented within the Manufacturing Groups' Industry 4.0 Lab @ Department of Management, Economics and Industrial Engineering of POLIMI.

For this scholarship a period of internship is planned at *MADE scarl, Milano*

Suggested skills for this research topic

Good knowledge of circular economy practices and industry 4.0 technologies

Type of scholarship and obligations

The type of this scholarship is: Pubblica Amministrazione (Public Administration). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Curriculum: 3. Technology and Territory

Chemometric optimization of synthesis of materials for adsorption of pollutants

Reference Person: Ruggieri Fabrizio (fabrizio.ruggieri@univaq.it)

Host University/Institute: Università degli Studi dell'Aquila

Research Keywords:	Adsorption
	Pollution
	Optimization
Reference ERCs:	PE4_5
	PE4_18
	PE4_9
Reference SDGs:	GOAL 6: Clean Water and Sanitation, GOAL 7: Affordable and Clean Energy, GOAL 12: Responsible Consumption and Production

Description of the research topic

The aim of this research program is to explore innovative approaches to the preparation of nanostructured materials, and to use these materials to remove pollutants and heavy metals present in soils or waters. The experimental conditions used to prepare the materials will be optimized by advanced chemometric tools. Chromatographic and spectroscopic analytical techniques will be used to evaluate the pollutant removal efficiency. In particular, during the project, analytical methods for the determination of pollutants will also be implemented. Chromatographic methods such as ion chromatography and high-performance liquid chromatography will be used during the project. In addition, emission spectroscopy will be used for the determination of heavy metals.

Research team and environment

The main objectives of our research activities are mainly the study of environmental issues. In particular, different materials are currently being studied for the decontamination of pollutants of xenobiotic origin present in environmental matrices. The team consists mainly of young PhD students and students of the degree course in chemistry. The main analytical instruments are present in the laboratory, such as GC-MS, HPLC, ICP-MS and IC.

Suggested skills for this research topic

Knowledge of the main chemometric techniques, autonomy in laboratory practices with excellent knowledge of chromatographic techniques and atomic emission spectroscopy

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 3. Technology and Territory

Electro-nanocatalytic approaches for high added value products

Reference Person: Sarno Maria (msarno@unisa.it)

Host University/Institute: University of Salerno, via Giovanni Paolo II, 132 - 84084 Fisciano (SA), Italy

Research Keywords:	Electro nano-catalysis
	Biomass and CO2 valorization
	Chemicals and syngas production
Reference ERCs:	LS9_11 Biomass production and utilization, biofuels
	PE8_11 Environmental engineering, e.G. Sustainable design, waste and water treatment, recycling, regeneration or recovery of compounds, carbon capture & storage
	PE11_9 Nanomaterials engineering, e.G. Nanoparticles, nanoporous materials, 1D & 2D nanomaterials
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 9: Industry, Innovation and Infrastructure, GOAL 13: Climate Action

Description of the research topic

Electrochemical processes are now a real opportunity for obtaining various chemical products at low temperatures and ""easily"", even starting from waste and biomass, water and CO2. In this context, it is extremely important to design nano-catalysts, through morphologies, couplings and "ad hoc" compositions to improve the processes performance. Electricity supplied from renewable energy sources allows for sustainable productions, and can be a real smart approach.

A large amount of agricultural wastes, other recycled feedstock's and more in general biomasses contain a high amount of lipids. Because of their non-toxic and environmentally friendly nature, biodiesel obtained from renewable resources has become very attractive. Biodiesel production can be achieved through esterification and/or trans-esterification of fatty acids, in the presence of alcohols and inorganic or enzymatic catalysts. The advantages of enzymatic catalysis, which doesn't require pre-treatment and operates in the presence of water moisture, are the high selectivity, flexibility to handle feedstock and feedstock amount variations, mild operating conditions, free fatty acid (FFA) processing, "eco-friendly" nature, simultaneous esterification and transesterification. Enzymes immobilization allows overcoming the main drawbacks, which are free enzymes, poor stability, and costs. Enzymatic immobilization on nanoparticles based on a suitable design and optimization can

significantly enhance catalytic performance. For enzyme immobilization, non-toxic magnetite is one of the most explored supports. On the other hand, new, more preforming solutions, using innovative and cheap nano-magnetic supports, are highly desirable. In particular, improvement of the enzyme loading, low tendency to aggregate during recycling, are very desirable properties.

Carbon dioxide, which is the main greenhouse gas, represents today one of the major reasons of global temperature increase. One of the possible ways to reduce CO_2 emission is to capture and eventually valorise it. In this scenario, the main challenge is to develop new solutions with low environmental impacts. On the other hand, CO_2, through a chemical way and use of non-fossil energy, can be transformed into chemicals, pharmaceuticals, or biofuels, e.G., syngas for mediated productions. Morphology control, catalyst composition, support effect, and adjustment of precisely exposed crystallographic facets were identified as the key parameters to improve electro-activity and selectivity of catalysts. Moreover, the observation that hydrogen evolution reaction (HER) is an inevitable rival reaction of the reduction of CO_2 in aqueous media, suggests attempting for a competitive approach, in search for the simultaneous CO_2 conversion and hydrogen production. The achievement of this goal requires the design of a catalyst capable, by virtue of multi-functionalities and multi-constituents, to produce controlled compositions: from CO to syngas and H_2 with specific ratios.

In this scenario of electrochemical nano-assisted catalysis, the exploration of carbon nanomaterials as catalysts support, due to their conductivity, large specific surface area, high porosity, and relative chemical inertness results also of particular interest

Research team and environment

The PhD student will work inside the Interdepartmental Research Center NANO_MATES (Research Centre for NANOMAterials and nanoTEchnology at Salerno University) c/o Department of Physics of the Salerno University. NANO_MATES was born with the idea of generating a research network within the Salerno Campus to enhance the skills acquired in the field of nanosciences and nanotechnologies with a particular focus on sustainability through a strong synergy between researchers from several departments. In particular, the research team mainly composed of Chemical Engineers, is constituted of 2 Full Professors, 3 Associate Professors, 2 PhD student, 3 senior researchers and several PhD/Post Docs responsible of different National and International collaborative projects. The laboratories are equipped with different facilities. For the characterizations, the following are available: Electron Microscopy (SEM, FESEM, TEM) with X-ray (EDX) and electron diffraction analysis (SAED), Magnetic Resonance Imaging (MRI), NMR and Raman spectroscopy, XRD, FT-IR and UV-Visible spectroscopy, thermal analysis (TG-IR), Ion Chromatography, N_2 adsorption / desorption, particle size distribution and numerous plants for testing and process analysis.

Suggested skills for this research topic

Chemical Engineering

Environment Engineering

Nanotechnology

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 3. Technology and Territory

Sustainable integrated strategies for preservation and maintenance of urban art

Reference Person: Scalarone Dominique Maria (dominique.scalarone@unito.it)

Host University/Institute: Università degli Studi di Torino

Research Keywords:	Innovative surface treatments
	Risk assessment of urban artworks
	Decision-making
Reference ERCs:	PE4_17
	PE5_15
	SH7_7
Reference SDGs:	GOAL 9: Industry, Innovation and Infrastructure, GOAL 11: Sustainable Cities and Communities, GOAL 12: Responsible Consumption and Production

Description of the research topic

The 2030 Agenda emphasizes the need to improve the well-being of urban centres. Today half of the world population resides in large urban agglomerations that cover only 3% of the surface of the globe. Between 60-70% of global energy is consumed in 3% of its territory. Art in all its forms and its conservation are a precious tool for increasing the well-being of the community, not only because it can have important economic implications, but also because art is able to strengthen the sense of belonging to a certain community. This is even more true for contemporary public art works, which often respond to a direct need of the community, like for instance many street art works, or are commissioned by institutions or individuals with celebratory intent or in the context of urban regeneration projects.

Unfortunately, outdoor urban works of art are continuously subject to the action of multiple agents of degradation, both anthropogenic (e.G. Atmospheric pollution, vandalism) and natural (e.G. Atmospheric agents), which cause their rapid degradation. Climate change abruptly modifies environmental conditions, making the picture of the mechanisms of degradation and their effects on urban works of art even more complex and dynamic than in the past.

This project aims to define methodologies, tools and best practices for the preservation and sustainable maintenance of urban works of art. The choice of materials, technologies and processes is fundamental to ensure the environmental and economic sustainability of any

preservation action. The PhD candidate will develop and test new solutions and protocols to identify environmental risks, to detect degradation processes, to effectively clean and protect the surfaces of outdoor urban works of art.

The working methodology will be based on:

- the use of innovative technologies (for the analysis of the condition state of the artworks) and materials (for the cleaning and protection of damaged surfaces)

- the attention to economic, environmental and social sustainability criteria

- the analysis of the socio-cultural and historical-artistic context of the artworks

- the analysis of the needs expressed by the community, by funding bodies of public art works and by institutions or authorities responsible for their maintenance.

Research team and environment

Most of the research activities will take place at the Department of Chemistry of the University of Torino where a research line on Cultural Heritage is active, involving experts in diagnostics, development of materials and methods for heritage conservation. In addition to the laboratories, equipment and services offered by the Department of Chemistry and by the other Departments and research groups of the University of Torino engaged in researches on Cultural Heritage, the project will benefit from the solid collaboration with a network of national and international partners who in recent years have shared and share research experiences centred on the theme of conservation of public art, urban decor and urban creativity, such as the European project CAPuS (Conservation of Art in Public Spaces, Erasmus + Knowledge Alliances Program) and the project SuPerStAr (Sustainable Preservation Strategies for Street Art, PRIN2020). The network includes universities (University of Pisa, University of Bologna, Politecnico di Milano, University of Split, University of Vigo), research centres (CNR), academies and conservation institutes (Conservation and Restoration Centre "La Venaria Reale", Academy of Fine Art in Warsaw, Cologne Institute of Conservation Sciences), museums, companies, local authorities and associations of artists and restorers. Through this network the access to the equipment and services of the E-RIHS.It infrastructure (European Research Infrastructure for Heritage Science www.E-rihs.Eu) is also provided, in particular as regards the application of the MOLAB-Mobile Laboratory Facility to contemporary urban art.

Suggested skills for this research topic

The ideal candidate is expected to have a technical-scientific background, preferably in the field of analytical chemistry and characterisation methods. Skills in polymer science and heritage conservation science and technologies will be positively assessed. The candidate must have an aptitude for interdisciplinarity, good critical and communication skills and a willingness to work in a heterogeneous team in terms of skills and background. The

successful candidate will need to be curious, highly motivated and independent in managing daily research activities.

Curriculum: 3. Technology and Territory

Urban resilience and participation for the territory safety from risks

Reference Person: Spadaro Ilenia (ilenia.spadaro@unige.it)

Host University/Institute: UNIGE - University of Genoa

Research Keywords:	Resilient spatial planning
	Territory safety
	Stakeholder participation
Reference ERCs:	SH7_8 Land use and planning
	PE8_11 Environmental engineering, e.G. Sustainable design, waste and water treatment, recycling, regeneration or recovery of compounds, carbon capture & storage
	SH7_10 GIS, spatial analysis; big data in geographical studies
Reference SDGs:	GOAL 11: Sustainable Cities and Communities

Description of the research topic

The main goal of the research is the definition and implementation of a resilient, participatory and therefore sustainable approach to the issue of the territorial safety from external risks. The natural and man-made disasters that have occurred in recent years show how the resilience of a city does not depend only on the actions carried out by public authorities but requires the joint work of all the actors who live or work in a city. Another aspect emerged is that the current instruments are not always able to plan and successfully manage the different phases that characterize the risks. The aim of the research is therefore to deepen the concept of exposure within the definition of risk.

Resilience represents the ability of an urban system to adapt to an external event and quickly return to normal. This research considers the topic of risk in relation to the concept of resilience in urban planning, participatory methodologies, technologies and policies. Urban resilience has become an important goal for cities (Agenda 2030 and/or National Recovery and Resilience Plan, PNRR in Italy, for example), particularly in addressing climate change.

Implementing resilience perspectives demands the definition of a multiscale and intersectoral approach. And this approach must support the transition and adaptation of institutions and communities through specific territorial governance strategies and urban planning tolls, to accomplish a sustainable and safe urban space.

Specific attention in the research is given to the involvement and participation of stakeholders. This proposal contributes to the implementation of the "Quadruple helix principle", according to which the involvement of these four actors - public bodies, research, businesses, citizens - is necessary to achieve a common objective, such as increasing urban resilience. For the definition of the methodology, according to the ""learning by doing"" approach, it will be useful to explore one or more case studies (mainly taken from experiences of local, national and European planning) to understand how the individual actors (mentioned above) have responded and collaborated, adapting in a resilient way, to natural and anthropic events they were subjected to. It's essential to consider places and times that characterize each exposure in order to create dynamic scenarios. The scenarios, created thanks to the GIS Geographic Information System, are defined to plan mitigation actions in times of peace and emergency. This last point refers to temporal urban planning (time-based urban planning approach) which can be strategic for building resilience in cities. In particular, the proposed methodology will have to reduce, mitigate the risk and increase resilience by identifying specific scenarios and actions that every citizen actor - public bodies, research, businesses, citizens - will be able to implement to attain the goal of sustainability (environmental, economic and social) and safety.

Research team and environment

The research activity will take place at the Department of Civil, Chemical and Environmental Engineering (DICCA) of the University of Genoa. The candidate will be part of the Urban and territorial planning working team. The PhD student will have access to the main researches developed on the topics: Strategic planning, Territory safety from natural events, Urban resilience (from natural and man-made disasters); Environmental, social and economic sustainability with attention to the participatory approach; Urban and territorial regeneration, with enhancement of internal areas; Sustainable mobility; Sustainable waste management; Sustainable and slow tourism; Sustainable energy; Promotion of the territory and creation / accompaniment of start-ups; Port planning and waterfront redevelopment. These researches are and have been carried out through European and national programs and research contracts with Public Administrations. In particular, the teachers of the team are part of the ""Sustainable UniGe"" working group.

Suggested skills for this research topic

The suggested profile is a graduate student in Civil or Environmental Engineering or Educational Sciences and Psychology. The PhD student should have: interest in participatory research, community involvement; skills in resilience, risks and participatory methodologies learned in courses, internships or degree theses; previous experience in European projects, preferably on the topics covered by the research; ability and willingness to work in a collaborative, multidisciplinary environment, with an interdisciplinary approach and interest. Other technical skills required: GIS or AutoCAD.

CU3.33

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Curriculum: 3. Technology and Territory

E-mobility and Smart-Grids

Reference Person: Testa Antonio (atesta@unime.it)

Host University/Institute: University of Messina

Research Keywords:	Decarbonisation of electric systems
	Smart-Grids
	E-Mobility
Reference ERCs:	PE7_2 Electrical and electronic engineering: semiconductors, components, systems
	PE7_12 Production, distribution and applications of the electric energy
	SH2_8 Energy, transportation and mobility
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 9: Industry, Innovation and Infrastructure, GOAL 11: Sustainable Cities and Communities

Description of the research topic

The decarbonisation of electric systems requires a rapid increase in the production of non-fossil electricity, as well as a significant improvement in the efficiency of the transport and use of electricity. This could be achieved through Smart-Grids, which are complex electric networks that exploit power and data infrastructures to ensure high levels of efficiency, sustainability, safety, resilience, continuity and quality of electricity supply. E-mobility deals with the development of land, sea and air vehicles which are powered by electric motors and which get their energy mainly from the electrical grid. Smart-Grids and E-Mobility are key pillars of the transition to a carbon neutral society, closely related to each other. In fact, E-Mobility is about to become a new important form of end-use of electricity and Smart-Grids will become the main energy source for transport, moreover, a spread of E-Mobility is fundamental to make profitable large investments on Smart-Grids infrastructures.

The scholarship will start with a deep insight on some possible interactions between E-Mobility and Smart-Grids. Among them:

-       The low range and long charging times of electric vehicles could be addressed in the near future with E-Roads integrated into Smart-Grids, where electricity is supplied directly to moving vehicles through wireless coupling systems. However, more efficient and reliable wireless charging systems are required as well as suitable energy management strategies.

- Parked electric vehicles can be turned into active elements of Smart-Grids, providing highly valued demand response services (V2G). This requires efficient bidirectional power converters, communication protocols and suitable business models.

- Charging stations are rapidly spreading while their power is increasing in a rush to reduce charging times. However, some practical problems arise, related to the battery safety and lifetime, grid stability and power quality.

- Millions of tons of lithium-ion batteries decommissioned from electric vehicles will have to be disposed of in the coming years. Since recycling is not cost-competitive, a possible alternative is a ""second life"" batteries reuse as storage systems in Smart-Grids. This requires the development of methodologies for estimating benefits in terms of costs and environmental impact.

- Naval and air electric vehicles will spread rapidly in the coming decades. This will set new challenges in the design of on board power systems and energy storage systems as well as in designing Smart-Grids for ports and airports.

- Power electronics is an enabling technology for both E-Mobility and Smart-Grids. It provides the glue that holds together in a controllable way all the components of a Smart-Grid and is essential for the development of electric vehicles and charging infrastructures. Innovative SiC and GaN power devices will allow in the next years to overcome the limits of conventional silicon devices in terms of efficiency, operating temperature and power density. However, new circuit topologies, cooling systems, magnetic devices and control techniques suitable for the new devices are required.

One of these topics will be selected and innovative solutions will be addressed, either from a theoretical point of view, either from an experimental one.

Research team and environment

The E-mobility and Power Electronics research team at the Department of Engineering of the University of Messina is composed of a full professor, an associate professor, a lecturer and three Phd students. Experimental research activities are accomplished at the Laboratory of Electrical Drives and Power Electronics which has been developed over the years to carry out research in the fields of industrial automation, power converters, electric mobility, electric grids and exploitation of renewable energy resources. Among the available instrumentation are some systems for the development of digital twins, a grid simulator, a simulator of photovoltaic generators as well as measurement and monitoring systems for vehicular and stationary battery packs. The team is partner of ST-Microelectronics, CNR and some Italian Universities and firms in research activities in the fields of E-Mobility and Smart-Grids.

Suggested skills for this research topic

The candidate should have a master's degree in electrical or electronic engineering and be familiar with simulation environments such as Simulink, Plecs, Psim, and Spice. Furthermore, a consolidated experience in laboratory activities is highly recommended, and in particular in the design, realization and experimental evaluation of electrical, electromechanical and electronic systems.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 3. Technology and Territory

Connecting online musicians and audiences to reduce travels and pollution

Reference Person: Turchet Luca (luca.turchet@unitn.it)

Host University/Institute: University of Trento

Research Keywords:	Networked music performance systems
	Sustainable smart city
	Musical interactions
Reference ERCs:	PE6_9
	SH5_5
	PE7_8
Reference SDGs:	GOAL 4: Quality Education, GOAL 9: Industry, Innovation and Infrastructure, GOAL 11: Sustainable Cities and Communities

Description of the research topic

This PhD project will focus on the development of radically new technologies based on 5G and Multisensory Extended Reality which are capable of truly interconnecting musicians as well as musicians and audiences. Such technologies will allow musicians to perform, rehearse, teach and learn online, and audiences to experience concerts remotely. A system with such capability has several benefits for society and the environment which are relevant for sustainable development. Firstly, it allows to drastically reduce the time and costs for travels, while zeroing any pollution due to travels. This impacts several users and a set of activities, the musical ones, which are widespread across society. Moreover, the proposed system is useful for all situations in which travels are difficult. This includes non-optimal atmospheric conditions, physical disabilities of the users, or the position of the users in geographically isolated areas.

The need to conduct musical activities remotely (e.G., live performances, teaching and learning music, rehearsing, recreational music making) has been promoted markedly by the social distance measures posed by the recent worldwide COVID-19 pandemic. However, today it is still impossible to connect musicians as well as audiences over the Internet as in real-life. End-users need real-time solutions that truly give them the feeling of being together in the same environment, sharing the same experience. This is crucial for a successful joint coordination of sounds and movement, and eventually for realising strong feelings of shared musical experience and sense-making.

The combined use of 5G and Multisensory Extended Reality technologies have the unexplored potential to cater to musicians and audiences needs by providing low- latency interactions in shared virtual or augmented environments.

This PhD project will create multisensory technologies exploiting audio, visual, and haptic stimuli to generate compelling illusions of being present in shared virtual or augmented environments. It will also design, develop and evaluate the resulting musical interactions possible in such environment. For this purpose, we will adopt user-centered design methodologies, in particular participatory design. The project will investigate a wide variety of musical activities. It will also involve a wide user basis which includes amateur and professional musicians and concert-goers, and will consider several diversity factors such as gender, age, and disabilities.

Research team and environment

The project will be hosted at CIMIL, the Creative, Intelligent and Multisensory Interactions Laboratory. This is a research team of University of Trento lead by the applicant, which is currently composed by 4 PhD students and 1 Postdoc. The PhD candidate will have access to the Multisensory Interactions Laboratories, a research facility composed by two rooms fully equipped with material for audio-based and virtual reality based interactions.

The PhD candidate can also count on the expertise of other professors within the Department who have complementary expertise to those of CIMIL researchers, such as Prof. Fabrizio Granelli and Paolo Casari, experts in networks.

Suggested skills for this research topic

The successful candidate will have a background as a computer scientist as well as will possess musical knowledge. In particular it is required to have competences in human-computer interaction as well as expertise with software frameworks for Virtual Reality and audio processing

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 4. Theories, Institutions and Cultures

Diachronic webfare: transgenerationality

Reference Person: Andina Tiziana (tiziana.andina@unito.it)

Host University/Institute: University of Turin (UniTo)

Research Keywords:	Transgenerationality
	Society
	Justice
Reference ERCs:	SH5_10 Ethics; social and political philosophy
	SH3_8 Population dynamics; households, family and fertility
	SH2_7 Environmental and climate change, societal impact and policy
Reference SDGs:	GOAL 4: Quality Education, GOAL 16: Peace and Justice Strong Institutions

Description of the research topic

The world in which we live is neither determined nor unified: technological progress, emerging complications, and ecological and health crises are increasingly forcing us to reconsider the terms of our existence, and especially our relations with natural and social reality as a whole.

It is now clear that many social practices implemented through information technologies create value: the so-called documedial capital, i.E. The value of the data generated by processing and sharing the traces we produce using the web. Documedial capital is increasingly exploited by digital platforms but is rarely conceptualised or capitalised for the benefit of the community or future generations, i.E. As webfare. An integration between the theory of transgenerationality and the theory of documedial capital therefore seems promising for identifying economic resources that policy makers can use to support the implementation of transgenerational policies aimed at social and environmental sustainability.

Within this framework, the project's research hypothesis is that societies are transgenerational devices, i.E. They are complex artefacts created by human beings with a view to a purpose. They enable the capitalisation of knowledge and resources by transferring them over time between generations. Some particularly urgent problems of the current historical phase, such as the climate and environmental crisis or the sustainability of national public debts and welfare systems, highlight what Gramsci already pointed out in his reflection

on the southern question, namely how the exploitation of the north by the south (for Gramsci it was Italy, but the discourse can be applied to the north and south of the world) was linked as much to the dynamics of industry and the production system as to the exploitation of the territory. They also make it clear that 'the preservation of time' is at least as urgent as that of space, hence the recent updates to the Italian Constitution with reference to future generations on issues such as the environment and welfare.We invite original proposals that address these issues, given the crucial problems opened up by transgenerationality and the impact that new technologies have on welfare systems: the nature of the transgenerational pact, the notion of future and past generations, the nature of transgenerational emotions, the formulation of criteria for intra- and intergenerational justice, the ways in which they are transferred to the social and political spheres, and the evolution that new technologies have brought about in the ways in which transgenerational relations are managed.

Research team and environment

The research activity will take place within the Department of Philosophy and Educational Sciences (DFE) of the University of Turin (UniTo), which is one of the largest and highest ranked universities in Italy (it has been classified by QS Subject Ranking in 2022 as the top Department of Philosophy in Italy and among the top 100 in the world). Awarded Excellence funding from the Italian Ministry of University, the DFE offers an innovative and interdisciplinary approach in teaching and research. Academic staff members include prominent scholars in philosophy, education, semiotics, communication studies and sociology. Key areas in these fields are studied with reference to both their historical development and influence on contemporary culture.

The researcher will also have the opportunity to collaborate with research centres involving the Department, such as CIRCe, the Centre for Interdisciplinary Research on Communication (https://www.Circe.Unito.It/en/), which brings together semioticians and scholars from various fields developing interdisciplinary analyses and promoting theoretical and empirical research on communication and culture; Labont - Centre for Ontology (www.Labont.It), an interdepartmental research centre specialised in ontologies; and Scienza Nuova (http://www.Scienzanuovainstitute.Com), a research centre involving researchers from the University of Turin and Turin Polytechnic, which aims to develop researches with a strong interdisciplinary character in which the social transformations produced by digital technologies are addressed through collaboration between the humanities and technology.

For this scholarship a period of internship is planned at *Ernst & Young Business School*

Suggested skills for this research topic

- Basic knowledge in philosophy: metaphysics, ontology, social and political philosophy.

- Knowledge in the humanities, especially in semiotics and philosophy

- Predisposition for interdisciplinary research

- Research and information management

– Self-management and interpersonal skills

Type of scholarship and obligations

The type of this scholarship is: Dottorati Innovativi (Innovative PhD courses). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 4. Theories, Institutions and Cultures

Institutions and governance of climate change

Reference Person: Beretta Ilaria (ilaria.beretta@unicatt.it)

Host University/Institute: Università Cattolica del Sacro Cuore

Research Keywords:	Institutions
	Interdisciplinarity
	European Green Deal
Reference ERCs:	SH2_7 Political systems and institutions, governance S
	H3_2 Environmental change and society
	SH3_1 Environment, resources and sustainability
Reference SDGs:	GOAL 13: Climate Action, GOAL 16: Peace and Justice Strong Institutions

Description of the research topic

The PhD program in 'Institutions and governance of climate change' focuses on the central role that institutions must play at all administrative and territorial levels in the transition to a sustainable and resilient society in front of climate change. Faced with the threat of increasing global risks, from health and environmental risks to financial and geo-political risks, the PhD program point to the creation of new administrative and business cultures based on a systemic interdisciplinary vision, which can drive innovative governance approaches and methods. The PHD in 'Institutions and governance of climate change' aims at generating the interdisciplinary skills (socio-economic, legal, political, administrative, methodological) that are essential to manage complexity and to adopt integrated perspectives for the governance of transformations related to climate change and sustainability. The PhD has a specific focus on the 'sustainable transition' led by the European Green Deal of the European Commission, which pursues climate neutrality by 2050, and to its implementation through the different levels of government and through the involvement of the actors from industry and finance.

Research team and environment

Università Cattolica is one the largest non-state universities in Europe, with more than 41.000 students enrolled and 1.293 professors and researchers in 5 campuses (Milan, Brescia, Piacenza, Cremona and Rome). The professional academic staff helps students to connect learning and desired career path. The range of campus facilities and services ensures that every student has access to all of the support, information and mentoring they need.

Università Cattolica offers 98 courses for 1st and 2nd level laurea degrees and 147 post-graduate masters, as well as 17 doctoral schools with 21 PhD programs in the ten disciplinary areas in which Cattolica is active. At present, the research portfolio includes more than 300 active projects getting funds from competitive calls. In 2014-2019, Cattolica has been partner or leader in 58 Horizon 2020 projects, including 14 MSCA and 2 ERC grants in humanities and social sciences. Università Cattolica pursues multidisciplinary and interdisciplinary approaches to scientific research, in particular aiming at a synthesis between the responsible use of methodologies of empirical sciences and speculative knowledge. The research team for the PhD program includes political scientists, sociologists, economists, and research methodologists. Part of the research team is affiliated to ASA - Alta Scuola per l'Ambiente', a postgraduate school that Università Cattolica created 13 years ago to gather competencies on the environment existing in different faculties and departments.

For this scholarship a period of internship is planned at *Comune di Brescia*, *Brescia*

Suggested skills for this research topic

Skills required: strong motivation, flexibility, resourcefulness; no specific disciplinary backgrounds will be excluded; previsous research and work experiences on environment/climate change /sustainability will be preferred

Type of scholarship and obligations

The type of this scholarship is: Pubblica Amministrazione (Public Administration). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Curriculum: 4. Theories, Institutions and Cultures

Shaping sustainable identities through literature and art.

Reference Person: Bolchi Elisa (elisa.bolchi@unife.it)

Host University/Institute: Univeristy of Ferrara

Research Keywords:	Sustainable identities
	Awareness and understanding of climate crisis
	Literary and rhetorical devices
Reference ERCs:	SH5_2 Theory and history of literature, comparative literature
	SH7_5 Sustainability sciences, environment and resources
	SH7_6 Environmental and climate change, societal impact and policy
Reference SDGs:	GOAL 4: Quality Education, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

Fear, alarm, anxiety, anguish and even panic are feelings engendered by climate change, often leading to denial. The three forms of denial described by Stanley Cohen in 'States of Denial: Knowing about Atrocities and Suffering' (2000) apply well also to the reactions of individuals and institutions to climate change. The first form, literal denial, is the outright rejection that something happened or is happening - this is often the position of those who have economic or political interests in denying climate change and maintaining the status quo. The second position is that of interpretive denial, mostly a defence mechanism in which people interpret facts in ways that distort their meaning or importance. The third and most common attitude toward climate change is implicatory denial, which is when people acknowledge that the problem exists but deny or minimise their moral implications, thinking that they cannot make any difference. While it is hard, when not impossible, to establish a dialogue with the first type of denialists, it is crucial to raise awareness of climate change in those showing an attitude of interpretive or implicatory denial. As these are often positions based on negative feelings, denial cannot be overcome only through scientific data and techniques of persuasion.

This research project will investigate how literature can play a crucial role not only in raising awareness about (un)sustainability and the climate crisis, but also in reflecting on and dealing with its repercussions, such as climate refugees; the interactions between the environment and human, other-than-human and AI; inequality and diversity. Works of literature and/or art, including but not limited to works based on utopian/dystopian and apocalyptic narratives, will

be selected as case studies to understand whether rhetorical devices such as irony and humour or literary devices such as pastiche and rewriting can provoke ecological thinking.

The method of investigation will involve the general public - schools and/or firms - through workshops, lectures, and interviews aimed at understanding if and how literature, by raising awareness, can help shape sustainable identities and thus allow people to face the challenges of ecological transition and innovation.

Research team and environment

The selected student will work at the Department of Humanistic Studies of the University of Ferrara. The main responsible of the project will be Doctor Elisa Bolchi, a member of the Scientific Board of the PhD Programme in Environmental Sustainability and Wellbeing. Members of the team have a strong expertise in English literature, literary ecology, ecolinguistics, and the digital humanities. The research environment is strongly interdisciplinary, interdepartmental, and international thanks to the activities of the PhD programme in Environmental Sustainability and Wellbeing (http://www.Unife.lt/studenti/dottorato/it/corsi/riforma/environmental-sustainability-and-wellbeing), coordinated by Prof. Paola Spinozzi, an expert in literary ecology and utopia who will also act as co-supervisor.

Suggested skills for this research topic

Candidates should be able to reflect and work on literatures and the arts as systems of knowledge and representation; they should also have familiarity with theory, critique, and history of literatures from a comparative and transnational perspective. A general knowledge of crucial issues such as ecological thought, cultures of sustainability, interconnectivity, speculative fiction and climate narratives is highly appreciated.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 4. Theories, Institutions and Cultures

The neuro-cognitive bases of sustainable decision-making

Reference Person: Canessa Nicola (nicola.canessa@iusspavia.it)

Host University/Institute: IUSS Pavia

Research Keywords:	Sustainable decision-making
	Cognitive modulators of decision-making
	Neuroscience of decision-making
Reference ERCs:	LS5_9 Neural basis of cognition
	SH4_7 Reasoning, decision-making; intelligence
	SH1_7 Behavioural economics; experimental economics; neuro-economics
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 4: Quality Education, GOAL 12: Responsible Consumption and Production

Description of the research topic

This project first aims to develop and validate novel tools for assessing the disposition towards sustainable (vs. Selfish) decision-making, using both explicit measures such as questionnaires and implicit measures such as the implicit association test, as well as metrics of choice-related brain activity resulting from neurophysiological response such as electroencephalography (EEG) and/or functional magnetic resonance imaging (fMRI). Once validated against simpler and well-established measures of sustainability such as the Fish-game, the developed tools will be used to investigate whether, and to what extent, a sustainable decision-making aptitude can be modulated by different experimental manipulations. These will include, for instance, the cognitive framing of the decisional problem and its outcomes (e.G.In terms of gains vs. Losses), the perception of emotional cues, and the degree of realism of its presentation (e.G., by comparing choices elicited by immersive virtual-reality vs. A standard experimental setup with stimuli presented on a PC-screen). Again, the effects of these experimental manipulations will be assessed both at the behavioral level and in terms of neurophysiological brain response, using an innovative immersive-EEG experimental setup. This project is expected to result in distinct outputs, including deliverables (i.E., tools for measuring a sustainable decision-making aptitude) and scientific articles reporting their applications in neuro-cognitive settings. Overall, these outcomes are expected to help refining the available socio-cognitive models of sustainable choice, thus paving the way to further multidisciplinary extensions of the inquiry on the cognitive precursors of sustainable decision-making in different contexts.

Research team and environment

This project will benefit from the recently-developed IUSS-Maugeri Cognitive Neuroscience Laboratory, that takes a multidisciplinary approach to investigate the neural bases of healthy or pathological human behavior with several research techniques applied to different populations. The lab is equipped with most of the techniques that are used in cognitive psychology and cognitive neuroscience to investigate cognitive functioning and its neurophysiological bases, including neuroimaging, non-invasive brain stimulation, eye-tracking, and immersive virtual reality. The Lab is run by researchers based at the IUSS School (Nicola Canessa, Giulia Mattavelli) in collaboration with external researchers. The members of the laboratory, and their collaborators, are specialized in all phases of research in cognitive and clinical neuroscience, from the definition of the experimental design to the collection and analysis of data.

Selected examples of the activities performed at the Cognitive Neuroscience Laboratory in the field of Neuroeconomics:

Altered striatal-opercular intrinsic connectivity reflects decreased aversion to losses in alcohol use disorder. Doi.Org/10.1016/j.Neuropsychologia.2022.108258

High-definition transcranial direct current stimulation of the dorsal anterior cingulate cortex modulates decision-making and executive control. Doi.Org/10.1007/s00429-022-02456-3

Risk perception and behaviour during the COVID-19 pandemic: Predicting variables of compliance with lockdown measures. Doi:10.1371/journal.Pone.0262319

Increased decision latency in alcohol use disorder reflects altered resting-state synchrony in the anterior salience network. Doi: 10.1038/s41598-021-99211-1.

Psychological precursors of individual differences in COVID-19 lockdown adherence: Moderated-moderation by personality and moral cognition measures. Https://doi.Org/10.1016/j.Paid.2021.111090, November 1 2021

Posterior fronto-medial atrophy reflects decreased loss aversion, but not executive impairment, in alcohol use disorder. Doi: 10.1111/adb.13088.

Suggested skills for this research topic

Preferred qualifications include

- Masters degree in Psychology or Economics

- Previous experience with design and/or performance of studies in cognitive psychology and/or cognitive neuroscience

- Previous experience with the fields of behavioural economics and/or psychology of decision-making

- Familiarity with psychological experiment software (e.G. Presentation, E-Prime, etc.)

- Strong motivation towards research in challenging environments

Good capability to work in a team and interest for multidisciplinary research are essential, along with a good knowledge of English language, both spoken and written.

Curriculum: 4. Theories, Institutions and Cultures

Governing Sustainable Development and Climate Change: Theories and Regulation

Reference Person: Chiti Edoardo (edoardo.chiti@santannapisa.it)

Host University/Institute: Sant'Anna School of Advanced Studies

Research Keywords:	Law and regulation
	Public policies
	Ecological transition
Reference ERCs:	SH2_9 Global and transnational governance, international studies
	SH2_7 Political systems and institutions, governance
	SH3_2 Environmental change and society
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action, GOAL 16: Peace and Justice Strong Institutions

Description of the research topic

We welcome projects addressing legal issues concerning the theories and regulation of sustainable development and climate change. In particular, we encourage ambitious submissions based on wide ranging theoretical foundations and relying on a plurality of approaches, including international law, constitutional law, transnational regulation, legal analysis of regional and national policies and remedies; further relevant fields of research include the impact of climate change on fundamental rights, the transition to agri-food sustainability, the legal issues related to the use of AI protocols and insurance mechanisms. We encourage interdisciplinary research projects, directed to the advancement of legal knowledge and research, but capable of benefiting from and possibly contributing to other disciplines, including philosophy.

Research team and environment

The research will be carried out in the intellectually stimulating and highly engaging academic environment of the Sant'Anna School of Advanced Studied and in the wider network of the scholars and institutions participating in the PhD Curriculum in 'Theories, Institutions and Culture'. At the Sant'Anna School, the research will be developed within the Institute of Law, Politics and Development (DIRPOLIS). The Institute conducts innovative research in the fields of law, political science, development economics, moral and political philosophy. Its multidisciplinary approach allows for a comprehensive representation of complex legal,

political, social and economic phenomena. Its manifold projects and activities on environmental-related issues, carried out within a cooperation network gathering a number of scholars from various European and non-European universities, promote high level scientific researches in the field of climate change and sustainable development.

Suggested skills for this research topic

Candidates are expected to have a robust legal background, a strong attitude for critical thinking and team-working skills.

Curriculum: 4. Theories, Institutions and Cultures

The Transformation of Work

Reference Person: Ferraris Maurizio (maurizio.ferraris@unito.it)

Host University/Institute: University of Turin (UniTo)

Research Keywords:	Work
	Digital transformation
	Economic sustainability
Reference ERCs:	SH5 Cultures and Cultural Production
	SH2_10 Communication networks, media, information society
	SH5_12 Computational modelling and digitisation in the cultural sphere
Reference SDGs:	GOAL 8: Decent Work and Economic Growth, GOAL 10: Reduced Inequality, GOAL 16: Peace and Justice Strong Institutions

Description of the research topic

Fear, much more than hope, is what characterizes the postcoronial world we are entering after two years of pandemic. As the Antivax movement shows, this fear has much less to do with the disease than with a widespread sense of irrelevance, whereby humanity feels it is being progressively replaced by machines. In fact, the Web is neither a spying machine nor a machine for social surveillance. Instead, it is a machine for recording human behavior and capitalizing on it via advertising, profiling, and, increasingly, automation. Automating means teaching a machine to behave like a human. And those who wrongly fear being spied on by their devices are in fact (since they keep using them) contributing to the creation of the machines that will eventually make them useless in their role as homo faber. Above all, this increases the enormous surplus value gained by the platforms, which, unlike users, own the data the latter produce, and can invest, resell, and reuse them; with no risk of shortage, because data, unlike oil, can never run out and will be increasingly useful and abundant in an economy that is more and more about collecting and managing data. The creation of a Webfare system, i.E. Digital welfare, starts from this vision and proposes a solution that has not been pursued so far because it has not even been conceived. There can be no going back, nor is it desirable to do so. What is necessary is to make the main international political organizations aware of the need to shift legislative intervention from the protection of privacy to the taxation of the surplus value gained by platforms. But these processes take time and, above all, knowledge. Reducing time and increasing knowledge requires an intervention capable of both providing timely relief to the needs of humanity and generating

the cognitive and conceptual apparatus to allow the political world to negotiate with platforms, going beyond simple taxation, so as to kickstart a virtuous circle that will restore hope where there is only fear. Although the Web economy corporations (unlike oil companies) no longer profit from the decomposition of dinosaurs that have been dead for millions of years, but from the activity of living humans, the latter are compared to dead dinosaurs whenever data is defined as the "new oil". Despite their role as data producers and recipients of services, users are thus excluded from sharing in the profits of this documedia capital (born from the intersection between the production of documents and the new media) – a capital that is much more performative than financial capital, because, in addition to advertising profits, it generates consumer profiling and process automation.

We need to create a Webfare that would provide the social, economic, and cultural conditions for a transition from the homo faber of the last ten thousand years to the homo sapiens of the new economy, in which humans are not valued for their physical strength and executive patience, but for their intelligence, their culture, and their humanity.

In this framework, we invite original proposals dealing with such issues, also in view of the labour transformations required by the energy transition and digital transformation.

Research team and environment

The research activity will take place within the Department of Philosophy and Educational Sciences (DFE) of the University of Turin (UniTo), which is one of the largest and highest ranked universities in Italy. Awarded Excellence funding from the Italian Ministry of University, the DFE offers an innovative and interdisciplinary approach in teaching and research. Academic staff members include prominent scholars in philosophy, education, semiotics, communication studies, and sociology. Key areas in these fields are studied with reference to both their historical development and influence on contemporary culture.

The researcher will also have the opportunity to collaborate with research centres as Labont – Centre for Ontology (www.Labont.lt), an interdepartmental research centre specialised in ontologies; and Scienza Nuova (http://www.Scienzanuovainstitute.Com), a research centre involving researchers from the University and Turin Polytechnic, which aims to develop researches with a strong interdisciplinary character in which the social transformations produced by digital technologies are addressed through collaboration between the humanities and technology.

For this scholarship a period of internship is planned at *Ernst & Young Business School*

Suggested skills for this research topic

- Knowledge in the humanities, especially in theoretical or political philosophy

- Predisposition for interdisciplinary research

- Research and information management

-      Self-management and interpersonal skills

Type of scholarship and obligations

The type of this scholarship is: Dottorati Innovativi (Innovative PhD courses). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 4. Theories, Institutions and Cultures

Synchronic Webfare and Sustainability

Reference Person: Ferraris Maurizio (maurizio.ferraris@unito.it)

Host University/Institute: University of Turin (UniTo)

Research Keywords:	Sustainability
	Welfare
	Wealth
Reference ERCs:	SH5_12 Computational modelling and digitisation in the cultural sphere
	SH1 Individuals, Markets and Organisations
	SH1_3 Development economics; structural change; political economy of development
Reference SDGs:	GOAL 4: Quality Education, GOAL 8: Decent Work and Economic Growth, GOAL 10: Reduced Inequality

Description of the research topic

The sustainability of welfare systems today seems to be put at risk for demographic reasons and labour transformation, as well as for the large investments required by the energy transition. Webfare, a digital welfare, must pass through education, which would teach us to find new names and new forms, more tolerant and just, to the human needs for security, identity and projection into the future that in the past have been recognised in those old names.

The project aims to at least partially correct the new forms of inequality, for social purposes, what is both the strength and the limitation of big commercial platforms. A platform is nothing more than an apparatus for obtaining results from data, which can be of two types: semantic or syntactic. This will be possible through the development of Webfare, i.E., a new form of welfare based on the great value derived from the Web.

Semantic data (SQL, structured query language: structured in such a way that it can be searched) is generally found in small or medium-sized platforms: businesses, healthcare companies, banks, libraries, universities. A healthcare provider, for example, records its patients' personal data, their pathologies and therapies; and every time one types in one's name on the website, the information is retrieved and, if necessary, enriched with new data (the same goes for the works of a certain author in a library catalogue, a students' tests and grades in a university filing system, or the invoices issued by a company). Such data is very

clear but necessarily limited, because it has to make sense in order to be recorded, and requires human intervention.

A completely different matter is syntactic data (no SQL in computer jargon), which consists of very long reports of data collected with the logic of Borges' Chinese Encyclopaedia. Now, in a classification of animals marked as "belonging to the emperor", "painted with a very fine brush" or "having broken a vase", the only thing that's clear is that the classification is illogical. Instead, when one has billions of data referring to the geolocation, biorhythms, behaviours and emotions of millions of people, one can discover unthinkable associations - and, for example, find that there is a correlation between smoking and long highway stops.

Syntactic data make up the capital of the biggest commercial platforms, which obtain them from users by means of 30-page long contracts that no one ever reads, whose clauses ensure that their data can be used, and above all correlated, with an enormous quantity of other data. Their value is obvious, for the reasons we have mentioned, but, on closer inspection, their use is sub-optimal, because their exploitation is in the hands of algorithms.

In this framework, we invite original proposals dealing with such issues, also in view of the new forms of capital that are made possible by the intensive exploitation of data by platforms that produce virtual wealth by exploiting energy and environmental resources. This exploitation requires not only mitigation policies but also economic and social strategies to redistribute the wealth produced.

Research team and environment

The research activity will take place within the Department of Philosophy and Educational Sciences (DFE) of the University of Turin (UniTo), which is one of the largest and highest ranked universities in Italy. Awarded Excellence funding from the Italian Ministry of University, the DFE offers an innovative and interdisciplinary approach in teaching and research. Academic staff members include prominent scholars in philosophy, education, semiotics, communication studies, and sociology. Key areas in these fields are studied with reference to both their historical development and influence on contemporary culture.

The researcher will also have the opportunity to collaborate with research centres as Labont - Centre for Ontology (www.Labont.It), an interdepartmental research centre specialised in ontologies; and Scienza Nuova (http://www.Scienzanuovainstitute.Com), a research centre involving researchers from the University and Turin Polytechnic, which aims to develop researches with a strong interdisciplinary character in which the social transformations produced by digital technologies are addressed through collaboration between the humanities and technology.

For this scholarship a period of internship is planned at *Ernst & Young Business School*

Suggested skills for this research topic

- Knowledge in the humanities, especially in philosophy

- Predisposition for interdisciplinary research

- Self-management and interpersonal skills

Type of scholarship and obligations

The type of this scholarship is: Dottorati Innovativi (Innovative PhD courses). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 4. Theories, Institutions and Cultures

Sustainability and resilience of cities in the face of climate change

Reference Person: Lazzeretti Luciana (luciana.lazzeretti@unifi.it)

Host University/Institute: University of Florence

Research Keywords:	Sustainability of cities
	Urban resilience
	City transformation
Reference ERCs:	SH1_9
	SH7_7
Reference SDGs:	GOAL 9: Industry, Innovation and Infrastructure, GOAL 11: Sustainable Cities and Communities

Description of the research topic

The research project is devoted to training the PhD Candidate and promoting research activity on the topic of the transformation of cities in response to climate change for improving urban and regional resilience.

The discussion concerning the resilience of cities has increased over the years, in parallel with the topic of sustainability and mitigation of risk related to climate change. The framework of resilience introduces some new concepts as the adaptability to change, recognizing the constant pressures that affect modern cities. According to the literature, resilience is a goal for the sustainability of places and has been considered as the fourth dimension of sustainability, following economic, social and environmental dimensions.

A research field that is gaining popularity concerns the carrying capacity of cities in front of the effects due to climate change and the continuous anthropogenic pressure. This topic is particularly relevant for places with a high impact of tourism or that have fragile resources, such as cities of art. However, the results of several empirical analyses underline that such adverse scenarios may represent an opportunity to favour processes of adaptation of cities that lead toward innovation paths or structural change, fostering resilience.

Focusing in particular on the case of art cities, the research activities are devoted to studying the topic of the transformation of cities in response to climate change through a multidisciplinary approach. In particular, analysing comparative cases studies of best practices developed by some cities worldwide (such as Italy, Brasil or Russia) in terms of technological innovation, innovative models of governance or social and economic transformation, the research activities want to study the role of institutions and norms,

economic actors, organisations and communities in fostering virtuous paths toward resilience and ecological transition.

Research team and environment

The candidate will be coordinated within a research group that carries out decades of activity on the themes of the economy of culture and the role of artistic and cultural heritage for the sustainability, resilience and development of the territories.

The candidate will participate in the research activity of the group and will be involved in the Department's activities through participation in seminars, conferences and training days organized on the topics covered by the research. In addition, the responsible and the members of the research group will make their skills and knowledge available to follow the research fellow both in the theoretical training phase on the issues and in the development phase of application methodologies to achieve the research activities objectives.

For this scholarship a period of internship is planned at *Comune di Firenze, Firenze*

Suggested skills for this research topic

The research project addresses ambitious doctoral candidates with a propensity for a multidisciplinary approach and with an interest in the local dimension of climate change and who want to integrate the knowledge of methodologies both qualitative and quantitative.

Type of scholarship and obligations

The type of this scholarship is: Pubblica Amministrazione (Public Administration). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 4. Theories, Institutions and Cultures

The regulation of sustainable finance and recent challenges: investor protection, technology and SMEs

Reference Person: Macchiavello Eugenia (eugenia.macchiavello@unige.it)

Host University/Institute: Università degli studi di Genova

Research Keywords: Investor protection against green-washing

Sustainable digital finance

SMEs ESG disclosure

Reference ERCs: SH2_4 Legal studies, constitutions, human rights, comparative law

SH7_6 Environmental and climate change, societal impact and policy

SH1_5 Corporate finance; banking and financial intermediation; accounting; auditing; insurance

Reference SDGs: GOAL 8: Decent Work and Economic Growth, GOAL 16: Peace and Justice Strong Institutions, GOAL 17: Partnerships to achieve the Goal

Description of the research topic

The research pertains to the European legal framework in the area of sustainable finance with special regard to ESG information, financial intermediaries duties and offering of investment products to clients to facilitate the transition towards a more sustainable economic system, as also recognized in the recent COOP 26. Starting with the European Commission's sustainable finance Action Plan (2018), the EU Regulator has been particularly active in the adoption of measures conceived to allow investors to take informed decisions also from a sustainability point of view. Intense information duties on financial operators (SFDR), labels (e.g. proposal for a Green bond standard), legal definitions (EU Taxonomy) and standards aim to limit green-washing behaviours (i.e. the presentation of economic activities as sustainable when this is not the case) and national regulatory fragmentation, and to achieve a higher level of comparability of sustainable products. Nonetheless, also financial operators' duties in terms of organization, risk management and conduct (e.g. MIFID II duties), recently reviewed to take into account sustainability factors, will have a significant impact on the integration of ESG factors (i.e. pertaining to environmental, social and governance issues) in investment decisions. The candidate will critically examine European and national laws in the area of sustainable finance, already adopted or currently reviewed/discussed, to assess the

effectiveness and adequacy of such regulatory policies and choices, as well as socio-economic implications deriving from sustainability-oriented financial choices, organizational structures and models as well as relative regulation. Particular attention will be reserved to the link between corporate non-financial information and financial intermediaries' duties, the challenges and opportunities in extending such disclosure duties to SMEs, the role of ESG ratings and the impact and possible contribution of digital finance and technologies to sustainable finance advancement and overcoming of current obstacles and solution of critical aspects.

Research team and environment

The candidate will join a stimulating environment for conducting research in the area of sustainable finance and corporate governance. The University of Genoa presents a rich portfolio of courses in the area of sustainability in different sectors as well as interdisciplinary courses on sustainability (https://unigesostenibile.Unige.It/Educazione). Moreover, the Department of Law of the University of Genoa has a long traditional of excellence in legal studies and its Jean Monnet Centre of Excellence on European Union Sustainable Finance and Law (Eusfil; director Michele Siri) specifically focuses on the research about the legal implications of the integration of sustainability factors in the financial sector. In this respect, the Centre brings together a European team of experienced scholars with a very high profile in their field of work (corporate governance, financial regulation, law and economics, etc.), conducting research in the area of CSR and/or sustainable finance. The activities are performed in collaboration with other well-known international research centres (e.G. Centre of Competence for Sustainable Finance of the University of Zurich). Professor Eugenia Macchiavello is an internationally recognized expert in the area of Fintech regulation, regulation of alternative and inclusive finance, responsible banking and sustainable finance. She is a member of the Italian Association of Professors in Economic Law (ADDE), of the EBI Associated Researchers Group and of the Expert Working Group on FinTech of the Italian Capital Markets Authority (Consob). Before joining the University of Genoa, she has been a visiting Research Fellow at the New York University Center of Financial Institutions.

Suggested skills for this research topic

The ideal candidate would have a strong background in law or in law and economics (experience in comparative law or empirical research would be a plus), mindfulness of legal determinants and principles of financial markets and banking sector, good knowledge of the English language and, preferably, other foreign languages. The candidate we are looking for should also show intellectual and interdisciplinary curiosity, critical thinking, commitment, passion for research, team-working skills and motivation in participating in an international network of young scholars.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research).This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 4. Theories, Institutions and Cultures

Food Safety and Criminal Compliance: Towards New Enforcement Models Against Individuals and Corporations

Reference Person: Mongillo Vincenzo (vincenzo.mongillo@unitelmasapienza.it)

Host University/Institute: Unitelma Sapienza - University of Rome

Research Keywords:	Food safety
	Criminal Compliance
	Corporations
Reference ERCs:	SH2_10
Reference SDGs:	GOAL 12: Responsible Consumption and Production

Description of the research topic

The regulatory framework aimed at fighting criminal offences in the food sector is still an under-investigated subject in the domestic and international scenario, despite the fact that these are forms of criminality that seriously endanger the health and economic trust of consumers, even in the context of the single European market, and considering also that no transition to a modern and sustainable food production can be achieved without building an adequate system of "criminal law protection" of these fundamental interests.

The European Union has so far regulated the subject of food safety and food quality in a detailed way in terms of administrative law, whereas no concrete initiative has ever been taken in the area of criminal law apart from an old proposal by the European Commission, which, however, has never been pursued at a regulatory level.

For these reasons, the various European national legislations are very different as the European countries do not have a common definition of food fraud and other food-related offences and, in general, have underdeveloped enforcement mechanisms where, inter alia: offences are often focused solely on the violation of administrative regulations on food production and trade; many legislations anticipate the "trigger mechanism" of criminal law (crimes of danger) even at a stage when there is no real danger for the consumer (using the approach of the "precautionary principle" that may jeopardies, in the criminal law perspective, the respect for fundamental rights); many food offences are sometimes not included among the predicate offences of corporate criminal liability (see, for instance, the Italian Case) notwithstanding the fact that it is often in the context of large multinational companies that these crimes occur, etc.

Another key issue is related to the fact that, in order to enhance the safety of food production, a large number of private technical standards have been developed in the food sector, which, despite being created and implemented in the private sector, greatly influence the standards of proof of criminal negligence, thus complicating the work of legal and commercial practitioners.

Having regard to this background, this research project will be carried out following various interconnected research lines:

1. Reaching a common definition of food fraud and food crimes in the international scenario not only to bring "order" in the subject from a theoretical standpoint, but also to assess the possibility of harmonizing the criminal legislation of the European countries in this field using the legislative tools of EU treaties (art. 83, par. II, TFEU);

2. Identifying useful amendments to the criminal enforcement mechanisms against individuals in order to overcome the main aforementioned problematic issued of this area of the criminal regulatory framework;

3. Investigating the possibility of building innovative enforcement mechanisms against legal persons for food offences, not only taking into account the fact that the high technical standardization of this sector makes it possible to test regulatory tools focused on the organizational fault/failure to prevent model, but also assessing the possibility of introducing offences whose exclusive perpetrator is the legal person that trades products that are dangerous for the consumer, regardless of the identification of the individual offender in the context of the corporation (so building a truly "autonomous" liability of the legal person).

Research team and environment

Research at UnitelmaSapienza (a young online & distance learning University directly linked to Sapienza University of Rome) is carried out in various Laboratories, Research Centers and Research Groups.

Prof. Mongillo, Full Professor of Criminal law and supervisor of the research project, is involved in a national and international research and institutional network, collaborating with various universities (e.G., Luiss Università, Unimore, Univ. Vanvitelli, Univ. Santiago de Compostela, Univ. Castilla-la Mancha , Università Autonoma de Barcelona, London University, Leipzig Univerisity) - and institutions (e.G., Cnpds, International Association of Penal Law, Italian Anticorruption Authority, Ministry of Justice) - in research on corporate criminal liability, food crime, corporate compliance. This research, coordinated by prof. Mongillo, will see also the collaboration of various young scholars with a specific expertise in this field, including the fight against food crime and corporate crime. This line of research aims at investigating the future perspective for improving these systems, fostering an increasing exchange of best practices between the public and private sectors.

Suggested skills for this research topic

Knowledge of the main research methodologies of criminal law, with regard to the analysis of private and public sources, case law and scientific literature.

The Ph.D. Student must also be able to apply the comparative law method and conduct empirical research by carrying out interviews with experts in the field.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 4. Theories, Institutions and Cultures

Market regulation and sustainable investment policies: a comparative law perspective

Reference Person: Monti Alberto (alberto.monti@iusspavia.it)

Host University/Institute: IUSS Pavia

Research Keywords:	Comparative Law
	Economic Analysis of Law
	Long term investments
Reference ERCs:	SH2_4
	SH2_5
	SH2_2
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 13: Climate Action, GOAL 16: Peace and Justice Strong Institutions

Description of the research topic

The polymorphism of the concept of sustainability requires the identification of criteria for assessing the consistency of the regulatory approach to long-term investment policies as well as the effectiveness of legal and fiscal tools seeking to govern the gradual transition towards sustainable development models in line with the goals set out by the United Nations (Agenda 2030).

A backward-looking analysis of certain recent pieces of legislation, for example in the field of renewable energies, shows how, under the label of sustainability, short-term speculative forms of investment have been encouraged, forms of investment hardly in line - and in some cases even contrasting - with the announced goals.

Drawing from recent regulations at EU level, such as the Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment (the so-called Taxonomy Regulation) and the Regulation (EU) 2019/2088 on sustainability-related disclosures in the financial services sector (the so-called Sustainable Finance Disclosure Regulation), the research aims at identifying, in a comparative perspective and using the tools of economic analysis of law, the cornerstones of a regulatory approach consistent with long-term investment policies effectively oriented towards sustainability.

Research team and environment

IUSS mission is to provide advanced education to undergraduate and graduate students, as well as fundamental and applied research in the fields of Science, Technology, Engineering and Mathematics (STEM), and Human, Social and Life Sciences. At IUSS, PhD candidates will find an open multidisciplinary environment offering real opportunities for developing academic and professional tools for facing the challenges arising from increasing complexity and fast changes in the society and the environment. IUSS is always and actively committed towards internationalisation, inclusion and diversity.

The selected candidate will join the Legal Science Research Group (LSRG) at IUSS (comprising, among others, Prof. Alberto Monti, Prof. Stefano Moratti e Dr. Lydia Velliscig) and will work in a pluralist and multi-disciplinary academic environment. The LSRG conducts policy-oriented research studies applying the methodologies of comparative law and economic analysis of laws and institutions; in the specific field of climate change, the LRSG collaborates with the IUSS research centre on Climate change impAct studies for RISk MAnagement (CARISMA).

Suggested skills for this research topic

Legal background (Law Degree), preferably in comparative law; intellectual curiosity.

Curriculum: 4. Theories, Institutions and Cultures

Climate Risks and the Media

Reference Person: Pasquaré Mariotto Federico (pas.mariotto@uninsubria.it)

Host University/Institute: University of Insubria

Research Keywords:	Anthropocenic Global Warming
	Media representation
	Climate risks
Reference ERCs:	SH7_6
	SH3_12
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 13: Climate Action

Description of the research topic

This research goal is dedicated to investigate the pivotal role of the media in shaping public perception of climate risks. As is well known, 97% of climate scientists acknowledge the threats posed by Anthropogenic Global Warming (AGW), whereas a great number of citizens – about 55% of the US population – believe that science has not yet reached an overall consensus on the role of human activity in altering global climate. The reason for these constrasting patterns is not difficult to find: in the US, several media outlets give voice to the so-called climate skeptics or negationists, the 3% of remaining scientists who, allegedly financed by fossil fuel companies, actively contribute to decreasing motivation of the general public to tackle the causes of climate change on an individual basis. On the contrary, there are other sectors of the media that fully exert their role of raising public awareness of the citizens about facing climate change through science-based mitigation and adaptation strategies.

Given the above, it is worth investigating to what extent politics and the media have acknowledged the undeniable link between climate change and meterological extreme events. Also in our latitudes, in fact, during the last ten years there have been devastating extra-tropical cyclones, most notably in Sardinia (in November 2013), in Serbia and Croatia (May 2014) and in Germany and Belgium in the Summer of 2021. While the tragedies in Sardinia and in the Balkans were almost neglected by the Italian media, and ignored by Italian and European politicians, the catastrophic floods in central Europe in July 2021 seem to have spurred the interest of politicians, the likes of Angela Merkel and Ursula von der Leyen; and the media, both in Italy and in Europe as a whole, have extensively underscored the need to consider such an extreme weather event as the result of anthropogenic forcing on the global climate system. It would therefore be useful trying to critically analyse, also by way of cutting-

edge text-mining softwares, the media coverage of climate change by Italian newspapers, both printed and online. The media have always, and always will, be a driving force in shaping public opinion. Studying how they cover climate change on a daily basis will enable to understand their influence on policy-makers and citizens, including the younger generations. Moreover, it would extremely important to come up with new ways to communicate climate risks in an unbiased and scientifically sound manner. Such new approaches may be discussed with representatives of the media during a dedicated event at the end of the three-year doctoral program

Last but not least, the present research project will investigate how scientists could play a major role in communicating climate risks to the media and also engage in outreach activities aimed at communicating directly to local residents the risks/benefits of renewable energy infrastructures such as hydroelectric power plants.

Research team and environment

The Reference person will be showing the PhD candidate how to analyze quantitatively the media representation of climate change. This task will mainly be performed by using TalTac and other similar, cutting-edge text mining softwares, capable of processing a huge amount of texts in time-efficient manner.

For this scholarship a period of internship is planned at *Alumni Insubria*

Suggested skills for this research topic

To successfully conduct the proposed research, the cadidate will need to possess: a) the ability to understand global warming, climate change ad climate risk processes; b) the ability to qualitatively examine the Italian news media, searching for recurring patterns of representation of climate change in a given time period; c) the candidate will also have to be skilled in learning how to use the text mining softwares needed to quantitatively assess the patterns indviduated in the previous step; d) last but not least, the candidate will have to come up with innovative strategies that the media might employ to communicate climate change in an unbiased and scientifically sound fashion.

Type of scholarship and obligations

The type of this scholarship is: Transizioni Digitali ed Ambientali (Digital and Environmental Transitions). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 4. Theories, Institutions and Cultures

Sustainability in the Anthropocene: The Politics of Plant and Ecosystem Conservation

Reference Person: Pellegrino Gianfranco (gpellegrino@luiss.it)

Host University/Institute: Luiss University

Research Keywords:	Anthropocene
	Sustainability
	Restoration
Reference ERCs:	SH2_7
	SH7_6
	LS8_2
Reference SDGs:	GOAL 13: Climate Action, GOAL 15: Life on Land, GOAL 16: Peace and Justice Strong Institutions

Description of the research topic

In the Anthropocene, the standard alternative between weak and strong sustainability fades, as much of nature is already anthropized and destined to further anthropization. The option of fully preserving pristine nature vanishes in the Anthropocene, or, if still possible, its costs can be radically unbearable. Due to climate commitment, some costs to future generations will be inevitable and compensation will be over-demanding for present generations. In the Anthropocene, the ideal of sustainability originally stated by the Brundlandt Commission needs deep revision. Moreover, two areas are of relevance when mitigation and adaptation policies are considered. First, plant management and reforestation can be a new helpful tool to increase carbon sinks and restore biodiversity. Second, ecosystem conservation and restoration should take into account the inevitable transformations connected to renewable energies' infrastructure impacts.

This research focuses on the political justification of sustainable patterns of ecosystem and plant conservation in the Anthropocene. The researcher will answer the following related research questions: 1. Which model of sustainability is the fittest (i.E., the most theoretically plausible and politically feasible) in the Anthropocene? 2. How can sustainability so understood suggest which plants and ecosystems should be preserved? 3. How can this model of sustainability support the value and the political opportunity of reforestation and landscape restoration, also in the light of climate change mitigation and adaptation? 4. How can this model of sustainability deal with trade-offs between the environmental impact of

renewable energies (such as wind and solar energy) and the conservation of plants, ecosystems and landscape? 5. Which conservation and restoration policies can be justified in the light of the above? 6. Which are the consequences of these conservation and restoration policies in terms of intergenerational justice?

The research will span the following fields: sustainability and Anthropocene studies; discussions about nature preservation and restoration; plant ethics; environmental and ecological citizenship and justice; climate justice (with a focus on mitigation policies); intergenerational justice.

The main outputs of the research will be the following: 1. A new theory of sustainability in the Anthropocene; 2. A new theory of nature conservation and restoration in the Anthropocene; 3. A set of sustainable policies concerning the restoration of plants and ecosystems, reforestation and landscape restoration, also in connection with global mitigation and adaptation policies as stated in the latest IPCC reports.

Research team and environment

The supervisor will be professor G. Pellegrino, i.E., the reference person above. However, the phd candidate will work with many other scholars at Luiss, whose research activities are closely related to the research topic - in particular with Pietro De Giovanni (https://impresaemanagement.Luiss.lt/docenti/cv/353898), whose work concerns mainly circular economy and economic sustainability, with Christian Iaione (https://giurisprudenza.Luiss.lt/docenti/cv/340609), whose work deals with urban studies, sustainability, climate change and the commons, with Raffaele Bifulco (https://giurisprudenza.Luiss.lt/docenti/cv/150300) and Jorge Vinuales (https://giurisprudenza.Luiss.lt/docenti/cv/354328). Moreover, the phd candidate will gain from involvement in Luiss network (especially in the International Universities Climate Alliance) and in Luiss' teaching activities (especially in programs such as Strategic management, with its major in Green economy and sustainability (https://www.Luiss.lt/ammissione/offerta-formativa/laurea-magistrale/strategic-management), and Law, Digital Innovation and Sustainability (https://www.Luiss.lt/ammissione/offerta-formativa/laurea-magistrale/law-digital-innovation-sustainability)

Suggested skills for this research topic

The ideal candidate for this research will have a background on one or more of these fields: political theory, qualitative political science, sociology. Previous publications on the topics will be considered a preferential title. Previous education on the fields of ecology, environmental ethics, environmental political theory, environmental sociology, public policy analysis will be considered a preferential title, too. He/she should be able to adopt an interdisciplinary perspective and to move from theoretical premises to policies.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Type of scholarship and obligations

The type of this scholarship is: Transizioni Digitali ed Ambientali (Digital and Environmental Transitions). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Curriculum: 4. Theories, Institutions and Cultures

The environment between philosophical conceptualisation and environmental aesthetics

Reference Person: Perissinotto Luigi (lperissi@unive.it)

Host University/Institute: Università Ca' Foscari di Venezia/ Ca' Foscari University of Venica

Research Keywords:	Nature
	Anthropocene,
	Environmental Aesthetics
Reference ERCs:	SH5_9 Metaphysics, philosophical anthropology; aesthetics
	SH5_4 Visual and performing arts, film, design and architecture
	SH4_13 Philosophy of science, epistemology, logic
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 11: Sustainable Cities and Communities, GOAL 12: Responsible Consumption and Production, GOAL 14: Life Below Water, GOAL 15: Life on Land

Description of the research topic

The research background problematises, on the one hand, concepts such as 'world' and 'environment' and, on the other, the opposition between 'natural' and 'cultural'. The starting point is the recognition that the dichotomies between culture and nature, natural sciences and humanities, as well as their respective epistemological ideals have crumbled under the environmental crisis and the anthropogenic transformation of the earth system.

The research lines are four:

(1) a recontextualisation of the topic of animality in light of a conception of environmental sustainability that avoids its widespread anthropocentric connotation.

(2) A reflection on the Anthropocene capable of, on the one hand, holding geological and historical time together in a non-dualistic way and, on the other, of soliciting an analysis, on a planetary level, of the environmental dimension of human action, sciences and technologies.

(3) A revival of environmental aesthetics to pragmatically rethink the exchanges between humans and the environment beyond the paradigm of a disinterested contemplation of nature. This analysis embraces an environmental aesthetic approach anchored in a post-

subjectivity perspective and in a pragmatically-oriented conception of the interactions between living beings and the environment.

(4) An examination of how artistic practices influence behaviour (especially through virtual / augmented reality and pre- / re-enactment and embodiment practices) and affect widespread sensitivity in view of an ""eco-aesthetics" critical of environmental exploitation.

Research team and environment

The team is made up of Luigi Perissinotto, Cristina Baldacci, Roberta Dreon, Diego Mantoan, Pietro Daniel Omodeo to which Shaul Bass, Elisa Caldarola, Alessandra Cecilia, Jacomuzzzi will be added. These are researchers who belong to 3 different Departments (Philosophy and Cultural Heritage, Humanities, Linguistics and Comparative Cultural Studies) of the Ca 'Foscari University of Venice. For some years they have been working on issues related to the philosophy of the environment, the concept of nature and the relationship between natural and conventional, environmental aesthetics, anthropocene. The JOLMA (The Journal for the Philosophy of Language, Mind and the Arts) belongs to this group; some of them are members of NICEH (The New Institute Center for Environmental Humanities) (Ca' Foscari).

Suggested skills for this research topic

The candidate must have a solid training in the field of philosophy and artistic and cultural studies, with particular reference to aesthetics, art philosophy, epistemology, art philosophy, new media, and must know how to use these knowledge and skills in relation to issues concerning the environment with particular reference, on the one hand, to the interactions between the environment and living beings, also including non-human beings (in a historical and critical-theoretical perspective) and, on the one hand, on the other hand, to artistic experiences and practices relating to the environment and its dynamics.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 4. Theories, Institutions and Cultures

Epistemology, trust and philosophy of technology: towards a philosophy of sustainable choice

Reference Person: Piredda Giulia (giulia.piredda@iusspavia.it)

Host University/Institute: IUSS Pavia

Research Keywords:	Decision-making and Sustainable choice
	Rationality and Mind
	Epistemology and Philosophy of Science
Reference ERCs:	SH4_12 Philosophy of mind, philosophy of language
	SH4_13 Philosophy of science, epistemology, logic
	SH4_7 Reasoning, decision-making; intelligence
Reference SDGs:	GOAL 4: Quality Education, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

How can we make reliable scientific predictions and act on their basis when faced with complex data and uncertainty? What is the role of philosophical analysis in the evaluation of current global challenges such as climate change and sustainability and in the development of informed solutions to them? How should humans conceptualize their relationship with the environment they live in?

The public debate on such global challenges is most of the time lacking in rigor. Reliable sources of information are often hard to individuate, and threats for an informed and reasoned decision can come from skepticism towards science and scientific truth, and more generally from an incomplete, and sometimes even mistaken, understanding of the proper features of the scientific enterprise. The role of experts and expertise in the formation of scientifically sensible opinions and beliefs is sometimes downplayed due to a decreased trust in them. The reputation of experts and of the scientific community more generally is thus at stake, and analyzing the mechanisms by which reputation is built – and eventually lost – becomes crucial.

Moreover, the recent extraordinary technological development (particularly in digital areas) asks for a rigorous philosophical reflection, both in the metaphysical and in the ethical realm. Which relation exists between the human mind and technology? Should we rethink the status of technological artifacts as not completely separate from natural entities? Many philosophers have dealt with such questions in the last decades, reflecting on the power of

the mind of engineering the environment humans live in, exploiting it for their own purposes, through the use of instruments, tools, artifacts and scaffolds. This operation, though, is not always morally neutral, and the analysis of how technological devices and infrastructures then act back on our way of dealing with information and our possibilities of action becomes crucial. Reflections on these topics are at the intersection between philosophy of mind and cognitive science, philosophy and ethics of technology.

The successful PhD candidate will be expected to investigate how, in such complex scenarios, rationality and trust towards scientific experts can be defended and made to serve public decision and action through sustainable choices. Ideal research projects will investigate how traditional issues in the study of scientific methodology, rational choice and decision-making should be framed in the renewed context of global challenges and of the complex interaction between nature and technology, especially when complexity and richness of data, uncertainty in outcomes, severe risk and public responsibility are at stake.

The research can focus on one among the many areas of philosophy involved in such problems, although interactions between the following disciplines will be encouraged: Philosophy of Science, Epistemology, Theories of Rationality and Behavioral Economics, Philosophy of Mind and Cognitive sciences, Cognitive Psychology, Decision-making Theory, Philosophy of Technology, and Public ethics. Other possible interdisciplinary research areas which will be positively considered are: philosophy of language, critical thinking and argumentation theory, informal and formal logic. Impact on public information and education will also be considered relevant within the research areas.

Research team and environment

Giulia Piredda (Lecturer). Her research interests are in the philosophy of mind and cognitive science, with particular attention to the situated, embodied and extended views of mind and affectivity. She also deals with the topic of trust and reputation in several projects.

Nicola Canessa (Associate Professor). Works in Psychobiology and Physiological Psychology. Director of the IUSS-Maugeri Cognitive Neuroscience Laboratory. His research concerns the study of the neural bases of cognitive processes, particularly decision-making and social cognition.

Michele Di Francesco (Full Professor). Past Rector of IUSS, Past President of the European and Italian Societies for Analytic Philosophy and of the Italian Society of Neuroethics and Philosophy of Neuroscience. His main research is in the philosophy of mind and cognitive science.

Scholarship code

CU4.15

Andrea Sereni (Full Professor). His research covers several areas in epistemology, philosophy of mathematics and philosophy of language and logic. He coordinates the Italian Network for the Philosophy of Mathematics.

Alfredo Tomasetta (Associate Professor). Specializes in philosophy of mind and analytic metaphysics (esp. The metaphysics of human persons). He is also interested in philosophical logic, philosophy of language, epistemology and classical Indian philosophy.

Research activities will be based at IUSS, a competitive and internationally-oriented school of advanced studies, home to the PhD program and located in an intellectually stimulating context in one of the oldest Italian university town.

Suggested skills for this research topic

Candidates should be intellectually curious and have a special interest in philosophy of science, epistemology and the study of how the human mind works when we have to make decisions in complex contexts, especially in relation to issues such as the nature of rationality, decision-making, and the impact of cognitive sciences. Students should be prepared to intense reading and learning, and open to explore novel lines of research in a multi-disciplinary environment. Rigor in arguments and in discussion will be encouraged, with particular focus on its application to the public debate on global challenges, where the impact of, and responsibility for public actions are at stake.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Curriculum: 4. Theories, Institutions and Cultures

Ethical, Political and Institutional Profiles of Sustainable Development and Climate Change

Reference Person: Pirni Alberto (alberto.pirni@santannapisa.it)

Host University/Institute: Scuola Superiore Sant'Anna

Research Keywords:	Ethics of Climate Change
	National and International Actors and Climate Change
	Political Theory of Climate Change
Reference ERCs:	SH5_6 Philosophy, history of philosophy
	SH2_7 Political systems and institutions, governance
	SH2_6 Violence, conflict and conflict resolution
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action, GOAL 16: Peace and Justice Strong Institutions

Description of the research topic

Proposed projects address ethical, political and institutional issues that fall within the thematic area of sustainable development and climate change. In particular, projects are expected to contribute to contemporary ethical and theoretical-political debates related to sustainability, environmental ethics, theories of justice (including intergenerational) and global political theories, through a critical discussion of issues such as allocation of responsibilities, potential redistribution of benefits/disadvantages, mitigation of discrimination and inequalities resulting from climate change, at supranational and global level. Also of interest are projects concerning the policy debate on human-driven global warming, the roles of governmental and non-governmental actors in shaping and implementing climate change policies, the relation between climate change and conflict, and other germane topics. Selected candidates should critically assess issues such as allocation of responsibilities, potential redistribution of benefits/disadvantages, mitigation of discrimination and inequalities resulting from climate change, at supranational and global level. Interdisciplinary research projects are encouraged, addressing issues relevant to the advancement of ethical, political and institutional knowledge and research, but capable of benefiting from and possibly contributing to other disciplines, including law.

Research team and environment

The research will be carried out in the intellectually stimulating and highly engaging academic environment of the Sant'Anna School of Advanced Studied and in the wider network of the

scholars and institutions participating in the PhD Curriculum in 'Theories, Institutions and Culture'. At the Sant'Anna School, the research will be developed within the Institute of Law, Politics and Development (DIRPOLIS). The Institute conducts innovative research in the fields of law, political science, development economics, moral and political philosophy. Its multidisciplinary approach allows for a comprehensive representation of complex legal, political, social and economic phenomena. Its manifold projects and activities on environmental-related issues, carried out within a cooperation network gathering a number of scholars from various European and non-European universities, promote high level scientific researches in the field of climate change and sustainable development.

Suggested skills for this research topic

Openess towards interdisciplinary approachs will be appreciated.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research).This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 4. Theories, Institutions and Cultures

The new trends in climate change litigation

Reference Person: Pozzo Barbara (barbara.pozzo@uninsubria.it)

Host University/Institute: Università dell'Insubria

Research Keywords:	Climate change
	Litigation
	Comparative law
Reference ERCs:	SH2_4
	SH2-5
	SH7-6
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 5: Gender Equality, GOAL 10: Reduced Inequality, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action, GOAL 16: Peace and Justice Strong Institutions

Description of the research topic

In the aftermath of COP 26 in Glasgow, where lot of attention was devoted to climate change litigation, the rapid development of suits related to climate issues around the world is inducing comparative lawyers to reflect on the underlying dynamics driving this phenomenon.

Among the aspects that will be taken into consideration in the research project there will be the importance of having an international binding treaty as the Paris agreement, for the evolution of climate change liability.

Further, the research project will analyze the different paths developing in the various national contexts and in particular:

1. Human-rights based claims,

2. Tort law claims,

3. Greenwashing claims,

4. Public trust claims,

5. Claims in favor of indigenous people and vulnerable groups

Other aspects of relevant importance that might be taken into consideration concern the role of attribution science in the development of climate change litigation, as well as the role of NGOs in the spreading out of litigation patterns.

Research team and environment

At the University of Insubria there are two Research Centers devoted to study climate change related issues: the CENTER FOR STUDIES ON ENVIRONMENTAL AND TERRITORIAL POLICIES and the CLIMATE CHANGE RESEARCH CENTER (CCRC)

The Department of Law, Economics and Cultures further organizes every year an International Summer school Program on Comparative environmental law, together with the universities of Utrecht (NL), Aix-en-Province (France) and Opole Univeristy (Poland) focusing on comparative climate change law.

The resarch team involved is also collaborating with the European Environmental Law Forum (EELF), organising seminars and workshops together, as well as with the Rivista Giuridica dell'Ambiente, one of the prominent law reviews specialized on environmental law.

Suggested skills for this research topic

A good background in comparative law, international law and EU law.

Curriculum: 4. Theories, Institutions and Cultures

Hydrogen Strategy and Policy: Italy in Comparative Perspective

Reference Person: Prontera Andrea (andrea.prontera@unimc.it)

Host University/Institute: University of Macerata

Research Keywords:	Hydrogen
	Energy Transition
	Comparative Public Policy
Reference ERCs:	SH2_1
	SH2_5
	SH7_9
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 9: Industry, Innovation and Infrastructure, GOAL 13: Climate Action

Description of the research topic

Hydrogen has a key role in the energy transition and in the current global climate change agenda. The European Union has recently acknowledged the role of this energy carrier in achieving its 2050 net-zero greenhouse gas emission targets. At the same time, several EU countries have launched strategies and policies to increase their stance in the emerging green hydrogen economy. This is the case of both large EU member states, such as Germany, France and Spain, and smaller ones, such as the Netherlands and Portugal. Beyond Europe, many industrialised countries are increasing their efforts to position themselves at the upfront of the green hydrogen technological race. Hydrogen is an important component of decarbonization policy worldwide, but also of many post COVID-19 industrial strategies. In addition, hydrogen features in the new geopolitics of the energy transition.

Against this background, this research project aims at analysing the Italian policies and strategies in the field of (green) hydrogen. Moreover, the project aims at offering a comparative perspective on the Italian hydrogen policy, both with regard to its energy, climate and industrial implications and with regard its European and international dimensions. Specifically, the project will employ the analytical tools and methods of comparative public policy and international political economy to illustrate the emerging features of the Italian (green) hydrogen policy and to derive lessons and best practices that can improve the effectiveness and impact of the Italian strategy and policy on the matter.

Research team and environment

The PhD student will have the opportunity to work with scholars from different backgrounds relevant for the research project, including Public Policy, International Relations, Energy Policy, Applied Economics and EU and International Law. Also, the PhD student will have the opportunity to have access to the network of international contacts of the University of Macerata's faculty, e.g. Institute for Advanced Sustainability Studies (IASS, Potsdam, Germany).

For this scholarship a period of internship is planned at *Safe Consulting (http://www.safe-consulting.it/), Senigallia (AN)*

Suggested skills for this research topic

Political Science, Public Policy, Energy Policy

Type of scholarship and obligations

The type of this scholarship is: Transizioni Digitali ed Ambientali (Digital and Environmental Transitions). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 4. Theories, Institutions and Cultures

Prosumagerism and Energy Communities: The Role of Local and Public Authorities. (P.E.C. Project)

Reference Person: Ruggeri Lucia (lucia.ruggeri@unicam.it)

Host University/Institute: Camerino

Research Keywords:	Energy Communities
	Public Administration
	Energy Market Decentralization
Reference ERCs:	SH2_4 Legal studies, constitutions, human rights, comparative law
	SH2_5 International relations, global and transnational governance
	SH2_1 Political systems, governance
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

The new Legislative Decrees (no. 199 and no. 210/2021) implemented in Italy the EU Directive RED II and IEM which introduced the Renewable Energy Communities (REC) and Citizens Energy Communities (CEC). Both Directive enable consumers to become prosumers and, also, to storage and sell energy. These new actors of the decentralized Energy Market are composed by a network of energy consumers included municipal administrations, research and training bodies, religious bodies. The primary purpose of the REC is to provide environmental, economic or social community benefits for its shareholders or members or for the local areas where it operates. The Energy Communities may engage in generation, in energy storage, energy efficiency services or charging services for electric vehicles or provide other energy services to its members or shareholders. The role of the public administrations disclosed by the new regulatory framework is pivotal to implement in an effective way the constitutional principle of subsidiarity (art. 118 It. Cost.): on the ground of energy transition the alliance between citizens, enterprises and local and public authorities can boost the wellness of each area interested by the creation of the CEC or CER. The Fit for 55 program now followed by the REPowerEU Plan enhance the role of public authorities: the amendments to the Regulation 2021/241 establishing the Recovery and Resilience Facility introduce the obligation to produce solar energy using the roofs of public and private buildings. The Public Administrations needs to adopt new specific policies and skills devoted

to the climate crisis and war crisis. The aim of the project is to investigate the use of the energy communities' legal models focusing the analysis on the contracts which can be used to create the energy communities and to manage the services of the CER and CEC. The project aims to give a new updated inclusive protection to all members of the Energy Communities as parts of new contracts and economic relationships. Citizens and Public Administrations need to sign contracts i) to set up REC or CEC and the REC and CEC; ii) to finance co-ownership; iii) to digitalize the energy exchanges, iii) to storage the energy; iiii) to distribute and sell energy; iiiii) to transform buildings in 'smart' and 'energy efficient' buildings. The prosumer, even if public body, continue to be a 'week' contractual part which needs protection, but the traditional notion of 'consumer' is not always useful or sufficient. The aim of the research is to adapt the consumer protection to this new kind of consumption models and to define the interplay between the Energy regulatory framework with the GDPR and the EU Directive 2019/770 which permits to use personal data as price for digital contents and services. The main objects of the research are: i) to analyze the Energy Packages, included the 'Fit for 55' and the REPowerEUPlan; ii) to collect Italian and EU best practices of REC and CEC; iii) to compare experiences in which the Public Administrations realized energy communities and to analyze the role of regional legislators in each experience; iiii) to analyze EU and national case-law in energy and data sharing. The expected outputs of the research are: i) a Prosumer 'vademecum' which define the level of protection in the different contracts signed by REC and CEC, with specific focus on the role of Public and Local Administrations; ii) a taxonomy of Energy consumer which define the different types of consumption (domestic or non-domestic; individual or collective); iiii) the different legal forms of REC and CEC (non profit organizations); iiiii) the different types of production; iiiiii) the distribution system; iiiiiiii) the selling systems and models; iiiiiiiii) the vulnerable energy consumers specific protection and inclusive system; iiiiiiiiiii) the data protection measures in each phases of the energy production, consumption and sharing. The result of the Programme is to offer a contribution to Consumer Protection and Public policies strategies in a new regulatory framework in which data sharing and energy sharing is pivotal to realize the goal of climate neutrality. Without citizens, local/public authorities and enterprises involvement REC and CEC cannot start or be succesful, so the PHD research programme includes dissemination and communication activities which will be realized in at least 2 public administrations/municipalities, 2 condominiums and 2 enterprises, which will be pilot communities of the research, which tested the materials and the activities of the project. The PHD student: i) will develop the programme in foreign research centres in agreement with Camerino University (6 months); ii) will realize materials on the basis of the feedback of public administrations, municipalities, condominiums and enterprises of the pilot (2 months of stage in local authorities or enterprises involved in the programme); iii) will attend courses and seminars dedicated to Energy Market, Consumer, Public policies and Data Protection, Sharing economy (10 Credits each year in the first and second year of PHD course).

Research team and environment

The Phd Student will benefit from a multidisciplinary and international team composed by the ECPE researchers (43, from 15 nationalities- https://ecpe.Unicam.It/en/node) and will be involved in specific experiences of study and research guided by University of Camerino (Administration areas) focused on energy efficiency of University buildings also involved in reconstruction after the earthquake of 2016. He/she will be inserted in skilled research small-group composed by 5 Phd Students and 1 RTDA who are developing studies focused on Energy Communities. The research activities, coordinated by Prof. Lucia Ruggeri, received grants by PON Green Economy, Agenzia Coesione Sociale and several PMI interested in Energy Market. The Phd Student will enjoy an international and multisectorial environment thanks to international collaborations developed with several Italian research centers and stakeholder (e.G. ENSIEL, AISFOR; Federconsumatori, Legambiente). At international level the Phd Student can follow activities in several universities skilled in Energy and Energy Consumer Protection Legal and Social issues: East Anglia University (UK), Sorbonne Business School (FR), Rijeka University (HR) Madrid Carlos III (ES), Toyo University (Tokyo) (JAP), Louisiana State University (USA), International Business University of Almaty. The PHD Student will be inserted, also, in the Energy Platform of the University of Camerino, a specific multidisciplinary team composed by experienced researchers skilled in Energy and Climate Change.

The Phd Student will benefit also from courses offered by UNICAM focused on Energy Law, Contracts and Markets, Environmental Law and Civil Economy.

For this scholarship a period of internship is planned at *Consorzio Interuniversitario Nazionale "Energia e Sistemi Elettrici", Cassino (FR)*

Suggested skills for this research topic

The following skills are useful to develop successfully the PHD Programme:

- attitude to work in team

- English language knowledge: at least level B2

- Italian language knowledge at least level B2

- legal or economic educational background is suitable, but not mandatory

Type of scholarship and obligations

The type of this scholarship is: Pubblica Amministrazione (Public Administration). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Curriculum: 4. Theories, Institutions and Cultures

The Evaluation and Remediation of Climate Change Risks in Old and New Media

Reference Person: Russo Katherine Elizabeth (kerusso@unior.it)

Host University/Institute: University of Naples L'Orientale

Research Keywords: Climate Change Risk communication

                             News Discourse Analysis

                             Social Media Discourse Analysis

Reference ERCs: SH4_11

                             SH4_9

Reference SDGs: GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

During the last decade, news and social media have intensified their role as a channel for the communication of risk. Risks are "threats to outcomes that we value" (Fischhoff and Kadvani, 2011: 22), yet while some outcomes, such as car mortality, are defined as risks, other outcomes such as climate change are contested and their measurement often leads to debate (Russo, 2017, 2018). The debate about about climate change policies and science are mediated by news media, which call lay people to think about them either as active participants or interested observers. In order to make risk decisions, citizens seek information, which is circulated through broadsheet news media, and later arises in social media such as facebook and twitter, or face-to-face conversations.

Risk communication faces the challenge of conveying specialized information to lay people, and bridging the gap between experts and lay decision-makers may be extremely difficult in the case of 'contested science' such as climate change (ibid: 116). Experts adopt non-persuasive communication, trusting data to speak for themselves, and describe both benefits and risks, often in quantitative terms. Scientists are cautious and generally speak about probabilities, which do not translate well in the "unequivocal commentary that is valued in the press" (Boycoff and Boycoff, 2007: 3). In contrast, sceptics explicitly address the fears of the lay public in a language that leaves lingering emotional effects and avoid technical terms, thus reaching a wider public.

Following this line of thought, the aim of the project is to provide a data-driven analysis of the evaluation of climate change in news and social media discourse. The analysis of climate

change risk discourse in newspaper and social media discourse may indeed reveal how they influence public opinion, providing a window into how societies express and define themselves as they grapple with uncertainty about facts, options, beliefs and common values. This spreading of climate change discourse across 'genre chains', is central to the present study on the recontextualisation of scientific studies on climate change in news discourse and social media since it may affect the citizens' evaluation of risk decisions (Fairclough 2003; Blommaert 2005). News chains and networks are particularly important to this study since they contribute to the systematic transformation and recontextualisation of information from genre to genre, and possibly affect its evaluation.

The project will provide a data-driven analysis of the recontextualisation and appraisal of climate change discourse in news and social media during the years 2011-2021. The analysis will be carried out by analysing a corpus specifically compiled to represent different interrelated news and social media discourse genres. The data will be analysed according to an approach which draws upon findings in Corpus-based Critical Discourse Analysis, Appraisal Linguistics, and Social Media Critical Discourse Analysis (Baker 2006; Martin and White 2005; Thomson and White 2008). Accordingly, it will situate quantitative analysis and qualitative analysis within a wider analytical framework which includes extra-linguistic social variables.

Research team and environment

The PhD student will collaborate with scholars who are experts in Corpus Linguistics, Appraisal and Critical Discourse Analysis with a strong interest in climate change discourse. The research team includes a Principal Investigator (Associate Professor Katherine Russo), a tenure track researcher (Rtd-B Anna Mongibello), and two PHD students (Arianna Grasso and Arianna Del Gaudio). The PhD students will be able to profit from the Research Centre ILAND and the PhD Programme in Literary, Linguistic and Comparative Studies

Suggested skills for this research topic

The candidate will have a sound grasp of English Language Linguistics and strong competence in the English language (C1+/C2 CEFR). They will ideally also have a good knowledge of Corpus Linguistics methods and Critical Discourse Analysis and a strong interest in climate change discourse.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 4. Theories, Institutions and Cultures

Population health, sustainable development and climate change

Reference Person: Sannella Alessandra (alessandra.sannella@unicas.it)

Host University/Institute: University of Cassino and South Lazio

Research Keywords:	Health
	Social Transition
	Technological innovations for health
Reference ERCs:	SH3_1
	SH3_14
	LS7_9
Reference SDGs:	GOAL 1: No Poverty, GOAL 3: Good Health and Well-being, GOAL 10: Reduced Inequality

Description of the research topic

The main objective of the research is to provide, within the epistemological framework characterized by the paradigm of sustainable development, the analysis of the impact of the various ""health actions"" in the social and environmental factors. The study will have to be distinguished by its transdisciplinary character: the interpenetration of the various scientific perspectives will be the glue for innovative research linked to multiple research structures in which a mix-methods methodological approach will be privileged. Among the research priorities, it will be possible to identify phenomena deriving from the emergencies of the acceleration of climate change and social transitions; the redefinition of the quality of life of citizens on eco-sustainable projects; the measurement of actions launched at the institutional level, aimed at the health of communities and citizens (goal 3). The analysis will have to consider the tools of the IV industrial revolution, such as Artificial Intelligence and robotics, to develop contexts of social and technological innovation aimed at reducing inequalities, for the promotion of social justice and health, especially towards populations at greatest risk of vulnerability. It will be possible to propose tools for sustainable health in the light of the principles of One Health (WHO 2017) through innovative policies. In this way, will enhance polycentric scientific advances and desirable models of social transition and health promotion within the paradigm of sustainable development.

Research team and environment

The research environment is supported by the culture of inclusion and cooperation in the research group with a ""circle"" management approach. The team is based on peer-to-peer

research activities, and all identified practices will support candidates. Candidates will be included in the International Observatory for Sustainable Development and Global Health 2030 (IOHS 2030).

Suggested skills for this research topic

The candidate must possess knowledge and tools of research in the field. Particular attention must be paid to the transdisciplinary nature of the proposal

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research).This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Curriculum: 5. Agriculture and Forestry

Optimization of wet co-product ensiling techniques to maximize the nutritional quality and minimize greenhouse gas (Volatile organic compounds) emissions from silage.

Reference Person: Ajmone Marsan Paolo (paolo.ajmone@unicatt.it)

Host University/Institute: Università Cattolica del Sacro Cuore

Research Keywords:	Circular economy
	Dairy farm sustainability
	Greenhouse gas emissions
Reference ERCs:	LS9_3 Agriculture related to animal husbandry, dairying, livestock raising
	LS9_5 Agriculture related to crop production, soil biology and cultivation, applied plant
Reference SDGs:	GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

Task 1. Identification and selection of wet co-products (W-CoP) in different regions of Italy, seasonal scenarios and processing status. W-CoP will include crop wet residues, sweet corn, former food products, by products from the olive, grape, citrus, tomato, pumpkins and nuts processing.

Task 2. Evaluation of the selected W-CoP for nutrients content, energy value, functionality and safety.

Methods: All W-CoP selected in the previous task will be characterized for:

1) chemical properties: wet analysis and fiber fractions (Gallo et al., 2013).

2) biological properties: NDF (Gallo et al., 2017, 2019b), starch (2016, 2018c) and crude protein (Gallo et al., 2018b) rumen digestibility rate by in vitro/in situ rumen-based methods, gas production and methanogenic potential (Gallo et al., 2019a)

3) physical properties: particle size, density, colorimetric, flotation and durability in rumen environment (Kaske et al., 1992; Gallo et al., 2017, 2019a).

Most promising W-CoP will be evaluated for amino acid profile, fatty acids, fat-soluble antioxidants and phenolic compounds (Biondi et al., 2020; Natalello et al., 2019), presence of

regulated and emerging mycotoxins (Gallo et al., 2018a) and microbiological quality (total viable count - TVC; ISO 4833 and presence of Salmonella spp.; ISO 6579). When pertinent, the presence of packaging remnants materials (Raamsdonk et al. 2012; Marchis et al. 2016) and other residues (e.G. Pesticides) will be investigated.

Task 3. W-CoP ensiling processing and technological quality.

Objective: Evaluation of selected W-CoP for improving ensiling conditions. Wet W-CoP will be tested for their preservability by ensiling technique adopting a mini-silo trial testing fermentation quality (pH, VFA, lactic acid, NH3-N, 1,2-propanediol, aldehydes, ketones, esters and alcohols) and farm-scale bunkers. The emission of greenhouse emission from experimental and farm silos will be evaluated by monitoring production of several volatile organic compunds.

The proposed activities will allow to:

1.   Take a census of the more promising W-CoP at national and local levels

2.   Characterize the most promising W-CoP for nutritional and safety traits, for their inclusion in animal diets to also exploit complementary characteristics

3.   Optimize conditions for combining different W-CoP in animal diets and optimize preservability conditions for selected wet W-CoP, by reducing greenhouse emission.

Research team and environment

In the research project, supporting the PhD, will be involved 1 Full professor and 1 Associate professor, expert in Animal Nutrition and Feed Evaluation. Further, the research team comprises a lab technician, 2 PostDoc and another PhD student. An experimental facility will be used to carry out specific trial on optimized ensiling techniques should be adopted on wet co-products to reduce greenhouse emission from silage and improve nutritional quality. The lab are equipped with a HPLC-MS/MS, a bidimensional GC-MS/MS, two GC, a UHPLC-HRMS Q-Tof and a UHPLC-HRMS Orbitrap MS-analyzers, three NIRS. Other labs are equipped to analyze forage for chemicals, biological and microbiological evaluations.

For this scholarship a period of internship is planned at *Chr Hansen Holding A/S, Parma, Italy or Hörsholm, Denmark*

Suggested skills for this research topic

The PhD student in this program should be able to combine and analyse knowledge regarding chemical analysis of feed, biochemistry, microbiology and animal nutrition. PhD student should also develop skills on how to design, organize and manage animal farms and animal production processes in animals, especially ruminants. PhD student should have good computer skills as they have to analyse data and make use of different univariate or multivariate statistical techniques.

Type of scholarship and obligations

The type of this scholarship is: Pubblica Amministrazione (Public Administration). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 5. Agriculture and Forestry

Modeling dairy farm management and nutrition facing climate impacts

Reference Person: Atzori Alberto Stanislao (asatzori@uniss.it)

Host University/Institute: University of Sassari

Research Keywords:	Dairy farm management
	Nutrition models
	Heat stress and climate adaptation of ruminants
Reference ERCs:	LS9_3 Applied animal sciences (including animal breeding, veterinary sciences, animal husbandry, animal welfare, aquaculture, fisheries, insect gene drive)
	LS9_7 Environmental biotechnology (including bioindicators, bioremediation, biodegradation)
	SH2_6 Sustainability sciences, environment and resources
Reference SDGs:	GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

The control of production efficiency in automated systems is every day more close to the managerial management of barn data for decision support. In this context, the companies which introduce technology and equipment in the barn, provide a support often aimed at the initial training for the use of equipment but little oriented to the improvement of production efficiency in the long run (Atzori et al., 2021a in Journal of Dairy Science; Atzori et al., 2021b in Integrated Environmental Assessment and Management). On the other hand, the standards of sustainability and technical-economic efficiency required of companies to achieve adequate levels of profitability are increasingly high.

Dairy farm management have high responsibilities to reduce environmental impact of dairy production systems. In the last 10 years the amount of data collected at farm level has tremendously increased. High opportunities for dairy management has been emerging especially if farm data are used to predict animal requirements and farm performances over time in order to support farmer decisions.

The research topic will focus on the use of farm available data (nutrition, milking , dynamics and reproduction softwares, meteo, etc) to dynamically predict nutrition requirements, feed efficiency, milk performances, environmental impact and profitability. Specific dynamic

models will be developed to address the heat stress effect and climate adaption to prevent production losses during high temperatures of Mediterranean summers.

In particular the research will study the adaptation of sheep and goats to climate change and heat stress deepening the physiological aspects of thermoregulation with different diets and under different environmental conditions of heat stress. It includes the development of a dynamic mathematical model for the estimation of the effects of heat stress on energy, protein and water requirements and on the quantitative-qualitative production of milk under conditions of heat stress, in order to identify foods that reduce the negative effects on production, animal welfare, and to improve the predictive and adaptive capacity of the sheep system with respect to climate change and the mitigation of GHG emissions.

The main output of the research will advance dairy farm models to increase the awareness of farmers and improve farm management in terms of sustainable and resilient productions.

The research will include environmental evaluations that focus on the roles and ecosystem services of intensive and extensive dairy farms

The Ph.D. Is designed to foster multidisciplinary interaction of biological and livestock expertise, physics for thermoregulation modeling and data analysis, economics, and mechanical and management engineering for optimization of farm production processes and climate change adaptation impact assessment.

Research team and environment

The Department of Agriculture, Livestock Science Section, has high background in farm modeling and environmental impact assessment. It have been working on estimation of animal emissions in the last 10 years and operates an experimental sheep and goat barn equipped with modern precision equipment, which allows: (a) electronic and automatic measurement of the milk production of the animals at each milking (Afimilk system of Afikim, Israel); (b) individual and continuous measurement of ingestion and feeding behavior of the animals (CRFI System, BioControl AS, Norway); (c) electronic weighing with high accuracy of the animals (WSS Weighing Unit, BioControl AS, Norway); the measurement of energy exchanges of animals by indirect calorimetry (respirometry in metabolic cages) and continuous analysis of gas exchanges (oxygen, methane and carbon dioxide), to quantify the energy and protein balance of animals and thus the effects of thermal stress on their needs and their GHG emissions.

Suggested skills for this research topic

Aptitude to work in experimental trails with farms and animla, curiosity for farming management and mathematical modeling applied to livestock science;

Multidisciplinary approach and curiosity;

Aptitude to work in team and to spend periods abroad with multidisciplinary research group.

Curriculum: 5. Agriculture and Forestry

Genomic tools for DNA-informed breeding for fruit crops resilience

Reference Person: Bianco Luca (luca.bianco@fmach.it)

Host University/Institute: Fondazione Edmund Mach

Research Keywords:	DNA-informed breeding
	Haplotype-resolved genomic sequence
	Breeding information management tools
Reference ERCs:	LS2_11
	LS2_5
	LS9_8
Reference SDGs:	GOAL 2: Zero Hunger, GOAL 3: Good Health and Well-being, GOAL 13: Climate Action

Description of the research topic

Climate changes are affecting crops production and both industry and consumers always demand new and improved cultivars. Genome-informed breeding can provide effective solutions to market demands and production challenges. The transition from 'classical' breeding to DNA-informed breeding techniques is often hampered by the availability of genomic tools and information that necessarily are at the basis of this enhanced process of breeding.

At the Fondazione Edmund Mach (FEM) of San Michele all'Adige (Trento-IT), large germplasm collections (particularly of grapevine, apple and small fruits) are maintained which could be used as the source of superior alleles to be introgressed into the breeding material (parental lines and selections) in response to abiotic or biotic stresses and to climate changes. At the same time, several genomic tools have been developed - particularly simple sequence repeat (SSR) assays and single-nucleotide polymorphism (SNP) arrays - to assess the genetic potential of the available material and correlate it with the phenotypic traits of interest. Although these tools alone can provide very useful information, they do not provide a comprehensive picture of the allelic state of each trait of interest and additional analyses are needed to unravel the complex mosaic structure of elite materials.

All this information is essential to bring genome-informed breeding to the next level, but in order to exploit its full potential high-quality and haplotype-resolved genome assemblies are needed, at least of the main founders of the breeding programs. Once produced, this allele-specific information has then to be integrated with all the genotypic and phenotypic data

available for the breeding programs and a breeding-information system has to be built to accommodate all this know-how.

The aim of this Ph.D. Project is twofold. From the one side, the project aims to obtain a high-quality, chromosome-scale and possibly haplotype-resolved genome of some of the most used genotypes in the breeding programs of apple and grapevine at FEM. A combination of the most recent sequencing technologies like PacBio HiFi, Omni-C and Illumina will be used to provide a state-of-the-art genome sequence and annotation of the selected genotypes. As for the second goal of the project, the work of the student will focus on the implementation of bioinformatic tools to mine and visualize this high-resolution information and combine it with all the available breeding information (including pedigrees), providing a useful toolkit to support breeding decisions.

The project has a strong bio-informatic connotation and will allow the student to gain hands-on experience with the assembly of genomes by using the latest technologies and most recent software. The student will also strengthen his/her programming skills by developing computational breeding tools that can effectively support the breeding activities at FEM.

Research team and environment

The Research and Innovation Centre (CRI) of the Fondazione Edmund Mach pursues scientific research, develops biotechnologies, and promotes innovation for agriculture, bioeconomy, ecology, biodiversity, the environment and food. The Centre focuses on basic and applied research on: (i) strategic supply chains of the Trentino agrosystem; (ii) forest and alpine ecology; (iii) biodiversity evolution and conservation; (iv) effects of climate change on natural and agro ecosystems; (v) bioeconomy, (vi) agrobiotecnology. The multidisciplinary functionality of the Center is guaranteed by the matrix organization and the transversal integration of the 21 Units and 21 Technological facilities on 4 thematic areas, namely Agrosystems and Bioeconomy, Biodiversity, Ecology and Environment, Food and Nutrition and Computational Biology. The technological platforms are operated by highly qualified personnel and cover Plant Phenotyping, Sequencing and Genotyping and Metabolomics. The Centre is equipped with a High-Performance Computing Facility with 376 cores and over 7.5TB of RAM (up to 2TB per node) and over 100TB of dedicated storage. The Centre hosts three major germoplasm banks, namely:

Grapevine germplasm collection that includes species of the genus Vitis, cultivars of V. Vinifera subsp. Sativa, V.V. Subsp. Sylvestris and interspecific hybrids;

Apple germplasm collection that includes species of the Malus genus, cultivar of M. X domestica, M. Sylvestris, M. Sieversii, M. Orientalis and interspecific hybrids;

Berries germplasm collection that comprises species of the Vaccinium genus, such as V. Corymbosum, V. Angustifolium, V. Virgatum, V. Myrtillus, V. Vitis ideae, V. Macrocarpon and hybrids, Rubus, Fragaria x ananassa, Ribes and other minor crops.

Suggested skills for this research topic

Good knowledge and experience in Computational Biology topics both as a user of bioinformatics tools (to analyze genetic data) and as a developer of software/scripts to accomplish data analysis. Preferred programming languages include Python, R and C. Prior experience with the analysis of genotypic data from plants is required.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Curriculum: 5. Agriculture and Forestry

Biodiversity and emerging technologies in agriculture for sustainable development

Reference Person: De Gara Laura (l.degara@unicampus.it)

Host University/Institute: Campus Bio-Medico di Roma

Research Keywords: In door agriculture

Plant metabolism and productivity in changing environmental conditions

Emerging technologies for plant sustainable and safety production

Reference ERCs: LS9_8

LS8_5

LS8_2

Reference SDGs: GOAL 2: Zero Hunger, GOAL 3: Good Health and Well-being, GOAL 4: Quality Education, GOAL 5: Gender Equality, GOAL 8: Decent Work and Economic Growth, GOAL 13: Climate Action

Description of the research topic

The necessity to produce food with high safety level but also high nutritional characteristics and the production of which responds to criteria of environmental and social sustainability is always more important for the society and consumers.

The indoor production of vegetables is promising strategies for innovative agriculture, in particular when the agronomic processes are assisted by emerging technologies (robotics, sensors, IA);by the comprehension of the environmental and biological mechanisms allowing plants to increase their productivity and to improve specific metabolic pathways (light, temperature, CO_2, mineral nutrition, elicitors etc.), and by the support of nutritional expertise directing the selection of the most appropriate species or metabolic pathways to be improved. The indoor cultivation systems could also been useful for studying the effects of environmental alterations induced by climate change, in order to identify the most resilient and nutritional appropriated species or cultivars.

The project will be aimed at setting up indoor agronomic and environmental conditions for the production of plants having specific nutritional characteristics (high level of antioxidant, healthy minerals and vitamins) and that could be useful in the context of precision nutrition. The biodiversity valorisation, with the possibility to introduce the cultivation of

alimurgic/spontaneous edible plants, and the aspects correlated to the sustainability of the processes will also taken into account in the identification of the most performing cultivation protocols.

Other aspect of interest will be the possibility to produce plant-derived matrices of well-defined and predictable nutritional characteristics, allowing their use as functional food with appropriate claims. This requires to set up of a chemical data base of the bromatological characteristics of plants produced in different conditions.

The project will also consider the aspect of technological transfers.In particular, the PhD student will have the possibility to interact with the classes of an agronomic secondary school with which the University has a MOU for research and didactic activities.

Research team and environment

The Department of Science and Technology for Human and the Environment of UCBM offers to students a multidisciplinary research environment in which researchers with different backgrounds (plant scientists, analytical chemists, nutritionists, and engineers) are used to work in the same project providing their specific points of view and expertise. This allows the students to increase her/his capability to address problems with a interdisciplinary approach.

The laboratory of the departments are well equipped with walk in growth chambers and phytotrons for growing plants in controlled environments, also simulating climate changes, equipment for molecular, biochemical and analytical analysis as well as the research groups of electronics and robotics have all the facilities for setting up technological systems for monitoring processes and their automation. Novel fields of research of the Department are recently oriented to analyse and set up protocol for life cycle assessment of processes aimed at food production.

Suggested skills for this research topic

Advanced knowledge in plant science, biochemisty and molecular biology

Basic knowledge in methods and protocols for defining process sustainability

Open mind for improving his/her knowledge in other scientific fields

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Curriculum: 5. Agriculture and Forestry

Sustainability assessment of agri-food processes with the Water-Energy-Food Nexus approach towards a climate-neutral economy

Reference Person: Del Borghi Adriana (adriana.delborghi@unige.it)

Host University/Institute: University of Genoa

Research Keywords:	Agri-food processes
	Water Energy Food Nexus
	Life Cycle Assessment
Reference ERCs:	SH3_1
	PE8_12
	LS9_5
Reference SDGs:	GOAL 2: Zero Hunger, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

The research concerns the evaluation of the sustainability of agri-food processes aimed at quantifying their footprint along the life cycle. The research will be carried out along the supply chain and will follow an approach based on the Water-Energy-Food (WEF) Nexus, evaluating the interconnection between food, water, energy and climate change. The methodology will be consistent with the international standards governing the Life Cycle Assessment (ISO 14040-44) and the principles of the Circular Economy. The basis of the WEF Nexus is an attempt to balance different uses of ecosystem resources (energy, water, land, soil and socioeconomic factors) on the assumption that there are clear interactions between water, food and energy that can result in synergies or trade-offs between different sectors or interest groups. The FAO definition of WEF Nexus explicitly addresses the interactions and feedback between human and natural systems, focuses on the resources we depend on for the achievement of social, environmental and economic objectives related to water, energy and food. The research aims at carrying out a multi-variable optimization of agri-food processes in which the optimum point will be defined by the ""best compromise"" between water footprint, energy consumption, global warming potential and agricultural yield of the crop. Taking into account the key role of the land sector for reaching a climate-neutral economy taking up practices leading to carbon sequestration, combined with strong benefits on biodiversity, the research will contribute also to provide improved knowledge, data management to land managers driving forward the standardisation of monitoring, reporting and verification methodologies to provide a clear and reliable framework for carbon farming.

Research team and environment

The PhD will take place at the Department of Civil, Chemical and Environmental Engineering (DICCA) of the University of Genoa. The PhD student will be integrated into the ""sustainable development of processes"" research group, a team that has been operating for almost 20 years within CESISP (Interuniversity Centre for the Development of Product Sustainability). The main research activities concern: GHG inventories and strategies, GHG calculation and monitoring, mitigation and adaptation strategies for industries and communities, Carbon Capture and Storage R&D, EU-ETS application, development, validation and verification of CDM projects, development of VER projects Carbon offsets, Carbon footprints, Life Cycle Assessment studies, Ecodesign and environmental labels, circular economy.

Suggested skills for this research topic

In order to perform a successfully research in this topic, a master's degree in a technical-scientific area is required that guarantees adequate knowledge of the concepts related to the assessment of environmental impacts and the definition of environmental indicators. The candidate should be familiar with data analysis and process engineering. A further skill is represented by the knowledge of the LCA methodology, its applications and use of the main calculation models used in the LCA analysis.

Curriculum: 5. Agriculture and Forestry

State and regional legislative power on agricultural energy in the perspective of the fight against the climate crisis

Reference Person: Di Salvatore Enzo (edisalvatore@unite.it)

Host University/Institute: Università degli Studi di Teramo

Research Keywords:	Agroenergy
	Agricultural energy
	Climate change
Reference ERCs:	SH2_1
	SH2_4
	SH1_15
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 9: Industry, Innovation and Infrastructure, GOAL 13: Climate Action

Description of the research topic

As pointed out by FAO, energy, agriculture and the climate crisis are strictly linked. Agricultural food systems currently massively rely on fossil fuels to operate. The increasing use of fossil energy in agriculture leads to increasing greenhouse gas (GHG) emissions from the agricultural sector, which in turn has an impact on agricultural production. One of the ways to overcome the mentioned problems is to increase the use of renewable energy in agriculture, including sustainable bioenergy from agri-food systems. To achieve this goal, special incentives for agricultural enterprises must be provided at the national level. In Italy, the national production, transport and distribution of energy is a matter of shared competence (see art. 117.3 of the Constitution): this means that the State sets the fundamental principles, while Regions are entitled to adopt detailed legislation only, which must be compliant with the principles laid down at State level. At the same time, agriculture is a matter of regional exclusive competence (see art. 117.4 of the Constitution): this means that the State has no law-making power in this respect, but regional legislation must always be compliant with the rules adopted at the EU level. In fact, when it comes to agriculture, the EU shares the legislative competence with the Member States (see art. 4.2 of the Treaty on the Functioning of the European Union). Moreover, the protection of the environment is a matter fully entrusted to the competence of the central State (see art. 117.2 of the Constitution). The regulation of agroenergy in the perspective of the fight against the climate crisis intersects all the three mentioned fields (agriculture, energy and protection of the environment), which are entrusted to different levels of government; for this reason, the

objective of this research project is to understand and clarify who (central State, Regions or both) has the right to adopt legislation aimed at promoting the production and use of renewable energy in agriculture, including sustainable bioenergy from agri-food systems.

Research team and environment

The research team is made up of 3 researchers: 1 Associate professor in Constitutional and Environmental Law, 1 Research Fellow in Constitutional Law with special expertise in Agrifood, 1 PhD candidate in Economic and Social Sciences, with expertise in Constitutional Law and protection of marine environment

For this scholarship a period of internship is planned at *EURAC, Bolzano*

Suggested skills for this research topic

Ability to work in a team

Strong legal background, with a focus on Constitutional and Environmental Law

Good command of Italian and English. Good command of other languages is a plus.

Type of scholarship and obligations

The type of this scholarship is: Transizioni Digitali ed Ambientali (Digital and Environmental Transitions). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 5. Agriculture and Forestry

Soil and plant-associated microbial communities for resilience to climate changes

Reference Person: Donati Claudio (claudio.donati@fmach.it)

Host University/Institute: Fondazione Edmund Mach

Research Keywords:	Plant microbiome
	Soil microbiome
	Metagenomics
Reference ERCs:	LS2_6
	LS8_12
	LS9_8
Reference SDGs:	GOAL 2: Zero Hunger, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

Every plant tissue is colonized by a complex microbial community that contributes to plant fitness in a variety of ways, including nutrient uptake, resilience to environmental stress and resistance to pathogens colonization. For this reason, arbuscular mycorrhizal fungi (AMF) and plant growth promoting bacteria (PGPB) are considered either as "biofertilizers" or "bioprotectors". Microbial communities associated with fruits influence their quality and the process of ripening with an impact on post-harvest conservation. The assembly of plant-associated microbial communities is a tightly regulated process that is determined by complex interactions between the microorganisms, their host and the environment. Soil is the major reservoir of plant colonizing organisms that are actively recruited by the host through a variety of mechanisms, but other sources of colonization, including insect vectors, also contribute to shaping plant microbiota. A holistic approach considering the effect of microorganisms on different plant organs and their interactions with the environment would be helpful for developing strategies for crop improvement based on plant-associated microbiota. In this framework, using crop wild relatives (CWRs) and their microbiota offers a wide range of new possibilities.

Metagenomics is the technique of choice to characterize complex microbial communities. By targeting conserved marker genes (16S for bacteria, ITS for fungi) it is now possible to characterize the taxonomic profile of complex microbial communities. Direct sequencing of the complete genomic repertoire of the community can provide a full account of its metabolic

potential, and, in addition, increase taxonomic resolution to subspecies-level for disentangling in greater detail the structure of the microbiome.

Fondazione Edmund Mach hosts some of the largest plant collections in Europe, including more than 3500 grape, 1000 apple, and 400 berries varieties. We will use both targeted and untargeted metagenomic sequencing to characterize the microbial communities that colonize host plants and the possible sources of microbial colonization. This approach will allow to gain a comprehensive picture with strain level resolution of the plant-associated microbiome and of its metabolic potential. Specifically, we will concentrate on soil, root associated microbiota, endophytic compartments and fruit microbiota using blueberry plants (Vaccinium spp.) as model organisms. A selection of wild plants from the Italian Alps will be collected and analyzed as well. The structure and composition of the plant-associated microbiome in different accessions grown under similar environmental conditions will be analyzed, in order to highlight the extent by which the genetics of the host shapes the composition of the microbial communities. Data on phenotypic characteristics of the plant, productivity and fruit metabolic features will be collected and correlated with composition of the microbial communities to identify microbial species associated with resilience against environmental stress, productivity, fruit quality and post-harvest conservation. These data will be complemented by a meta-analysis of publicly available plant and soil-associated metagenome data, to build a comprehensive genomic catalog of soil and plant associated microorganisms that will pave the way for further studies to understand the assembly, evolution, and biogeography of microbial communities in cultivated and wild perennial plants.

Research team and environment

The Research and Innovation Centre (CRI) of the Fondazione Edmund Mach pursues scientific research, develops biotechnologies, and promotes innovation for agriculture, bioeconomy, ecology, biodiversity, the environment and food. The Centre focuses on basic and applied research on: (i) strategic supply chains of the Trentino agrosystem; (ii) forest and alpine ecology; (iii) biodiversity evolution and conservation; (iv) effects of climate change on natural and agro ecosystems; (v) bioeconomy, (vi) agrobiotecnology. The multidisciplinary functionality of the Center is guaranteed by the matrix organization and the transversal integration of the 21 Units and 21 Technological facilities on 4 thematic areas, namely Agrosystems and Bioeconomy, Biodiversity, Ecology and Environment, Food and Nutrition and Computational Biology. The Centre has 21 cutting-edge technological platforms operated by highly qualified personnel, including a Plant Phenotyping platform, a Sequencing and Genotyping platform and a Metabolomic platform. The Centre hosts three major germoplasm banks, namely:

Grapevine germplasm collection that includes species of the genus Vitis, cultivars of V. Vinifera subsp. Sativa, V.V. Subsp. Sylvestris and interspecific hybrids;

Apple germplasm collection that includes species of the Malus genus, cultivar of M. X domestica, M. Sylvestris, M. Sieversii, M. Orientalis and interspecific hybrids;

Berries germplasm collection that comprises species of the Vaccinium genus, such as V. Corymbosum, V. Angustifolium, V. Virgatum, V. Myrtillus, V. Vitis ideae, V. Macrocarpon and hybrids, Rubus, Fragaria x ananassa, Ribes and other minor crops.

Suggested skills for this research topic

The successful candidate is expected to have good knowledge of basic microbiology and microbial genomics. In addition, the ideal candidate has good knowledge of major bioinformatic tools and methods, including genome assembly and annotation tools. Working knowledge of one high level programming language such as python and/or of the R statistical programming language is a plus.

Curriculum: 5. Agriculture and Forestry

Soil functions for mitigating climate change

Reference Person: Freppaz Michele (michele.freppaz@unito.it)

Host University/Institute: University of Turin

Research Keywords:	Belowground C allocation
	Soil organic C stabilization
	Biogeochemical redox cycling
Reference ERCs:	PE10_9 Biogeochemistry, biogeochemical cycles, environmental chemistry
	PE10_12 Sedimentology, soil science, palaeontology, earth evolution
	LS9_8 Applied plant sciences, plant breeding, agroecology and soil biology
Reference SDGs:	GOAL 2: Zero Hunger, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

Understanding soil processes driving organic carbon sequestration and greenhouse gas emissions in terrestrial ecosystems is fundamental to enhance soil functions that contribute to mitigating climate change. This knowledge is particularly important for hydromorphic soils that characterise both natural and anthropogenic wetland ecosystems. Apart from representing some of the most biologically productive ecosystems on earth and sustaining global food security (e.g. rice paddies), wetland soils represent major contributors to global methane emissions though, at the same time, hold an important potential to sequester atmospheric C. The balance between C source and sink functions of these ecosystems is however not always clear due to several knowledge gaps in the soil processes that regulate belowground C cycling as a function of different edaphic and environmental variables. Moreover, soil processes driving the trade-off between methane emissions and C sequestration are still not fully understood, especially due to the complex interactions and feedbacks between plants, soils and microorganisms.

The PhD project will focus on C cycling in rice paddies, as model wetland ecosystems for their global relevance with respect to food production and environmental implications, as well as for the extensive background knowledge of soil and plant processes occurring in the paddy rhizosphere. In particular, the research is expected to contribute scientific knowledge essential to improve our conceptual model of soil C cycling and budgets in these

agroecosystems, by providing novel insights into belowground C allocation by rice plants and the contribution of root-derived C (including rhizodeposition and root detritusphere C turnover) to labile and stable organic matter pools as a function of different variables such as soil redox conditions, nutrient availability and soil properties. The implications of belowground C inputs on driving methane production and C sequestration in these redox-dynamic environments, will be elucidated even through the use of stable isotope tracing approaches in soil-plant systems. Apart from providing advances in our understanding of wetland functioning in general, research outcomes will also integrate our understanding of the effects of agricultural practices on the environmental sustainability of rice cropping systems.

The project contains a certain degree of flexibility and could take on both methodological and applied focuses depending on the interests of the candidate. The candidate will learn how to formulate hypotheses, design experiments and apply statistical techniques to address specific research questions, and will have the opportunity to publish his/her results in peer-review journals and present them at national and international conferences. Moreover, an internship of up to 6 months as a visiting researcher in an international research centre will complement the training.

Research team and environment

The DISAFA is a leading academic institution that undertakes strategic research at the forefront in agricultural, forest and food systems. The campus includes cutting-edge research labs and greenhouses equipped with advanced instruments for the analysis of complex and structured matrices for specific topics (e.g. soil science, plant physiology and genetics, plant pathology, agronomy and forest science). A network of experimental platforms and field research sites complement the campus facilities. The department's research environment attracts leading international scientists and collaborations with international research institutes. Researchers are also committed to engage with end-users, policy makers and key stakeholders at local and national levels. The campus is located near the city of Torino to which it is well connected (15 minutes underground metro ride), and includes libraries, sports facilities, ample green areas and meeting points. The candidate will work with Prof. Daniel Said-Pullicino (https://www.disafa.unito.it/persone/daniel.saidpullicino) as part of the Soil Biogeochemistry and Fertility research group which focuses on biotic and abiotic processes that regulate soil functions including climate change mitigation, plant nutrition, food safety, and water and air quality, over a range of scales. The research group also includes scientists with expertise in (i) soil organic matter cycling and interactions with nutrient cycling; (ii) soil-plant-microbe interactions driving soil organic matter composition, stabilization and turnover; (iii) biogeochemical cycling of nutrients and contaminants in soil and water environments; (iv) element interactions in the soil-plant interface and plant regulatory responses; (v) microbial ecology and functional role of microorganisms in biogeochemical cycles. For more information, visit:

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https://en.disafa.unito.it/do/home.Pl/View?doc=/research/research_lines/groups/soil_resource/soil_biogeochemistry_and_fertility.html

Suggested skills for this research topic

Candidates should be well-motivated, curious and committed to pursuing research in soil science. The ideal candidate should have a solid background in soil chemistry, physics and biology, and a broad interest in soil processes and functions related to the sustainability of agroecosystems. Experience with field sampling and chemical laboratory analysis (in particular soil chemical analysis and stable isotope mass spectrometry) will be considered an asset. The candidate must have the ability to work independently with flexibility as part of a team, and a willingness to learn new skills related to soil biogeochemistry. The candidate is expected to demonstrate capacity to manage and critically analyse new and complex concepts, develop own research questions, pursue lines of though, and hold a working proficiency (both oral and written) in English. The University of Torino seeks to increase the number of women in those areas where they are underrepresented and therefore explicitly encourages women to apply.

Curriculum: 5. Agriculture and Forestry

Resilience strategies for the adaptation to abiotic stress of plants in altered climatic conditions.

Reference Person: Lovisolo Claudio (claudio.lovisolo@unito.it)

Host University/Institute: Università degli Studi di Torino

Research Keywords: Embolism formation and recovery

Drought and heat

Physiological and biological mechanisms

Reference ERCs: LS8_5

Reference SDGs: GOAL 2: Zero Hunger, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

Climate change is expected to bring general increase of earth temperature at a global scale, but locally it might lead to increased frequency and intensity of extreme environmental conditions like changes to minimum and maximum temperatures, duration of drought periods, intensity of rainfall/snowfall events, and wind strength. These local extremes and not average climatic conditions are considered to be responsible for woody plants survivals, as trees have to deal with such events over their lifespan. Xylem provides trees strength and is considered to be the robust part of the tree's structure. However, it is also the physiologically most fragile part, as survival of the tree depends on its ability to sustain the supply of water to the tree crown under variable environmental conditions. Many structural, functional and biological tree properties evolved to protect xylem from loss of transport function due to embolism or to restore xylem transport capacity in the event of embolism formation. How 'the new climate normal' conditions will affect these evolved strategies is yet to be seen. However, a full understanding of xylem physiology and of the biology behind the refilling process current can provide insights to near future challenges that woody plants will face.

The major goal of this research is to understand changes in biological activity of xylem parenchyma cells induced by the formation of embolisms in xylem vessels. These changes result in the generation of the osmotic gradients, which drive water into empty vessels. In order to achieve this goal, different molecular and physiological approaches will be used and the presented objectives will be investigated:

-In vivo quantification of embolism recovery and its restoration through optical method and microCT

-Elucidation of refilling physiology including analysis of cellular microenvironment properties (pH, osmotic potential, ionic concentration and composition), membrane transport activity (transport of carbohydrates, ions and water), and enzymatic activity (cellulosic and apoplastic metabolism of carbohydrate).

-Expression analysis of genes involved in metabolism pathways during the onset of embolism and embolism refilling.

Research team and environment

Francesca Secchi will be the PhD-student's Tutor. She has expertise in molecular plant physiology. Her current research focuses on whole woody plant water relations, sugar metabolism, structure and function of plant vascular network and abiotic plant stress biology.

Suggested skills for this research topic

The candidate is expected to have good knowledge in plant physiology, molecular biology and biochemistry. The candidate should have as well a good knowledge of English. Experience with tree species will be considered as an advantage, but it is not essential.

Curriculum: 5. Agriculture and Forestry

Impacts of climate change and its uncertainty on agriculture

Reference Person: Monteleone Beatrice (beatrice.monteleone@iusspavia.it)

Host University/Institute: IUSS Pavia

Research Keywords:	Climate change
	Uncertainty
	Agriculture
Reference ERCs:	PE10_3 Climatology and climate change
	PE10_21 Earth system modelling and interactions
	PE1_19 Scientific computing and data processing
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

As highlighted by the UN development goals and the European Climate Law, climate change is a reality to which society needs to adapt. The possibility to effectively address the adaptation issue lies on our ability to include climate change into impact studies and risk assessment. Up to now, climate modelling and natural hazard assessment have been separate disciplines with limited communication and interaction due to different backgrounds and requirements.

Until recently, climate modellers did not have the capability to generate long-term projections at a spatial and temporal resolution useful for impact studies such as risk assessment for the agriculture at local scale. With the advent of kilometre-scale atmospheric models, called convection-permitting models CPMs, we are now in a position to bridge the gap between the two communities thanks to a spatial resolution closer to what many modellers in the field of agriculture need and to an improved representation of sub-daily precipitation characteristics.

Climate model ensembles are used to evaluate the uncertainties related with the climate change signal. An open question remains on how climate change uncertainties will propagate into impact models such as crop models, used to estimate the effects of climate on agriculture. In fact, when using climate model as input, the weight of climate projection uncertainties affects the final output of the impact model.

This research aims to investigate the impact of using high-resolution climate model into models traditionally applied to estimate agricultural productivity

And focuses on the propagation of uncertainties. The purpose is to learn how to deal with uncertainties to provide examples of good practice, storylines and a clear message to stakeholders and policymakers. The study will rely on climate data accessible from the European Union Copernicus project, in particular the most recent global ERA-5 reanalysis, as well as CPM data created under the CORDEX Flagship Pilot Study (CORDEX-FPS).

Research team and environment

IUSS mission is to provide advanced education to undergraduate and graduate students, as well as fundamental and applied research in the fields of Science, Technology, Engineering and Mathematics (STEM), and Human, Social and Life Sciences. At IUSS, PhD candidates will find an open multidisciplinary environment offering real opportunities for developing academic and professional tools for facing the challenges arising from increasing complexity and fast changes in the society and the environment. IUSS is always and actively committed towards internationalisation, inclusion and diversity. The selected candidate will join the research centre on Climate change impAct studies for RISk MAnagement (CARISMA). The CARISMA team is composed by STEM and Social scientists working in the prism of climate change on: data analysis and modelling of Earth system and economic system processes; impact assessment of extreme natural events and anthropogenic activities on human and natural environments; risk management of natural and anthropogenic hazards; formulation and proposal of new economic, political and legal models of sustainable development. Within CARISMA, G. Fosser is an expert in climate modelling at convective-scale, extreme events, climate change uncertainties analysis and impact studies . B. Monteleone works on the assessment of the impacts of extreme events on agriculture through the use of crop models.

Suggested skills for this research topic

The ideal candidate will have experience with impact models and statistical analysis. Specific skills in the field of climate science and with large climate dataset will be considered a plus. Moreover, the candidate should be strongly motivated to work in a multi-disciplinary environment, collaborating with the STEM and social scientists of the CARISMA research centre and beyond.

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Curriculum: 5. Agriculture and Forestry

Insects as a source of novel feed for high-value aquatic and terrestrial animal rearing: a multidisciplinary approach

Reference Person: Nali Cristina (cristina.nali@unipi.it)

Host University/Institute: University of Pisa

Research Keywords:	Sustainable feed production
	Food quality
	Food safety and security
Reference ERCs:	LS9_10 Veterinary and applied animal sciences
	LS9_9 Plant pathology and pest resistance
	LS9_12 Ecotoxicology, biohazards and biosafety
Reference SDGs:	GOAL 2: Zero Hunger, GOAL 3: Good Health and Well-being, GOAL 11: Sustainable Cities and Communities

Description of the research topic

Insects are commonly eaten by more than two billion people around the world. EFSA's recent approval of Tenebrio molitor larvae as food paves the way for insect consumption in the European Union. The introduction of insects as food in the diet of Western countries could be an environmental-friendly solution to the growing demand for animal proteins over intensive farming. Despite advances in legislation and food safety, there is still a cultural barrier to be overcome, which still considers insects as organisms harmful to agriculture and humans. Furthermore, insects represent interesting sources of feeds for animal rearing.

In this scenario, the present Ph.D. Research project will focus on insect species to be used as food and feed in a context of circular economy. Three trophic systems will put to the test. In the first one, larvae of the Mediterranean fruit fly, Ceratitis capitata, will be reared on a cheap and organic semi-artificial diet, then the larvae and pupae will be tested as a novel feed for poultry, to examine the possible beneficial contribution of this feed supplement on the meat and egg production, with special reference to the contents of amino acids, vitamins, antioxidants, and lipids. Mycotoxins contamination of meat and eggs from chickens feed on commercial cereal-based feed vs. Insect-enriched feed will be assessed.

Within the circular economy framework, the exhausted medfly diet, still rich in proteins, sugars, and fibers, will be tested as a feed supplement for organic rearing of free-ranging swine, putting in comparison two breeds, i.E., Large White and the local Tuscan breed Cinta

Senese. In both cases, the potential impact of the feed supplement described above on the meat quality, in terms amino acid, vitamin, antioxidant, and lipid contents will be studied.

Third, while massive research efforts are currently ongoing to shed light on the potential of insects and food and feed, very little is known about their potential as feed for high-value aquatic crustaceans. Herein we propose the creation of microcosm-like rearing of at least two crayfish species which will be feed using mass-reared Tenebrio molitor and Musca domestica larvae. Besides comparing the production of crayfishes if compared to rearing methods currently used in the real world, the impact of insect-based feeding on crustacean meat quality (in terms of amino acids, vitamins, antioxidants, and lipids) will be investigated. The expression of detoxification genes (e.G. GST and cytochrome P450) in crustaceans reared or not with insect-based feeds will be assessed.

The insect metabolic byproducts will be used as novel fertilizers, conducting experiments on horticultural crops, and assessing the contents in nutraceuticals of the final products, if compared to control ones.

For all the trophic systems reported above, the impact and overall appeal of final food products will be assessed through dedicated analyses of consumer choices within the agri-food sector.

Research team and environment

The research team include the Entomology, Animal Science and Plant Pathology research units. The Entomology unit deals with the study of olive and vine entomofauna and foodstuffs, medicinal herbs, insects of urban and medical-veterinary interest. It owns equipment for morphological and behavioural studies (e.G. SEM, Laser Vibrometer, Wind Tunnel, olfactometers). The Animal Science unit is interested in milk and cheese quality, meat quality and influence of feeding and farming systems on fatty acid composition of intramuscular fat, effect of genetic and environmental factors on milk fat composition, study of the effects of genetic polymorphisms on milk fatty acid composition. It is equipped of field and lab equipment for morpho-physiological and biochemical analyses (e.G. HPLC, GC-MS, Kjeldahl tools). The Plant Pathology unit is focused on the oxidative stress on plant species, biopesticides and contamination by mycotoxins of plant products and food. It is equipped of greenhouses, a growth chamber, as well as field and lab equipment for morpho-physiological and biochemical analyses (e.G. Microplate reader, HPLC, GC-MS). Andrea Lucchi, Giovanni Benelli, Marcello Mele and Elisa Pellegrini are involved in the present research programme.

In addition, the scientists of the group belong to the interdisciplinary center of the University of Pisa in charge of the management of large facilities and instrumentations. The key-qualities of this group are: clear communication among all team members; consensus among all team members; problem solving ability; positive, supportive working relationships among all team members; national and international connections with other research teams; good capability of fund raising.

Suggested skills for this research topic

Successful candidates are expected to have: knowledge of basic biology and biophysics laboratories, as well as good theoretical background to execute the above described activities; creative problem-solving ability; open-mindedness; active listening capability; reliability; accountability and attention to detail; desire to learn and learning agility. Applicants would be expected to demonstrate high motivation and to be fluent in English.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research).This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 5. Agriculture and Forestry

Engineering Photosynthesis For Global Sustainable Supply Of Plants For Food Crops, Bioenergy And More

Reference Person: Pinnola Alberta (alberta.pinnola@unipv.it)

Host University/Institute: University of Pavia

Research Keywords:	Photosynthesis
	Photoprotection mechanisms
	Plant productivity
Reference ERCs:	LS9_2
	LS9_7
	LS1_9
Reference SDGs:	GOAL 2: Zero Hunger, GOAL 13: Climate Action

Description of the research topic

Life on Earth ultimately depends on energy derived from the sunlight. Through the process of photosynthesis, plants are capable of harvesting sunlight to produce energy, biomass and oxygen.

The growing demand for bio-products, global warming and climate change require urgent adaptation of agricultural practices to increase biomass production yields. This also constitutes a top priority of the EU agenda, as defined in the European Green Deal: new proofs of concept are needed to provide healthier food and new-generation fuel while protecting natural life.

Improving photosynthesis efficiency and abiotic stress tolerance is a promising, yet not realized, strategy to increase crop productivity in a sustainable way. Plants are exposed to numerous abiotic stress that negatively impact on their photosynthetic performance: Non-Photochemical Quenching (NPQ) is a photoprotection mechanism essential to protect plant from ROS production in high-light conditions but such mechanism down-regulate photosynthesis and decrease plant productivity. Not only, light intensity changes continuously (i.E. Even throughout sunny days, clouds may produce dramatic light intensity variations): the limitation of NPQ is that its activation and relaxation is too slow thus affecting strongly the average photosynthetic efficiency, resulting in reduced plant growth. Modern farming is based on high density cultures causing an unequal light intensity distribution. In tall, dense plant canopies the upper leaves are exposed to excess light, while 85% of

photosynthetic tissues is light-limited even at midday. Active NPQ in upper leaves prevents ROS production, but also causes crop productivity reductions up to 30%.

This project aims at modulating NPQ response to enable safer and more efficient usage of solar energy by plants, improving their adaptive responses to light intensity variations. Additional fine tuning of NPQ gene expression levels as a function of light intensity might further maximize plant growth by preventing photoinhibition and possibly resulting in more profitable crops due to more efficient usage of light, land, and water resources.

We found out that LHCSR, a key gene essential for moss NPQ responses not found in modern plants, can switch between different states in response to sunlight change. LHCSR introduction in wild-type (WT) Arabidopsis increased photoprotection in stressful light conditions, without detrimental effects during normal light exposure. Furthermore, LHCSR introduction in Arabidopsis variants deprived of canonical key NPQ genes partially rescued the WT phenotype. This is a proof of concept for the heterologous expression of moss genes in enhancing photosynthetic efficiency and abiotic stress resistance in higher plants.

This project will investigate the molecular mechanisms of LHCSR in triggering NPQ:

1) by constructing a model for energy transfer among the chromophores bound to LHCSR;

2) by creating mutated versions of the protein on pH detection and chromophore binding sites.

Such model will allow to design mutations in order to tune NPQ activity vs light harvesting ratio and manage photosynthesis vs photoprotection for optimal productivity in each range of climatic conditions.

Our findings will provide crucial milestones for applied research in line with Sustainable Development and Climate change priorities and they will contribute to ENGINEERING PHOTOSYNTHESIS FOR GLOBAL SUSTAINABLE SUPPLY OF PLANTS FOR FOOD CROPS, BIOENERGY AND MORE.

Research team and environment

The research team is composed by the PI, Alberta Pinnola and 2 master thesis students for the molecular cloning and heterologous expression of the LHCSR protein in sp. Nicotiana. The team collaborate with the group of Prof. Federico Forneris for the purification procedures and biochemical characterization of the different LHCSR variants. The Isolated LHCSR variants will be spectroscopically analyzed in collaboration with Giulio Cerullo (University of Milan, Italy) and Prof. Gabriela-Schlau-Cohen (Massachusetts Institute of Technology, Boston, USA). The candidate will join and work with these different teams having different but combined expertise.

Suggested skills for this research topic

The skills required include: analytical and innovative thinking, autonomy, critical skills, lateral skills, ability to achieve goals, problem solving, communicative spirit, teamwork.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research).This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 5. Agriculture and Forestry

Coupling sensors and modelling to support sustainable irrigation practice

Reference Person: Provenzano Giuseppe Antonio (giuseppe.provenzano@unipa.it)

Host University/Institute: University of Palermo

Research Keywords:	Agro-meteorological and energy balance models
	Remote Sensing
	Machine Learning
Reference ERCs:	PE10_14 Earth observations from space/remote sensing
	PE6_12 Scientific computing, simulation and modelling tools
	PE10_3 Climatology and climate change
Reference SDGs:	GOAL 2: Zero Hunger, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

In the last few decades, average temperatures have been increasing by about 0.2¬∞ C per decade, as a result of the effects of global warming and climate change, which cause important consequences on agro-ecosystems, such as long drought periods, the reduction of crop water availability, and the onset of water stress conditions. Furthermore, since agriculture still represents the main pressure on renewable water resources, the accurate estimate of irrigation demands is of paramount importance to meet the requirements of sustainable water-related policies, promote better-informed decisions, and increase the resilience of productive systems. Disproportionate use and allocation of Water-Energy-Food-Ecosystem (WEFE) resources have created an imbalance in the physical and natural systems which may be further altered due to the current climate change scenarios. At this aim, modelling approaches can play a key role in the evaluation of crop water demands and in the definition of strategies aimed at optimizing water use efficiency (WUE). Several modelling tools of the soil-plant-atmosphere system, integrated with data acquired in the field or from remote platforms have been developed to calculate crop irrigation requirements and to support irrigation planning and water management at different spatial scales. Remote Sensing (RS) techniques in the visible, near-infrared (VIS/NIR) and thermal infrared (TIR) regions of the electromagnetic spectrum have been used to identify, over large areas, some biophysical properties of vegetation such as leaf area index, albedo, crop coefficient, etc.

The research intends to develop and test a robust methodological approach to support and planning of irrigation water applications at different spatial scales (from plots to irrigation districts) based on the use of agro-hydrological and/or energy balance models integrated with data acquired in the field and/or by proximal and remote sensing (drones and satellites). Application of new and existing technologies to monitor soil and plant water status, with sensors installed in experimental and demonstrative fields, as well as on unmanned aerial vehicles, collected by satellite platforms (Sentinel, Landsat8, MODIS) or obtained by agro-hydrological models, will provide new definitions of water use efficiency indicators at different observation levels. Such indicators will be used to optimize water distribution and for the process of irrigation audit.

The research activities will be carried out in eco-systems characterized by typical Mediterranean crops, in which the joint use of available climatic and remote sensing data will be considered to estimate actual crop water requirements and to manage irrigation at different spatial scales. The proposed approach will be also used to assess the effectiveness and the potential of improvement associated with the actual irrigation strategies practiced by farmers and at larger spatial scales (irrigation audit), as well as to identify scenarios of future management accounting for climate change and the consequent necessary mitigation strategies. Finally, the availability of extended datasets of soil, crop and climate information will allow the identification of machine learning algorithms aimed at performing gap-filling procedures in the event of a lack of data and forecasting future actions to achieve climate mitigation and adaptation.

Research team and environment

The staff has a long experience in sustainable irrigation of Mediterranean tree crops, soil quality, agro-hydrological models, remote sensing, and GIS, as well as on the estimation of crop water requirement and monitoring and partition of evapotranspiration fluxes across different observation scales and under soil water stress conditions. The team has carried out experimental investigations aimed to identify irrigation scheduling strategies for water and energy saving in agriculture. Strong expertise was acquired on soil and plant sensors, micro-meteorological systems, proximal sensing, and field spectroscopy, to identify crop water stress conditions and to evaluate water requirements and irrigation timing. The team has a fully-equipped laboratory of soil hydrology and electronic applications for detailed soil physical analysis and to detect soil and plant variables. The team is also conducting field research activity to monitor the soil and plant water status of Mediterranean tree crops, as well as to assess the effectiveness and water-saving achievable when using surface/subsurface drip irrigation systems. Experimental sites are equipped with sensors to monitor soil and plant water status, climate stations, and Eddy Covariance towers, both of which are equipped with a three-dimensional sonic anemometer, an open-path infrared gas analyser, a four components net radiometer, a sensor for relative air humidity and air temperature, two pyranometers oriented to measure soil and vegetation surface radiometric temperature, two self-calibrated soil heat flux plates and, finally, a reflectometer, to monitor

actual evapotranspiration fluxes. A Parrot Anafi Thermal drone is also in the availability of the research team.

For this scholarship a period of internship is planned at *Irritec s.p.a., sede legale: Via Gambitta Conforto, c.da S. Lucia, 98071 Capo D'Orlando (ME)*

Suggested skills for this research topic

Geographical information systems for soil protection, environmental remote sensing, hydro-informatics, hydrology, hydraulics, Irrigation systems, image processing, programming, machine learning, big data processing, modelling crop water requirements.

Type of scholarship and obligations

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Curriculum: 5. Agriculture and Forestry

High Throughput Screening to select resilience dairy feeding systems

Reference Person: Rallo Giovanni (giovanni.rallo@unipi.it)

Host University/Institute: University Of Pisa

Research Keywords:	High throughput screening system
	Combined stress
	Resilient agri-food system
Reference ERCs:	LS9_8 Applied plant sciences, plant breeding, agroecology and soil biology
	PE10_3 Climatology and climate change
	PE6_12 Scientific computing, simulation and modelling tools
Reference SDGs:	GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

Current and future impacts of the drought and salinity stresses due to climate change, as well as the intrinsic shade stressor induced over the lower crop layer, pose a threat to agroforestry for low-intensive and organic dairy systems which could negatively affect the yield and quality capacity in the Mediterranean area.

An integrated quantification of the livestock-crops response to combined stressors (drought, salinity and shade) and the ruminal methanogenesis, are topics of relevant priority at the global level. Consequently, multidisciplinary studies and integration of a wide range of emerging technologies could supply awareness regarding the conception of eustress, where mild combined stressors could modulate the induction of the plant-communities defense system and the synthesis of phytochemical components, that are able to enhance plant resilience and the nutraceutical quality.

Currently, there is the need to early detect the crop resilient traits more adaptable and responsive to the effects of combined stressors. In this sense, the High-Throughput Screening (HTS) systems can represent robust tools and could be used for an early parameterization of the crop response as well as the biomining rumen-methanogenesis.

In these contexts the proposal aims to study, under a HTS logic, the stress response of typical herbaceous livestock crops (i.E. Lawn, Triticale spp and Sainfoin) useful to be implemented in agroforestry systems for low-intensive and organic dairy systems.

In order to select the climate-ready herbaceous livestock-crops of an agroforestry system the research topic deals with: 1) using HTS system to select resilient livestock-crop to be implemented in agroforestry systems for low-intensive and organic dairy systems, 2) screening the nutraceutical and sanitary status (i.E. Mycotoxin contamination) and the rumen-methanogenesis activity of the biomass cultivated under the effects of combined stressors (drought, salinity and shade), 3) using and developing agro hydrological crop models able to simulate the crop growth under combined stressors, 4) using and developing new and non-invasive hyperspectral models to detect crop parameters associated to the functional and health status of the crop and 5) validate the selected resilient livestock-crops system in field conditions.

The thesis will use a sensor platform for high-resolution and high-throughput diagnostic-screening designed for a first rapid parameterization of the water-salinity stress function at pot scale. The possibility to integrate a shading system will allow the coexistence of the stressors according to climate change scenarios. Winding down its outcome, the research will analyze the rumen methanogenesis activity of the crop biomass produced in the first step of the research.

Finally, the project will also aim to analyze the socio-economic and managerial implications to enhance and promote ecosystem services related to the agroforestry system for low-intensive and organic dairy systems.

Research team and environment

The main hubs of the research activities will be the four laboratories of the Department of Agriculture, Food and Environment (DAFE): AgrHySMo (4Sensing and Modeling), Plant Science, Animal Production and Plant Pathology.

The research group involves Prof. Giovanni Rallo, Prof. Giuseppe Conte, Dr. Lorenzo Cotrozzi, Dr. Marco Landi, Prof. Gianluca Brunori and Prof.Ssa Iduna Arduini, all members of the Centro Interdipartimentale di Ricerca per lo Studio degli Effetti del Cambiamento Climatico. The major issues of the research group address in agrohydrological sensors and modeling, animal production, physio-chemical and molecular bases of differential responses of plants to abiotic stresses, sustainable rural development and related innovation processes.

The AgrHySMo lab. Manages the HTS-system implementing three hardware segments for high-frequency detection of the agrometeorological forcing variables (i.E. Atmometry), the weights (i.E. Gravimetry), and the soil water content (i.E. Time domain reflectometry) of sixteen pots (extendable up to 256 modules) in which livestock-crop will be seeded.

The laboratory of animal science is equipped with the Daisyll Incubator, which reproduces in-vitro ruminal assay to study the digestibility of feed ration and estimates gases production, with particular reference to methane emission.

The laboratory of Plant Science investigates the short and long-term growth response of plants and plant mixtures to abiotic stresses.

The laboratories of plant pathology and biochemistry are fully equipped with semi-controlled greenhouses, as well as field and lab equipment for morpho-anatomical physio-chemical analyses (e.G. Full-range spectroradiometer, photosynthetic gas-exchange systems, chlorophyll-a fluorometers, pressure chamber, osmometer, HPLC, IC, GC-MS).

Suggested skills for this research topic

Motivation and the ability to integrate data and derive insights from a multidisciplinary approach are required.

The PhD candidate should have a background imprinted in agricultural and environmental sciences, technological and laboratory skills related to herbaceous livestock crops and stress physiology. Good knowledge of the aspects relating to the formulation of a feed ration and rumen metabolism is required.

Finally, experience in hydro-informatics and calibration/validation of agrohydrological and spectral models must be demonstrated.

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Curriculum: 5. Agriculture and Forestry

Land planning for biodiversity conservation and food production

Reference Person: Rondinini Carlo (carlo.rondinini@uniroma1.it)

Host University/Institute: Sapienza Università di Roma

Research Keywords:	Extinction risk
	Ecosystem Services
	Food-Climate-Biodiversity Nexus
Reference ERCs:	LS8_2
	LS8_3
	PE10_4
Reference SDGs:	GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

In response to the global biodiversity crisis, most countries have been investing resources for at least three decades to achieve progressively bolder targets in biodiversity conservation. Recently, a new Biodiversity Strategy has been adopted by the European Commission for the 2020-2030 decade as a core part of the European Green Deal. The Strategy commits member states to several obligations, including the protection of at least 30% of the land by 2030 (a substantive increase from the current 18% covered by the Natura 2000 network), with one third of it (10% overall) being strictly protected. At the same time, if current trends of land and soil consumption continue, pressures on biodiversity will increase substantially; projections based on population growth and dietary transitions estimate the need for 2-10 million km2 of new agricultural land globally, largely cleared at the expense of natural ecosystems. In the face of these trends, conventional conservation approaches, such as site-based conservation, have to confront the concurrent need to secure food production in the landscape. The goal of this project is to identify sites where to expand the Natura 2000 network to achieve the EU 2030 goals for biodiversity, while ensuring at the same time high quality and quantity of food production. This can be achieved through spatial planning techniques (systematic conservation planning) that enable the achievement of multiple goals concurrently. To set quantitative goals for biodiversity, we will extend the aim of the Habitats Directive to restore or maintain a favourable conservation status (FCS) for all species and habitats in Annex I and II, to all priority habitats and species referred to in the drafted guidelines, e.G. Species listed as threatened with extinction according to the IUCN Red Lists of ecosystems and species, and all bird species, in compliance with the Birds Directive. To

set targets for FCS we will determine Favourable Reference Values (FRVs) for habitat types and species ranges (FRR), for area of habitat types (FRA) and for population size of species (FRP). We will use information on the biology of the species/ecosystem types (e.G., life history strategies and dispersal capacity, habitat requirements at different life stages, migration routes, potential range, units to define population size including proxies), spatial scale of population processes (e.G., migratory, sedentary species etc.) or functioning (e.G., macro-habitats, meso-habitats etc.) to set specific FRVs. After selecting the appropriate spatial scale and historical perspective, we will finally set FRVs by evaluating the viability of populations/functioning of ecosystems. We will ensure that key high-level area-based conservation targets (e.G. 10% strictly protected land and 30% coverage in EU MS) are met, covering all EU primary and old-growth forests, significant areas of carbon-rich ecosystems for climate change mitigation as well as complementing the existing N2000 network. We will also ensure that the spatial design of the proposed new Natura 2000 sites covers ecosystem services in all its aspects, and identify areas suitable for restoration or improvements in ecosystem conditions, with at least 10% of agricultural land having high-diversity landscape features allowing greater connectivity.

Research team and environment

The research team includes Professors Maurizio Barbieri, Fausto Manes, Livio De Santoli, Marco Casini, Angelo Lalli, Mariella Nocenzi, Maurizio Muscaritoli, an interdisciplinary team with extensive collaborative networks in Italy, Europe and globally

Suggested skills for this research topic

- good skills in quantitative analysis;

- a strong ecological background;

- knowledge of biodiversity conservation goals and strategies;

- willingness and capacity to work in a multidisciplinary team and an international environment

Type of scholarship and obligations

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PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Curriculum: 5. Agriculture and Forestry

Identify and preserve the unique microbial terroir in a changing alpine environment

Reference Person: Rota Stabelli Omar (omar.rotastabelli@unitn.it)

Host University/Institute: University of Trento

Research Keywords:	Microbial biodiversity
	Metagenomic analyses
	Climate change
Reference ERCs:	LS8_6 Phylogenetics, systematics, comparative biology
	LS8_2 Biodiversity, conservation biology, conservation genetics
	LS8_10 Microbial ecology and evolution
Reference SDGs:	GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

The uniqueness of the Alpine territory and of its agricultural products depends on various abiotic and biotic factors: one of these factors is the microbial community (bacteria, protozoans and fungi) that resides on soil. Commonly used metagenomic techniques such as (amplicon based) metabarcoding can reveal the overall microbial diversity of an ecosystem, but it fails to identify microbial strains or species that are unique to a given environment or area. The indentification and phylogentic profiling of these microorganisms is key to define the uniqueness of specific mountain terroirs, and a first step in planning their conservation in a scenario of continuous climate change.

It is now possible to discriminate otherwise indistinguishable microbial varieties using shotgun metagenomic techniques by coupling metagenome-assembled genomes with evolutionary studies. This project aims at applying advanced metagenomic and phylogentic tecniques to characterize the local microbial uniqueness of the Alpine territory. Material of study will be environmental soil samples for which shotgun genome samples is present in databases. Bioinformatic pipelines will be developed to metagenomically assemble genomes from these samples with particular emphasis on the understudied fungal biodiversity. Assembled genomes will be compared with available reference genomes to identify unique local variants using phylogenetic method, and their diversification will be infer the timing of. Molecular clock techniques. These analyses shall reveal unique microbial strains/species that characterize certain regional areas or conditions. A special case of study will be the

microbial communities sampled on an Alpine altitudinal gradient to understand the diversity associated with different temperatures. An other case study will be the identification of unique fermenting yeasts associated with spontaneous fermentation in selected Alpine wines. Both studies will be used to forecast the risk of loosing unique terroirs because of global warming and industrialization processes.

The project has both long-term biodiversity and economic goals. Definition of unique terroirs is an added value to Alpine agriculture because it helps defining identity, cultural rootedness, and irreproducibility. Knowledge of the actual diversity and uniqueness of soil microorganism is a key step to plan future conservation management in a scenario of continuous climate change.

Research team and environment

The Molecular Evolution and Phylogenomics lab at University of Trento.

The lab is specializes in reconstructing the evolutionary and ecological history of all types of organisms in particular those of agricultural and biomedical importance. We infer phylogenies using model driven inferences, we reconstruct pattern of molecular evolution using phylogenomics, and estimate divergences using molecular clock techniques. Different types of organisms and data are used ranging from barcoding to whole genomes, from metabarcoding to shotgun metagenomics. We collaborate with various colleagues worldwide to study insects, plants, fungi, bacteria and viruses of economical, conservation, biomedical, and environmental interest. The lab has access to state of the art biomolecular, microscopy and computational facilities (two clusters).

Suggested skills for this research topic

Knowledge of phylogenetic methods including molecular clock and DNA Barcoding

Data processing and pipelines using self-made scripts in Python and Bash.

Good evolutionary and ecological background

Knowledge of soil organisms in particular fungi and bacteria.

Principles of morphological identification

Type of scholarship and obligations

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Curriculum: 5. Agriculture and Forestry

Integrated approaches for carbon, water, and energy ecosystem exchanges

Reference Person: Spano Donatella (spano@uniss.it)

Host University/Institute: Università degli Studi di Sassari/University of Sassari

Research Keywords:	Innovative approaches for estimating carbon and energy fluxes
	How to offset anthropogenic carbon emissions
	Improve natural and urban ecosystems resilience to climate change
Reference ERCs:	LS9_8 Applied plant sciences, plant breeding, agroecology and soil biology
	PE10_9 Biogeochemistry, biogeochemical cycles, environmental chemistry
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

Carbon dioxide (CO_2) is the most important anthropogenic greenhouse gas (GHG) in the atmosphere, and it is recognized as one of the main drivers of the global warming phenomenon. Anthropogenic activities, such as fossil fuel combustion, cement production, deforestation, land use changes and replacement of natural or agricultural ecosystems by impervious surfaces in cities (dwellings, roads, roofs etc.), are mainly responsible for the increasing trend in CO_2 emissions in the last decades. With an estimated increase in urban population by 2050 up to 70%, an increase in energy demand and carbon emission is expected. It is, then, crucial to improve our understanding about the interaction between natural and anthropogenic processes in response to environmental conditions and surface conditions, and to deeply investigate the role of natural and urban vegetation in sequestering CO_2 and in offsetting emissions due to human activities.

Continuous and automated measurements techniques and approaches are actually very diffuse to monitor CO_2 and energy fluxes at different scales, from site level (with in-situ measurements) to large areas (with modeling tools and remote sensing applications). The Eddy Covariance (EC) technique is a standardized technique allowing a direct and not destructive gas and energy exchange between vegetation and atmosphere at ecosystem scale (300 m up to 1-2 km).

In recent years, international EC flux measurements networks has been established to provide standardized and reliable dataset of carbon sequestration and release from several ecosystems, including urban areas (such as Fluxnet and ICOS). However, the need to better understand the role of different ecosystems in emitting GHGs require further efforts in developing new technologies, tools and data processing protocols able to estimate and partitioning the different components of the carbon budget (i.E. Processes involved in gross and net productivity exchanges, as well as respiration processes) and in evaluating the ability of different vegetation types in sequestering CO2 depending by environmental and morphological characteristics and by ecosystem types (e.G. Agricultural, natural and urban ecosystems).

The increasing interest for flux monitoring is nowadays highlighted for their potential in studies related to climate change (CC) mitigation due to their ability in estimating the global carbon budget across different ecosystems. This knowledge will also contribute to develop adaptation strategies to cope with climate change and identified sustainable soil and vegetation management able to both increase carbon sequestration and species tolerance to increasing temperature. This is particular relevant in urban areas, where nature-based solutions could be implemented to enhance cities resilience to climate change.

The main aims of this research line are: (i) to better investigate carbon and energy fluxes in natural, agricultural, and urban ecosystems in order to highlight differences and similarities in terms of diurnal and seasonal physiology, water use, carbon emissions and sinks and the main drivers affecting their behavior; (ii) to develop/apply innovative techniques (both at local and large scales) and the most advances protocols to monitor fluxes across ecosystems; (iii) evaluate the role of vegetation and nature-based solutions, including management options, for climate change mitigation and adaptation goals.

Research team and environment

The team focuses on research activities more related to CC impacts and adaptation, natural resources monitoring and management (e.G. Carbon and water), agronomy, mainstreaming climate adaptation, sustainable management and policies development. In recent years, it acquired experience in developing and testing tools and models for estimating and managing natural resources under CC conditions, both at local and regional scale, as well as methodologies and guidelines for developing adaptation strategies and options, through participative approaches, for a better governance of water resources. The team has monitoring sites, part of the FLUXNET and ICOS international networks and platforms, as well as a unique laboratory of Agrometeorology to monitor plant ecophysiology and functions. The team will provide offices and computing facilities, and vehicles for reaching experimental sites.

Suggested skills for this research topic

Agrometeorology/ecophysiology knowledge base; Large database management and analysis capacity

Curriculum: 5. Agriculture and Forestry

Exploring the role of data to support the ecological transition of European agriculture: barriers and opportunities from a user perspective

Reference Person: Taramelli Andrea (andrea.taramelli@iusspavia.it)

Host University/Institute: IUSS Pavia

Research Keywords:	Copernicus
	Common Agricoltural Policy
	Space Economy
Reference ERCs:	PE10_14 Earth observations from space/remote sensing
	LS9_5 Agriculture related to crop production, soil biology and cultivation, applied plant biology
	LS9_7 Forestry, biomass production
Reference SDGs:	GOAL 9: Industry, Innovation and Infrastructure, GOAL 15: Life on Land

Description of the research topic

The double role played by agricultural production, the driver and victim of climate change, is now recognized. Europe introduced new and ambitious environmental and climate change targets, notably the European Green Deal which includes the EU climate adaptation strategy to make Europe a climate resilient society by 2050, in July 2021 also adopted the 'Fit for 55' legislative package, known as the "Green Package", to achieve the objectives of the Green Deal, which establishes an even more ambitious goal of reducing emissions by 2030: -55% by 2030 compared to 1990, considering all economic sectors, with the inclusion of the LULUCF (Land Use, Land Use Change and Forestry) sector relating to the inclusion of greenhouse gas emissions and removals resulting from land use, land use change and forestry (https://www.lspionline.lt/it/pubbubblica/fit-55-il-nuovo-pacchetti-climatico-dellue-e-le-sfide-litalia-31197). As part of the European Green Deal, at the end of May 2020 the Commission made public two strategies that make operational some of the main objectives related to food systems, agricultural sustainability and conservation of natural resources: the From Producer to Consumer strategy (A Farm to Fork strategy, for a fair, healthy and environmentally-friendly food system) and the Biodiversity strategy for 2030 (EU Biodiversity strategy for 2030). In this context, each Member State was called to define the Strategic Plan of the CAP 2023-27 (PSP) by the end of 2021, with the identification of actions and

interventions aimed at increasing the environmental ambition and sustainability of production, preserving biodiversity. , to intensify the action for the climate by mitigating the emissions of pollutants and greenhouse gases into the atmosphere, and to contribute to the achievement of the environmental and climate objectives indicated in the F2F for 2030: to reduce the use of chemical pesticides by 50% and by 50% % losses of nutrients in the environment, while preserving the fertility of the soil; reduce fertilizer use by 20% and sales of antimicrobials for farmed animals and antibiotics for aquaculture by 50%; reach 25% of organic agricultural land at European level.

The support actions envisaged by the Italian national agricultural policy include national eco-schemes which must operate in synergy with agro-climatic-environmental (ACA) interventions, interventions in favor of sustainable forestry, productive, non-productive and infrastructural investments for environmental, including in the PNRR as an integral part of this strategy.

The limit remains the way in which environmental and climate-related policies are monitored, that is, the quantification of data and information relating to the agricultural practices adopted that make it possible to evaluate their progress and effectiveness. This undermines the potential of European agriculture to combat climate change.

The needs expressed in recent years by the user communities (national policy makers, subjects operating in the sector, trade associations and end users) in the context of national surveys conducted to support national research and innovation activities in the context of the "Space Economy "- Mirror Copernicus Program, and the PNRR highlighted two essential requirements: information needs linked to the" footprints "of the primary sector Agriculture (CO_2, in terms of greenhouse gas emissions, water, in terms of real consumption of the water resource used in agriculture, socio-economic, in terms of quality and quantity of the soil intended for agriculture, enhancement of the entire production chain of an agricultural product, up to guaranteeing the agri-food quality of the same); the presence of a national data and information collection and management infrastructure that is updated both from a technological and governance point of view. To meet these needs, many studies have already highlighted the benefits deriving from EO data: classification of the different types of crops and following their phenological status; monitoring of biophysical parameters including those that characterize the state of health and water stress and drought events; data collection for water resource management; monitoring for the identification of different soil tillage practices; for ecosystem services and biodiversity conservation. Furthermore, the European Union which has validated the use of Copernicus satellite data and information as an official means to monitor the implementation of the CAP and to issue payments to farmers (European Commission, 2018a), has predicted that, by 2024, all MS will have to have an area monitoring system: a procedure for the continuous, reliable and systematic observation, tracking and evaluation of agricultural activities and practices on agricultural areas by Copernicus Sentinels satellite data or other valuable data at least equivalent. However, adequate technological means are still lacking to achieve these objectives and people often rely on cumbersome administrative procedures. While remote sensing technologies have the

potential to significantly improve the monitoring of these targets, the characteristics of these missions do not always take into account the needs of users, do not fully meet the expectations in terms of areas of interest, frequency of observations and spatial resolution. and therefore they lack in terms of ensuring return on investment and effective policy implementation. Furthermore, there is a lack of adequate knowledge and training of non-technical users for the correct use of the information and services provided.

Research team and environment

IUSS mission is to provide advanced education to undergraduate and graduate students, as well as fundamental and applied research in the fields of Science, Technology, Engineering and Mathematics (STEM), and Human, Social and Life Sciences. At IUSS, PhD candidates will find an open multidisciplinary environment offering real opportunities for developing academic and professional tools for facing the challenges arising from increasing complexity and fast changes in the society and the environment. IUSS is always and actively committed towards internationalisation, inclusion and diversity. The selected candidate will join the research centre on Climate change impAct studies for RISk MAnagement (CARISMA). The CARISMA team is composed by STEM and Social scientists working in the prism of climate change on data analysis including Copenricus and modelling of Earth System and economic system processes; impact assessment of extreme natural events and anthropogenic activities on human and natural environments; risk assessment and management of natural and anthropogenic hazards; formulation and proposal of new economic, political and legal models of sustainable development. The research activity will be carried out in collaboration with the Space Unit and Data Unit of the The Italian Institute for Environmental Protection and Research (ISPRA) and may include stays at the ISPRA Research Centre (Rome).

Suggested skills for this research topic

-Knowledge of artificial intelligence approaches (fuzzy logic, Bayesian systems) applied to determine the response of ecosystems both agriculture and forestry to climate change;

- Experience in the implementation of integrated decision support systems for the innovative tool in forestry and agriculltre domain;

-Experience in using the European Earth Observation Program (Copernicus).

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 6. Health and Ecosystems

Is human well-being enhanced by exposure to high biodiversity?

Reference Person: Bertorelle Giorgio (ggb@unife.it)

Host University/Institute: University of Ferrara

Research Keywords:	Biodiversity loss and climate change
	Human wellbeing
	Biological evolution and -omics
Reference ERCs:	LS8_2
	LS8_5
	SH4_3
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 15: Life on Land

Description of the research topic

Climate change is modifying levels and patterns of biodiversity. In particular, increased temperatures, modifications in physical-chemical parameters, and extreme meteorological events, produce either extinction, migration, or adaptation in many animal and plant species. Recent studies suggest that biodiversity plays an important role not only in ecosystems stability and services, but it may also produce psychological benefits to humans. Human well-being is enhanced by exposure to nature, but it is not well understood if this effect is higher in more biodiverse natural or urban habitats (e.G., areas with higher species richness). Understanding this relationship is important to better evaluate the effects of biodiversity loss due to global warming on human health, and to help planning urban green-spaces. This research project will investigate using public surveys the "feel-good factor" as a function of biodiversity levels in different environmental contexts. The possible evolutionary explanation that may justify the preference for more biodiverse habitat will be experimentally tested using animal models. In particular, fish models will be analyzed in choice experiments (biodiverse versus homogeneous settings), and the relationship between polymorphisms in the preference traits and its genetic determinants will be analyzed using genomic and transcriptomic data.

Research team and environment

The selected student will work at the Department of Life Sciences and Biotechnology of the University of Ferrara. The main responsible of the project will be Professor Giorgio Bertorelle, the evolutionary biologist head of the population genetics and genomics group (www.ls.Gd/popgg). Members of the team have an established experience in evolutionary

studies and biodiversity conservation, using DNA and RNA data. Co-supervisors of the project will be the Prof. Tyron Lucato Xiccon (expert in evolution and behavior studies in animal models). The research environment is strongly interdisciplinary, interdepartmental, and international thanks to the activities of the PhD programme in Environmental Sustainability and Wellbeing (Giorgio Bertorelle is vice-coordinator of this PhD programme).

Suggested skills for this research topic

Candidates should have basic knowledge in evolutionary biology and genetics, and be familiar with the scientific method. Additional skills in statistics and the analysis of interviews data are welcome.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Curriculum: 6. Health and Ecosystems

Forecasting the consequences of glacier extinction for ecosystem functioning

Reference Person: Caccianiga Marco (marco.caccianiga@unimi.it)

Host University/Institute: Università degli Studi di Milano

Research Keywords:	Global Change Ecology
	Biodiversity, Ecosystem Functions and Services
	Ecological Networks
Reference ERCs:	LS8_1
	LS8_5
	PE10_4
Reference SDGs:	GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

An iconic sign of global warming is the retreat and extinction of glaciers worldwide. As glaciers are retreating, new terrain is continuously exposed to colonization by diverse organisms, prompting distribution shifts and changes in the functioning of ecosystems. But glacier extinction will also be followed by

The loss of species from local communities, with the inherent impoverishment of ecosystem functions. However, lack of comprehensive system-level studies impairs our ability to predict the fate of biodiversity and the functioning of ecosystems on forelands of retreating glaciers. An integrative understanding of ecosystem functioning following glacier retreat is therefore of paramount importance to biodiversity maintenance, environmental health and human well-being.

To address such challenges, it is crucial to go beyond the traditional approach of examining individual species or ecosystem components in isolation and overcoming the difficulties associated with addressing complex biogeochemical cycles. Using cutting-edge analytical techniques, we plan to investigate ecosystem functioning in environments ranging from recently ice-free terrains to late stages of development on six Italian and Swiss glacier forelands. Our objective is to (1) Understand the evolution of biophysical soil and vegetation functions including productivity, biodiversity, carbon sequestration, nutrient and water retention; (2) Develop predictive models of ecosystem functioning response to glacier extinction, and (3) Design systemic nature-based interventions for mitigating the risk of ecosystem functioning collapse.

Combining traditional sampling with robotic measuring and cutting-edge analytical techniques, we will investigate ecological network dynamics in environments ranging from recently ice-free terrains to late stages of development on five glacier forelands in the Italian Alps. We will reconstruct interactions among multiple ecological communities (fungi, plants, pollinators, herbivores, and predators) by means of DNA metabarcoding. This novel aspect will allow us to unveil cryptic species and hidden interactions, and analyze the assembly, structure, and dynamics of ecological networks at unprecedented resolution. Furthermore, we will use state-of-the-art biogeoscience methods (eg. CHN analyzer, Leco TruSpec). Soil and ecological network functionality will be analyzed together with environmental and biological data by means of structural equation modeling. This will allow us to understand the interactions among ecological processes and devise recommendations for managing ecosystems. The contribution this project will provide is crucial to predicting the fate of ecosystem functioning and anticipating the consequences of global warming on mountain environments.

The ambitious work proposed here will be feasible thanks to the following points: (i) the applicants (Prof. Caccianiga as Reference Person and Dr. Losapio as Direct Supervisor) have matured expertise and advanced skills in alpine ecosystems, biogeochemical cycles, data analysis, and computational modeling, spanning plant-environment interactions and ecological network models; (ii) the field sites are already studied by glaciologists, geomorphologists and other ecologists, offering a wealth of geochronological and environmental information; (iii) Università degli Studi di Milano hosts outstanding facilities offering lab instrumentation, expert staff, and specialized scientific services.

Research team and environment

The Research Team links the expertise in alpine botany of the Reference Person (Prof. Marco Caccianiga) with the research experience in biodiversity and ecosystem functioning of the Direct Supervisor (Dr. Gianalberto Losapio). Furthermore, it matches with the long-standing studies of the host institution in climate change and mountain environments. The PhD student will develop their own research project while working in a multicultural, diverse, collaborative, and dynamic environment. We provide great opportunities for academic and professional training as well as acquisition of transversal skills. We offer stimuli for developing critical thinking and to become an independent scientist. In all, we are both professional and empathic. We select motivated, experienced, self-organized and passionate students. As we start, we clarify reciprocal expectations and set achievable goals. The student will be guided through the graduate school, will be trained and assigned to specific research subjects with diverse and achievable tasks. They will receive individualized attention and will be advised from the beginning (i.E., from the pilot study and planning data collection) and throughout the whole process (analyzing samples, implementing models, presenting results and writing publications). The PhD student will have many opportunities to develop close collegial relationships with fellow students (two ongoing PhD students), recruited Bachelor and Master students from different courses as well as different collaborator faculties (Prof. Ficetola and Prof. Trombino; Prof. Guisan and Prof. Grand at

University of Lausanne; Prof. Schmid and Prof. Bascompte at University of Zurich; Prof. Dirzo at Stanford University).

Suggested skills for this research topic

We are looking for a highly motivated PhD candidate with particular interests in biodiversity, ecosystem functioning and global change ecology. The ideal candidate is a highly motivated, enthusiastic, and independent person with a passion for science and nature. Talented students with a degree in biodiversity, ecology, conservation biology, environmental sciences or related fields interested in taking an integrative approach are particularly encouraged to apply. Applicants are expected to have research experience with field work (hiking at high-altitude), lab work (e.G., DNA metabarcoding, soil functionality, carbon sequestration), good quantitative skills (i.E., knowledge of R or gis), and be keen to learn experimental and computational techniques. A high level of written and spoken English proficiency is required.

Type of scholarship and obligations

The type of this scholarship is: Transizioni Digitali ed Ambientali (Digital and Environmental Transitions). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 6. Health and Ecosystems

Pollution and health: exploiting geolocalized Emergency Medical Services data, ground monitoring and Earth observation

Reference Person: Caiani Enrico Gianluca (enrico.caiani@polimi.it)

Host University/Institute: Politecnico Di Milano

Research Keywords:	Health Geomatics and Earth observation
	Emergency medical Services
	Pollution measurement and risk prediction
Reference ERCs:	LS7_14
	SH7_6
	LS7_9
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

Our current society is developing at expenses of the environment, with increased land consumption and pollutants emission due to anthropic activities, with an impact on our health by relevant environmental risk exposure. Air pollution constitutes the fourth largest risk factor for global mortality, of which >50% deaths are attributable to cardiovascular (CV) causes. Health Geomatics (HG) refers to the process of gathering, storing, processing, and delivering geographic information relevant to health through a Geographical Information System (GIS). HG techniques have the potential to evidence spatio-temporal correlations in diverse geolocalized information available for a specific territory. Emergency Medical Services (EMS) are managed in Italy at regional level by specific Agencies (in Lombardy, AREU is in charge): these services represent the first evidence of a suspected disease-related event on the territory, with the capability of geolocalization of the patient through the caller phone cell when the 112/118 emergency number is reached. Data gathered during this process is able to potentially indicate insurgence of communicable diseases (as we showed applied to COVID-19) as well as to evidence the spatial and temporal map of events relevant also to non-communicable diseases. These information can be linked with those relevant to the air pollutant concentration. measured through ground stations or derived from satellite images, in order to provide industry and policy makers with new tools and information to support their decisions on sustainable development, including preserving health. A case scenario will be represented by the Lombardy region, the most polluted in Italy, with possible focus on CV and respiratory diseases, as well as on COVID-19 diffusion, by taking into account also mobility

data and land use. Risk prediction mapping for different diseases will be produced on the basis of retrospective data, to highlight possible links with pollutants exposure and spatio-temporal effects on a given territory. Decision support tools for policy makers will be proposed based on the predicted models in order to simulate in advance possible benefits of mitigation actions and related costs, that could span from mitigating emissions to reorganizing the medical services to better cope with the geographical distribution of the observed phenomena.

Research team and environment

The research team is multidisciplinary: Ass. Prof. Caiani, biomedical engineer with 1 post-doc and 1 PhD in Data Science; Prof. Brovelli, environmental engineer and her team at GISGeoLab. A strong collaboration with AREU allows access to EMS data, as well as feedback from stakeholders. In addition, possible links with the ESC advocacy committee and its reach to WHO will complement the exploitation phase.

For this scholarship a period of internship is planned at *Agenzia Regionale Emergenza Urgenza (AREU)*

Suggested skills for this research topic

Data science methods, Python programming skills, basic knowledge in GIS and Earth observation data analysis, interest in multidisciplinary research, basic knowledge of Italian language

Type of scholarship and obligations

The type of this scholarship is: Pubblica Amministrazione (Public Administration). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 6. Health and Ecosystems

Impact of atmospheric pollutant on human health: from mouth to lungs

Reference Person: Di Carlo Piero (piero.dicarlo@unich.it)

Host University/Institute: University 'G. D'Annunzio' of Chiti-Pescara

Research Keywords:	Air pollution
	Health
	Climate change
Reference ERCs:	PE10_3
	PE10_1
	LS7_6
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 13: Climate Action

Description of the research topic

The proposed research is focused on the analysis of the impact of atmospheric pollutant and meteorological parameters on human health focusing on the genotoxicity on mouth and lungs tissues. The study includes in vitro analysis using different levels and chemical composition of particles and atmospheric trace gases under different levels of temperature and unidity.

Research team and environment

The research team includs a full professor of atmospheric physics, an assistant professor of dentistry, 2 assistant professors and a post doc.

Suggested skills for this research topic

Candidates with good skills in programming and data analysis are appreciated. Background in medicine, dentistry, biology, engineering, environmental science, chemistry is desirable.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and

Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

![PhD SDC - SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE]

Curriculum: 6. Health and Ecosystems

Conserving the evolutionary potential of endemic species under global changes

Reference Person: Ficetola Gentile Francesco (francesco.ficetola@unimi.it)

Host University/Institute: Università degli Studi di Milano

Research Keywords:	Genetic diversity
	Cliamte change
	Species distribution models
Reference ERCs:	LS8_5 Biological aspects of environmental change, including climate change
	LS8_2 Biodiversity
	LS8_4 Population biology, population dynamics, population genetics
Reference SDGs:	GOAL 15: Life on Land

Description of the research topic

Environmental change is rapidly accelerating, and many species will need to adapt to survive. However, animal species are not homogeneous entities, as they often comprise multiple populations, each of which evolved local adaptations to specific local conditions. Local adaptations are extremely important, as they constitute the intra-specific genetic diversity and allow each species to have high fitness in specific habitats. Genetic variation strongly impacts population performance, and this can influence their response to global changes: (i) high genetic diversity populations might be more tolerant to stressors and occupy broader niches; (ii) local evolutionary adaptations might allow to exploit different niches. For instance, populations that live at the warmer edge of a specie's range (e.g. at low altitude or at the southern limits) could have evolved adaptations favoring species persistence and evolution under warming climates. Despite progresses in understanding how species can respond to global changes, very little is known about how intra-specific diversity can affect the adaptive potential of any given species, and intra-specific genetic variation is rarely integrated into analyses of the response of species to environmental change.

The situation is particularly problematic for endemic species, which are restricted to narrow areas and can be particularly sensitive to global changes, being among species expected to suffer the fastest declines. Effective strategies for the conservation of endemic species

require to identify local adaptations exists, and to evaluate how evolutionary distinct populations will respond to global changes.

Italy is among the European countries with the largest number of endemic species, and also hosts an amazing level of unexplored variation, with new endemic species and lineages described every year. Endemic reptiles will be used as model group, because of their vulnerability to climatic and habitat changes, and because they are particularly suitable for both modelling and genetic analyses.

The aims of the project are:

1) measuring genetic diversity in representative reptile species using genetic markers covering the whole genome (e.g. Rad-SEQ). This will provide unforeseen information on the intra-specific variation of endemic species, allowing to identify evolutionary significant units that require special attention for conservation

2) linking genetic variation with present-day environmental variation (e.g. along climatic gradients). This allows to identify local adaptations, for instance populations of a given species that are expected to better persist under climate change scenarios and could be suitable targets for future conservation actions

3) integrating information on intra-specific variation with species distribution models (SDM). SDM are perhaps the most used approach to assess the impact of climate change on biodiversity, but generally assume that all populations of a species have similar response to environmental changes and occupy the same ecological niche. Integrating information on intra-specific diversity into SDM will improve our understanding and prediction of the impact of environmental changes on biodiversity. The improved models will consider the role of genetic diversity on species tolerance, and will also take into account the possibility of evolutionary adaptations of populations.

This project will produce unprecedented information on the response of endemic species to fast environmental changes.

Research team and environment

The PhD candidate will be part of the animal biodiversity and conservation (ABC) team at the department of Environmental Sciences and Policy (University of Milano). ABC is a dynamic group of researchers analyzing the impacts of global changes on multiple facets of biodiversity, and is a world leader in the use of emerging tools (e.G. Environmental DNA; population genomics; ecological modelling). The team is funded by the European Research Council, by PRIN, and by other national and international funding agencies. ABC is an international team and includes researchers from both Europe and other continents, with two permanent researchers, four PhD students and five post-doctoral researchers. The researchers work together and share their interdisciplinary and complementary competences. Our team has state-of-the-art facilities and laboratories for multiple

approaches to biodiversity analysis, including both traditional and environmental DNA analyses, and data analysis.

Suggested skills for this research topic

We are looking for young candidates with a strong attitude toward the use of advanced statistical techniques to understand ecological processes. Applicants for the position will be enthusiastic, hard-working, independently motivated and willing to lead a significant part of the research Project, and will join a highly-dynamic work group, with a strong emphasis on research excellence.

Candidates must be available to perform field activities in natural environments.

Candidates with experience in population genetics, population genomics and / or in species distribution models will be favored

Type of scholarship and obligations

The type of this scholarship is: Transizioni Digitali ed Ambientali (Digital and Environmental Transitions). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Curriculum: 6. Health and Ecosystems

Contaminants of Emerging Concerns in Marine Ecosystems: Evaluation of Presence and Ecotoxicological Effects

Reference Person: Gorbi Stefania (s.gorbi@univpm.it)

Host University/Institute: Università Politecnica Delle Marche

Research Keywords:	Contaminant of Emerging Concerns (CECs)
	Marine Ecosystems
	Bioindicators and biomarkers
Reference ERCs:	LS8_5 Biological aspects of environmental change, including climate change
	LS8_13 Marine biology and ecology
	LS8_14 Ecophysiology, from organisms to ecosystems
Reference SDGs:	GOAL 6: Clean Water and Sanitation, GOAL 13: Climate Action, GOAL 14: Life Below Water

Description of the research topic

Contaminants of emerging concern (CECs) comprise a vast array of contaminants that have only recently appeared in water, or that are of recent concern because they have been detected at concentrations significantly higher than expected, and/or their risk to human and environmental health may not be fully understood. CECs span natural and artificial chemical substances including pharmaceuticals, microplastics and their additives, but also bioactive natural molecules such as biotoxins.

There are many evidences that CECs can alter the normal biological physiological functions of marine organisms and evaluating these effects may require testing methodologies not typically available, along with endpoints not previously evaluated using current guidelines.

The project aims to evaluate the presence and the ecotoxicological hazard of CECs in marine ecosystems through a multidisciplinary approach. The involved steps will be: i) development/validation of analytical protocols for CECs determination in different marine matrices (including water, sediment and organisms); ii) measurement of their occurrence in representative key sentinel species (bioindicators) collected in Mediterranean Sea; iii) laboratory exposures of marine invertebrates (such as mussels Mytilus galloprovincialis) to a selected group of CECs in order to investigate uptake/excretion kinetics and adverse biological effects at transcriptional, biochemical and cellular level.

Research team and environment

The project will be carried out at the Ecotoxicology and Environmental Chemistry Lab, Department of Life and Environmental Sciences of the Polytechnic University of Marche (DISVA).

DISVA includes more than 100 interdisciplinary laboratories, ranging from biological physics, cell and molecular biology, biochemistry and genetic organic biology, microbiology and applicative biotechnology, physiology and reproductive biology, marine ecotoxicology and oceanography.

Http://www.Disva.Univpm.It/

The Ecotoxicology and Environmental Chemistry Lab team in mainly involved in the following research topics: use of organisms as bioindicators of chemical pollution; molecular and cellular effects induced by pollutants; analysis of contaminants along food networks, food risk and enhancement of fish resources; development of environmental risk analysis models; environmental impact analysis in port areas and off-shore extraction platforms; monitoring of industrial complexes, plants at environmental risk, and in emergency conditions; emerging contaminants: microplastics and drugs; ecotoxicological effects of biotoxins and algal metabolites; mechanisms of adaptation to extreme environments.

Http://www.Disva.Univpm.It/content/laboratorio-di-ecotossicologia-e-chimica-ambientale

The DISVA offers the possibility to use the Actea Mobile Laboratory to sampling activities and hosts the ""Aquarium"" Laboratory representing a unique infrastructure at National level. Recently, thanks to the Italian Excellence Department Projects, the DISVA of UNIVPM has developed a well-advanced technical platform fully equipped for chemical analyses of all classes of environmental pollutants and ecotoxicological analyses.

Suggested skills for this research topic

Successful candidates are expected to have a background in marine biology, with an interest in ecotoxicology and biological effects of anthropogenic pollutants.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Curriculum: 6. Health and Ecosystems

Climate Change Impacts in Polar and Alpine permafrost areas

Reference Person: Guglielmin Mauro (mauro.guglielmin@uninsubria.it)

Host University/Institute: Università dell insubria

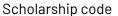|	
Research Keywords:	Permafrost
	POlar areas
	Alpine
Reference ERCs:	PE10_3 Climatology and climate change
	PE10_18 Cryosphere, dynamics of snow and ice cover, sea ice, permafrosts and ice sheets
	PE10_13 Physical geography, geomorphology
Reference SDGs:	GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

The research will be focused on the analyses of the impacts of the climate change on permafrost environments and the related ecosystems in polar areas and alpine mountains. In these areas permafrost is thawing almost everywhere ,changing deeply the landscape and triggering surface instability that interacts with the evolution of the ecosystems and with the CO_2 and CH_4 fluxes. The

Research will be focused on these complex and dynamic relationships in Alaska where Insubria will open in 2022 his international Branch and, for comparison in the Italian Alps where Insubria had traditional study sites in Upper Valtellina. This comparison will be important because both the areas are suffering the more intense warming in the planet.

Research team and environment

This PhD is within the framework of Climate Change Research Center of Insubria University where it will be

Possible work in a multidisciplinar team including the CRyosphere Lab (resp. Prof. Mauro Guglielmin) with a Researcher (Dr. S. Ponti, expert in remote sensing), one Post Doc (dr. Alessandro Longhi, expert in soils) and twp PhD dr. Silvia Picone (expert in debris flows and permafrost hydrology) and dr. Vasudha Chaturvedy. (expert of CH_4 emissions modelling and remote sensing). THis group interacts with the Botany and Climate Change Lab (Resp. Prof. Nicoletta Cannone) in which other experts of vegetation and terrestrial ecology of alpine and polar areas are working. The Climate Change Research Center of Insubria will have since 2022

the possibility to use the International Branch of Insubria at Barrow (USA, Alaska). The team is working in cooperation of many national and international Instititution like the British Antarctic Survey, the Alfred Wegener Institute, the Trieste University and many other foreigner universities.

Suggested skills for this research topic

The candidate should have basic knowledge on the climate change, on the climate change impacts on the

Cryosphere and on the ecosystems of periglacial environment. Basic knowledge on GIS and statistical analyses are also welcome. The candidates should be ready to work in a dynamic, international context with an important field work activity in polar environment.

Curriculum: 6. Health and Ecosystems

Evaluation of global warming effects on pathogenesis of aquatic Mycobacterioses

Reference Person: Marino Fabio (marinof@unime.it)

Host University/Institute: University of Messina

Research Keywords: Global warming in Aquaculture and Fisheries

Aquatic infectious and parasitic diseases

In vivo aquatic models

Reference ERCs: LS9_10

Reference SDGs: GOAL 3: Good Health and Well-being, GOAL 14: Life Below Water

Description of the research topic

Climate change and in particular global warming can have direct and indirect effects on the health status of farmed and wild aquatic organisms, in both fresh and saltwater ecosystems. At this regard, the impact of bacterial and parasitic pathogens whose pathogenic potential is known to be influenced by high temperatures should be placed under surveillance in order to predict and avoid devastating changes and already occurred mass mortality events (MMEs) in aquatic populations. At this regard, bacterial diseases due to atypical Mycobacteria should be primarily considered for their possible impact on teleost and mollusk populations in the context of climate change, evaluating in the meanwhile the abiotic and biotic factors characterizing the hosting aquatic environments. Mycobacteria have recently been reported as cause of MMEs in the Pen Shell (Pinna nobilis) and possible related to global warming (Carella et al. 2019), moreover, these atypical acid-fast bacilli have been widely reported to affect wild and farmed fish, causing high mortality rates. The research proposal aims to perform in vivo experimental infections, to test pathogenicity of infectious agents and susceptibility of aquatic organisms, that will be carried out at the Centre for Experimental Fish Pathology (CISS) of the University of Messina, using isolated mycobacteria strains.

Specimens will be sampled from farms and housed at CISS in 120 l tanks, water parameter will be constantly monitored through Tecnos oxywifi 2 system. Health status of aquatic organisms will be randomly controlled throughout a complete health monitoring program with bacteriology, histopathology and molecular techniques. After a 45 days acclimation period, specimens will be injected with pathogens at DL 50 and subdivided in two groups reared at different temperatures and housed up to 120 days. During the period of the experimental trial specimens will be sacrificed every 15 days and analysed for histopathology, haematology and immune system evaluation. All kind of fish handling procedures will be

carried out prior anaesthesia with MS-222. Anaesthesia and euthanasia procedures with MS-222 will be carried out according to 2010/63/EU. For haematology and immune system evaluation, from each specimen blood and hemolymphwill be collected for the evaluation of haematological, immune, oxidative and antioxidative parameters. Sera will be used for the evaluation of the immune parameters. The evaluation of oxidative and anti-oxidative parameters, will be performed by using spectrophotometric and molecular methods. Tissues samples under experimental challenge on mycobacteria will be subjected to immunohistochemical (IHC) evaluation to characterize the inflammatory response against pathogens.
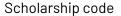
Research team and environment

The veterinary comparative pathology research team, of the Dept. Of Chemical, Biological, Pharmaceutical and Environmental Sciences of the University of Messina, carries out experimental research in the field of comparative veterinary pathology, with particular attention to the diseases affecting livestock and affection animals as well as aquatic organisms destined for production in aquaculture and wild. The group also carries out preclinical research on aquatic models, always in the context of applied and translational pathology. Experimental procedures of the research team are carried out at the Centre for Experimental Fish Pathology (CISS) of Department of Veterinary Sciences, University of Messina, Italy. CISS is accredited since 2006 for use and since 2010 for production of aquatic organisms for experimental research (DM n¬∞39/ Marzo/2006).

Suggested skills for this research topic

Candidates should possess a degree in veterinary medicine or marine biology and have achieved experiences and knowledges in the field of fish pathology and aquatic experimental models.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 6. Health and Ecosystems

Use of microalgae for the sustainable treatment of dairy wastewater and as a renewable source of compounds for plant biostimulation and protection

Reference Person: Mattei Maria Benedetta (mariabenedetta.mattei@univaq.it)

Host University/Institute: University of L'Aquila

Research Keywords:	Microalgae-based wastewater treatment
	Biostimulants and biopesticides from microalgae
	Plant immunity
Reference ERCs:	LS9_8 Applied plant sciences, plant breeding, agroecology and soil biology
	LS9_11 Biomass production and utilisation, biofuels
	LS9_9 Plant pathology and pest resistance
Reference SDGs:	GOAL 2: Zero Hunger, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

Microalgae have received increasing interest as part of wastewater treatment, based on their ability in mixotrophic cultivation to utilize organic and inorganic carbon, as well as inorganic nitrogen and phosphorous, reducing the concentration of these substances in the water. Moreover, the use of microalgae can improve the purification performance of bacterial systems (microalgae-bacteria aggregates) by providing additional oxygen from photosynthesis, thus reducing the total energy costs of oxygen supply.

Microalgae are also a renewable source for biomass and for biologically active metabolites with potential application in the pharmaceutical and agrifood industries. Preliminary evidences show that plant treatment with microalgae extracts can stimulate both their productivity and immunity, conferring a broad spectrum resistance.

The aim of the research project is to use microalgae grown in dairy wastewater to obtain a biostimulating product for agricultural sector, able to replace chemical fertilizers and pesticides.

Currently, agricultural production is dependent on the massive use of fertilizers and pesticides with damage to the environment and human health. However, sustainable control

of plant diseases is possible by exploiting the innate immunity of plants, that can counteract the infection of the plant by microorganisms.

The multidisciplinary approach, in a natural synergy between environmental sciences, plant physiology and biotechnology, includes:

1) optimization of microalgae growth in small to medium scale dairy wastewater under non-axenic conditions,

2) microbiological and chemical analysis on both the algal biomass and the dairy wastewater,

3) preparation and characterization of various formulations of algal extract using eco-sustainable extraction techniques,

4) treatment of Arabidopsis thaliana and Solanum lycopersicum with the different formulations of algal extract and evaluation of:

 A) productivity and nutritional quality of treated plants

 B) pest and disease control (infection test with different plant pathogens, both fungal and bacterial),

5) treatment of human umbilical vein cells (HUVEC) in culture with the various formulations of algal extract, to estimate any toxic effects for humans that may derive from their use in the agrifood sector,

6) evaluation of the economic convenience deriving from the use of algal extracts in use of current pesticides through a ""technical-economic"" evaluation,

7) evaluation of the potential risks deriving from the use of algal extracts in agriculture through a life cycle assessment (LCA).

The use of microalgae for wastewater biodepuration, reducing the need for expensive treatments before their discharge, represents an important goal with social and economic consequences.

The cultivation of microalgae provides valuable biomass for different industrial sectors, as a source of innovative biological compounds such as pharmaceuticals, biofertilizers / biostimulants for agriculture, cosmetics and fine chemicals.

The development of efficient microalgae treatments is necessary to profitably and sustainably exploit the potential of these biomasses, recovering and separating high value-added components and minimizing waste generation.

Furthermore, the research will also concern the protection of plants from diseases, an important field of scientific and applied research. The impact that climate change has on the biodiversity of plants and microorganisms, and consequently on agricultural crops, is a

current issue of growing scientific interest for the protection of species of agronomic importance.

Research team and environment

The Laboratory of plant physiology and biotechnology of UNIVAQ has a long and recognized experience in the field of plant biotechnology and biochemistry, and in particular in the study of oligosaccharins derived by the plant cell wall that act as elicitors of plant defense responses. The research team is composed by the PI prof. Mattei and 3 researchers. Using biochemistry and molecular biology techniques, the group contributed to identifying oligosaccharin oxidases involved in the defense against plant pathogens. In recent years, the laboratory has devoted its attention to the growth of microalgae for wastewater treatment and for the production of bio-fuels. This research activity has been recognized at national and international level, as evidenced by publications on high impact scientific journals, patents and national and international research projects coordinated by the same operating unit. The research unit has active partnerships with industrial and university colleges and research organizations at national level. Collaborations already established with agrifood and biotechnology companies have allowed the research unit to develop industrial research and development activities. Equipment available at MESVA includes molecular and biochemical biology laboratories equipped with all basic equipment, growth chambers for microalgae and plants, filamentous fungi, yeasts and bacteria. Specific instruments for biochemical and molecular biology analysis available are: HPLC; FPLC; cell counter; Multi-Cultivator, a photobioreactor for small-scale screening experiments of phototrophic organisms as algae, cyanobacteria and plant cells; Real Time PCR.

Suggested skills for this research topic

The candidate will need skills in plant/microalgae growth, physiology and molecular biology, extraction and analysis of bioactive compounds, plant defense responses towards biotic and abiotic stresses.

Curriculum: 6. Health and Ecosystems

Climate sensitive diseases in a changing environment: a one-health approach

Reference Person: Maule Milena (milena.maule@unito.it)

Host University/Institute: University of Turin

Research Keywords:	One Health
	Emerging infectious diseases
	Environmental changes
Reference ERCs:	LS7_9 Public health and epidemiology
	LS8_5 Biological aspects of environmental change, including climate change
	SH7_6 Environmental and climate change, societal impact and policy
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

Climate change has been defined as the biggest global health threat of the 21st century. Among its many possible effects on health, climate change influences the spread of infectious diseases. Vector-borne diseases (VBDs) are particularly sensitive to changes in the environmental conditions, given the multiple interactions between the environment-vector-pathogen-host. Potentially, any factor influencing the presence of the vector species, such as urbanization, land use and climatic parameters, can modify the probability of disease transmission. Estimating the effects of climate change on VBDs spread is challenging because the underlying mechanisms imply complex interactions between causal components acting at different spatial and temporal scales. In recent years, the idea of a one-health approach has been emerging that addresses this complexity and recognizes that the health of people is closely connected to that of animals and of our shared environment.

The research project aims to explore the role of environmental, meteorological, and climatic parameters in shaping the epidemiology of VBDs in Italy and Europe through a One Health approach. Possible topics to be addressed are: a) understanding the recent spatio-temporal patterns of VBDs spread; b) evaluating the association between climatic and environmental parameters (temperature, precipitation, Normalized Difference Vegetation Index (NDVI), etc) and VBDs; c) estimating dose-response relationships and lag-effects of weather conditions

on the incidence of VBDs; d) modelling the relationships between human cases and circulating vectors in relation to different environmental factors; e) projecting future trends under different climate change scenarios. Environmental, entomological, animal, and human datasets will be interrogated for the generation and testing of research hypotheses. Climatic data will span from land-based meteorological data for specific locations to high-resolution gridded satellite data. Health outcomes data will be obtained at the regional, national, and European level. Methodological aspects will involve epidemiological methods for spatio-temporal epidemiology (geostatistical analysis, point-pattern analysis, disease mapping, time-series analysis), machine learning techniques, causal inference approaches to explore the pathways from environmental and climatic drivers to health, mechanistic mathematical models to simulate and investigate VDBs epidemiology under different climate change scenarios.

Research team and environment

The research team includes a multidisciplinary group working on environmental, social, life-course and molecular epidemiology and includes, among others, epidemiologists, biostatisticians, computer scientists and molecular biologists. The team is based at the Cancer Epidemiology Unit of the Department of Medical Science (DMS) of the University of Turin. DMS is a large multi-disciplinary department with broad research interests, encompassing 16 medical disciplines, including epidemiology. The DMS has been ranked by the Minister of Education, University and Research (MIUR) as one of the Department of Excellence, and is an ideal place to carry out multidisciplinary projects thanks to the presence of shared facilities and collaborations among scientific domains, within the department and the whole University, such as the Competence Centre for Scientific Computing (https://c3s.Unito.It/). The research team is involved in several other collaborations, such as with the Istituto Zooprofilattico Sperimentale and the HPC for biomed and AI laboratory in ICxT of the Department of Computer Sciences of the University of Turin, and is a member of the Italian Network for Environmental Health.

Potential data will be available at the Regional level (Healthcare System and Istituto Zooprofilattico Sperimentale), National level (Ministry of Health and Istituto Superiore di Sanità) and European level (European Center for Disease Control and prevention). Examples of sources of environmental data of potential interest are the Copernicus Land Monitoring Centre database and environmental monitoring stations.

Suggested skills for this research topic

Multidisciplinary attitude, basic knowledge in quantitative research (biostatistics, epidemiology, statistical softwares), interest in environmental determinants of human health, one health approach and epidemiology of vector borne diseases, teamwork, willingness to learn and acquire new skills.

Curriculum: 6. Health and Ecosystems

Alternative protein sources for human nutrition

Reference Person: Muscaritoli Maurizio (maurizio.muscaritoli@uniroma1.it)

Host University/Institute: Sapienza University of Rome

Research Keywords:	Alternative protein sources
	Environmental sustainability
	Proteins, ecosystems, health, disease
Reference ERCs:	LS4_5 Metabolism, biological basis of metabolism-related disorders
	LS7_11 Environmental health, occupational medicine
	LS7_9 Public health and epidemiology
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

Proteins represent an indispensable dietary macronutrient both in healthy conditions and during acute and chronic diseases. In fact, protein shortage is associated with severe consequences in healthy subjects and in particular in chronically ill patients and in older adults that are associated with poor prognosis including disabilities and reduced survival.

The environmental cost (greenhouse gas emission, global warming, water consumption, deforestation) of protein-rich animal food production is a real threat for next generations, particularly when considering the expected planet population growth.

The search for alternative protein sources represents an inevitable policy option in order to reduce the impact on ecosystems. Besides plant-derived protein sources, protein-rich insect meals should be considered as a challenging solution. Nowadays the knowledge and the availability of this new protein sources is limited and research on this topic should be implemented particularly in PhD programs.

Preliminary data from clinical trials show that insect-derived protein meals may increase plasma aminoacid concentrations and muscle protein synthesis rate in a fashion similar to whey proteins.

Experimental and clinical studies are urgently needed to confirm the nutritional validity of alternative animal sources, respecting the ecosystems, as well as their safety in health and

disease. Also, research will focus on the potential differences of these new protein sources with regard to the activation of specific metabolic pathways which regulate protein and fat body mass.

Research team and environment

The research team will involve researchers of the Departments of Translational and Precision Medicine, Experimental Medicine, Public Health and Infectious Diseases, Biology and Biotechnologies, Physiology and Pharmacology Sapienza University. In addition, to the refenrence person Prof Maurizio Muscaritoli, the professors Marco Casini, Livio Santoli, Carlo Rondinini, Maurizio Barbieri, Fausto Manes, Angelo Lalli, Mariella Nocenzi. International research links are active among other European universities and with leading industrial partners.

Suggested skills for this research topic

In order to perform successful research, a master's degree in Medicine and Surgery, Biology, Biotechnology, Pharmacy is needed. Ideally, the successful candidate should be able to work in a multidisciplinary team and an international context and have a basic knowledge of:

- Basic Nutrition

- Applied Nutrition

- Clinical Nutrition

- Metabolism

- Food technology

- Alternative food sources for human consumption

- Ecosystems and interactions with health

Type of scholarship and obligations

The type of this scholarship is: Pubblica Amministrazione (Public Administration). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 6. Health and Ecosystems

Ecological, morphological and human safety impacts of hydropeaking mitigation measurements

Reference Person: Pisaturo Giuseppe Roberto (gpisaturo@unibz.it)

Host University/Institute: Free University of Bozen-Bolzano

Research Keywords:	Hydropeaking
	Ecological impacts
	Human safety
Reference ERCs:	PE8_3 Civil engineering, architecture, maritime/hydraulic engineering, geotechnics, waste treatment
	PE8_11 Sustainable design (for recycling, for environment, eco-design)
	LS8_1 Ecosystem and community ecology, macroecology
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 11: Sustainable Cities and Communities, GOAL 14: Life Below Water

Description of the research topic

The increasing attention on climate change has shown that there has been and continues to be a change in the rainfall and hydrological regime that affects the globe and in particular mountain areas. Short and very intense precipitation events are becoming more frequent and consequently also the management of hydraulic structures in mountain areas will have to be adapted to the new hydrological conditions. In particular, it is also necessary to modify the management of hydropower plants with reservoirs. Among the currently used energy sources, hydropower plants are considered as renewable sources and their main characteristic, especially for reservoir hydropower plants, is to be able to satisfy the electricity demand almost instantaneously and therefore to supply the peaks of energy demand during the day. This type of hydropower plant therefore has the possibility and the capacity to switch from minimum to maximum power generation in a very short time (<10 minutes) and consequently to process and release a very high water flow rate into downstream rivers in short time. These rapid changes in flow rates in receiving rivers are called hydropeaking and, depending on their intensity, can cause negative effects in the downstream ecosystem (morphological changes, effects on Benthos and fish) and effects on hydraulic safety for people. Scientific studies have tried to investigate possible solutions for the mitigation of the effects of hydropeaking on the river system but focusing sectorial aspects (especially effects on Benthos and fish) and consequently not looking for a solution

or at least a synergy between the various aspects involved. The proposed solutions against hydropeaking are of different types and include management aspects of the plant, morphological interventions in the receiving watercourse and structural interventions such as compensation basins or bypasses.

This research project aims to create a synergy of all the aspects involved and to analyse which mitigation measures can maximise habitat, hydraulic safety, and morphological aspects. The research project will have as case studies hydropower plants located in the province of Bolzano and there will be a direct contact with the plant operators.

Preliminary bibliographic research will give an overview of the current scientific knowledge on the issue. It will also allow to focus on the still open questions that have to be investigated during the research project. In particular, flow data will be collected in the rivers under study, habitat quality measurements for benthos and fish, surveys for the understanding of hydraulic safety and substrate sampling. All this information will be used to use and eventually implement models of ecological and global quality of the river system. These models will then be used for modelling mitigation measures against hydropeaking effects to understand which interventions maximise all aspects considered.

Research team and environment

The PhD candidate will be part of the Faculty of Science and Technology at the Free University of Bozen-Bolzano. The research team he will join consists of various experts in the fields of hydraulics, hydropower, ecosystems and hydraulic safety. Despite its young age, the team consists of experienced researchers. There are many opportunities for contact with external provincial and private entities and with local hydroelectric companies, which operate the main hydroelectric plants in South Tyrol. The contact person for this research topic usually co-operates with the hydroelectric operators and the provincial authorities in order to create a dialogue between the public and the private sector with regard to the management of hydropower plants.

Suggested skills for this research topic

The main skills required of the candidate are the willingness to participate in the working team, creating a relaxed environment but pursuing clear research aims. Furthermore, it is necessary that the candidate has a desire to learn and to get to know new aspects. From the point of view of technical skills, the candidate should have the basics of programming (Fortran and/or Matlab) or the use of at least 2D hydraulic modelling software (Basement, Flow-2D, etc.). He/she should show willingness to perform field sampling that will mainly concern liquid flow measurements, substrate sampling and as support to eventual fish and benthos sampling.

Curriculum: 6. Health and Ecosystems

Biomolecules and biomaterials for ecosystems protection and human health (acronym: BREATH: BiomateRial for hEAITH)

Reference Person: Pucciarelli Sandra (sandra.pucciarelli@unicam.it)

Host University/Institute: University of Camerino

Research Keywords:	Biomaterials and Bioactive compounds
	Environmental decontamination
	Biodiversity protection
Reference ERCs:	LS9_4 Microbial biotechnology and bioengineering
	LS8_12 Microbial ecology and evolution
	PE5_7 Biomaterials synthesis
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 6: Clean Water and Sanitation, GOAL 13: Climate Action

Description of the research topic

The demand for bioactive molecules and materials with desirable properties is constantly growing. Several molecules that we use for everyday life, such as cellulose, pigments and drugs, are obtained from exploitation of natural resources. The extraction of these substances from the environment can lead to severe consequences like mineral depletion, loss of biodiversity, food insecurity and climate changes (10.1016/j.Jenvman.2017.12.048). Nowadays, we are using more ecological resources than nature can regenerate in different ways. Preservation of the forestry, particularly trees, is essential for keeping global warming in check. Deforestation is also caused by cellulose extraction. Natural resources exploitation can be avoided by finding alternative sources of these compounds.

Marine organisms living in extreme environments have capacity in biosynthesizing novel bioactive compounds, which are potentially useful for pharmaceutical, cosmeceutical, and biotechnological applications (doi: 10.3390/md18120657). For example, Antarctic bacteria can produce different drugs (doi: 10.3390/antibiotics7040090).

The goal of this PhD project is to characterize useful and sustainable biomolecules produced by bacteria. New Antarctic bacterial strains are available in the laboratory of the Reference person. The genomes from these strains have been sequenced and ready to be analyzed to discover metabolic pathways involved in the synthesis of molecules of interest.

Some metabolic features of these Antarctic microorganisms are already known and can be exploited in several different applications:

- These strains can degrade hydrocarbons and, in the presence of heavy metals, can synthesize metal nanoparticles. Therefore, these bacteria can be used in bioremediation to remove pollutants from the environments and to transform them into useful materials. Indeed, these bio nanoparticles have been shown to possess antimicrobial activity against pathogens, including Streptococcus and Candida (granted patent n. PCT/EP2020/071193).

- in different growing conditions such as the presence of glutamate or biodiesel, these bacteria can produce siderophores and biosurfanctants (granted patent n PCT/EP2020/071193).

- in the presence of different sugars (or food waste) these bacteria can synthesize biocellulose (patents PCT/EP2021/086747 and PCT/EP2021/086800).

The PhD candidate will work on: 1- characterization of the metabolic pathways involved in biomolecules and biomaterial synthesis in order to discover new potentiality; 2- biomolecules characterization by Scanning Electron Microscopy (SEM), Fourier transform infrared (FTIR) and UV-Vis spectroscopy; 3- protocols optimization for the biosynthesis and definition of potential uses;in collaboration with industrial partners; 4- possible application of these bacteria in bioremediation, in particular for hydrocarbons and heavy metals (the methods are reported in patent PCT/EP2020/082865).

Activity timetable is reported in the GANNT.(see image).

This PhD project is interdisciplinary since implies applications of bioinformatics, biochemistry, microbiology, and biotechnology. Furthermore, it foreseen both basic and applied research. The PhD student will spend a stage of at least 6 months in associated industrial partners. The outputs of the research can bring to the development of new and more cost-effective bioproducts, as biocompatible wound dressings with antibiotic activity. These production of biomolecules of interest avoiding natural resources exploitation gives a contribution to ecosystems and public health preservation.

Research team and environment

Sandra Pucciarelli is a Senior researcher (with habilitation) in the field of environmental adaptation and microbiology. She is also expert in molecular biology and biotechnology. From a long time, she is part of a research group working on environmental adaptation and molecular evolution in Antarctic microorganisms. Recently, her research moved in the synthesis of biomaterials using bacteria, focusing mainly on metal nanoparticles with antibiotic activity, and bio active fluorescent pigments. Furthermore, she optimized a protocol for large scale production and purification of biocellulose.

Being the President of the startup IrIdES (https://www.lrides.Eu/wp/homepage/), she can rely on the expertise of the other members of the company in the field of environmental/analytical chemistry, environmental remediation, functional nanomaterials,

characterization, and application of natural dyes. The team is also composed by young researchers with skills in microbiology and bioinformatics.

The research group can also rely on international collaborators: Prof Pietro Liò (University of Cambridge) that can support the bioinformatics approach, and prof. Ilidio Correia (Universidade da Beira Interior) that can provide his expertise in the application of biocellulose and metal nanoparticles in the production of wound healing materials.

Paper mills can support the PhD student in biocellulose production.

The research group is operating at the School of Bioscience and Veterinary Medicine of the University of Camerino (UNICAM) that hosts the coordination of the PhD course in Life and Health Sciences. The University has a strong commitment to doctoral training and internationalization. From 2005 the School of Advanced Studies at UNICAM promotes structured doctoral courses with high level of internationalization and collaborative interaction with industries.

For this scholarship a period of internship is planned at *IRIDES, Camerino*

Suggested skills for this research topic

Basic skills in microbiology, engineering, biotechnology,

Type of scholarship and obligations

The type of this scholarship is: Dottorati Innovativi (Innovative PhD courses). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 6. Health and Ecosystems

Tick-pathogen interactions: impact on ecology and transmission of tick-borne diseases

Reference Person: Salata Cristiano (cristiano.salata@unipd.it)

Host University/Institute: Università degli Studi di Padova

Research Keywords:	Tick-borne diseases
	Ticks genetic variability
	Vector competence
Reference ERCs:	LS8_10 Ecology and evolution of species interactions
	LS6_8 Biological basis of prevention and treatment of infection
	LS2_6 Metagenomics
Reference SDGs:	GOAL 3: Good Health and Well-being

Description of the research topic

Ticks are hematophagous ectoparasitic arthropods that parasitize a wide range of vertebrates, thrive in variable settings from the Arctic to the tropical regions, and transmit a greater variety of pathogens (bacteria, viruses, protozoa, and helminths) than any other group of arthropod vectors. Climate changes are favoring the spread of different tick species in new areas, both in terms of latitude and altitude. This results in an increase in the risk of transmission of pathogens to humans and domestic/wild animals with important socio-economic and ecological impacts. Arthropod vectorial capacity is a complex process governed by a multifaceted suite of genetic mechanisms. First, interaction with a new pathogen generally induces antimicrobial molecular activity, thereby establishing a strong vectorial resistance. Second, the novel metabolite pool resulting from the initial (and potentially recurrent) pathogenic infection may impose permanent and unique changes in the vector's existing epigenetic landscape, thus initiating vectorial tolerance. Finally, during future infections, the newfound vectorial tolerance could usher a mutually beneficial relationship between the vector and pathogen.

The research proposal is aimed at studying the vector capacity of ticks by evaluating their genomic variability in relation to functional aspects (such as the microbiome and virome) analyzing ticks collected from different Italian regions. In particular, we will focus on the identification of molecular markers of infection and factors affecting the vector capacity. Furthermore, performing experimental infections of tick cell lines and whole ticks with viral and/or bacteria models, we will characterize: i) the immune mechanisms associated to

control of pathogens proliferation in ticks; ii) the putative markers of infections; iii) if the infection can increase the efficiency of the pathogen to spread in the environment modifying the behavior and fitness of infected ticks.

The identification of markers of infection may lead to the development of new models for monitoring and assessing the risk of transmission of infections as well as new systems to control the spread of tick-borne diseases.

Research team and environment

The research team includes experts in microbiology, parasitology and bioinformatics.

The enrolled student will take part in laboratory activities inside the BSL2 and 3 facilities using the most common cellular and molecular biology techniques. He/she will have to work in a team of young and senior scholars. The ideal candidate should be also opened to learn and implement the team's skills and competences with new approaches and ideas to tackle the objectives of the proposed research.

Suggested skills for this research topic

Candidates should be motivated and have skills in: i) tick-borne pathogens; ii) manipulation of microorganisms in Biosafety level 2 and 3 facilities; iii) cellular and molecular biology techniques.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Curriculum: 6. Health and Ecosystems

Novel methodology for development of Safe and Sustainable by Design products using systems biology and bioinformatics methods.

Reference Person: Sarigiannis Denis (denis.sarigiannis@iusspavia.it)

Host University/Institute: IUSS Pavia

Research Keywords:	Sustainability
	Safety
	Systems biology
Reference ERCs:	LS9 Biotechnology and Biosystems Engineering
	LS9_1 Bioengineering for synthetic and chemical biology
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 9: Industry, Innovation and Infrastructure, GOAL 12: Responsible Consumption and Production, GOAL 17: Partnerships to achieve the Goal

Description of the research topic

The research object of the present study concerns the development of systems biology models and bioinformatics models in order to link the integrated exposure assessment to multiple chemicals with the identification of toxicity pathways and the dose-relationship relationship associated with adverse outcome pathways associated with industrial chemicals, before their production phase, aiming at sustainable and safe products. It is important to determine the quantitative relationships between key events, utilizing data from transcriptional and metabolic analysis from a combination of in vitro and in vivo data, as well as data from structure-activity relationships, and chemical groups associated with specific forms of toxicity. For this purpose, data from transcriptional and metabolic analysis will be utilized after a range of expected environmentally related doses of combined exposure to chemicals expected to be found in consumer products, taking their entire life cycle. In this sense, predictive tools will be developed, able to identify risks related to chemicals and products at an early stage of design.

Research team and environment

The Environmental Health Engineering Research Team in IUSS consists of Prof. Sarigiannis and 4 PhD students working on salient aspects of sustainable development and the health impacts of climate and environmental change. The research team is expected to grow

significantly with research associates and PhD students during the coming years based on funding coming primarily from the EU research programs Horizon 2020 and Horizon Europe. Our research projects focus on deciphering the link between environment, climate and human health through the use of the human exposome concept, urban health and the promotion of safe and sustainable by design chemicals, materials and products. The team is embedded in the CORDA (Complex Risk Data Analysis) research centre of IUSS, which is directed by Prof. Sarigiannis. CORDA comprises 5 IUSS professors and over 10 researchers and PhD students who work on advanced risk analysis methods including big data analytics for natural and technological hazards, the climate crisis and environmental and industrial chemicals. Prof. Sarigiannis and the Environmental Health Engineering research team also lead the IUSS Department of Excellence with particular emphasis on the line of work on complex hazards affecting critical infrastructures. The Environmental Health Engineering Research Team of IUSS is part of the EU partnerships on chemical risk assessment and human biomonitoring; it also leads the urban health cluster of the EU and EU research projects that tackle climate change and urban air pollution towards the development of win-win solutions that address the link between climate, environmental change and public health.

Suggested skills for this research topic

Degree in Chemical Engineering or Chemistry or Biology, with a diploma thesis in chemical and / or bioinformatics techniques of biological systems. Experience in using biological systems modeling tools (e.G. Cytoscape) and / or bioinformatics (e.G. Panther, Bioconductor, Agilent Genesping), programming knowledge (R or Python or C ++ or Matlab)

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

Curriculum: 6. Health and Ecosystems

Plastics in marine Environment

Reference Person: Spanò Nunziacarla (spano@unime.it)

Host University/Institute: University of Messina

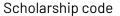|	
Research Keywords:	Biodiversity
	Plastics Pollution
	Marine Environment
Reference ERCs:	LS8_2
	LS8_5
	LS8_13
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 6: Clean Water and Sanitation, GOAL 13: Climate Action

Description of the research topic

BIOdiversity and PLAStic pollution: exploring the ecological and biological effects of plastic debris in marine environments

BIOPLAS

Conservation of marine habitats biodiversity is of fundamental importance to maintain ecosystem services and permit a sustainable exploitation of natural resources. As required by Directive 92/43/EEC (Habitat Directive), European member states should adopt conservation measures in order to preserve the integrity of habitats or stop their degradation. Furthermore, the Marine Strategy Framework Directive 2008/56/EC, requires a deepening of the knowledge on the characteristics and conservation status of marine habitats and living species in order to protect and preserve the marine-coastal environments. These actions could help to reduce degradation and biodiversity loss to maintain and/or reach a ""Good Environmental Status"" for national marine waters in the near future.

In order to pursue this goal, the first step is the evaluation of the biodiversity status of such areas and the possible environmental pressures that could alter them.

It is by now clear that one of the most severe threat to maintain coastal biodiversity is the increasing abundance and distribution of plastic litter. In fact, plastic polymers due to their versatility and durability have become the most used materials. Thanks to their properties, plastics, once entered in the marine environment, are difficult removed. Nano-plastic (<100 nm) and micro (<5 mm) particles, directly produced or resulting from degradation and

fragmentation processes in the natural environment, are one of the most important sources of anthropogenic pollution, bioaccumulating along the trophic network in marine and terrestrial ecosystems.

To date, plastic polymer pollution has been examined primarily in marine environments. However, some studies have emphasized the lack of knowledge about the impact of plastic microparticles in these environments, although it is known that aquatic organisms can be affected at ecological, molecular, cellular and organic level.

The aim of this project is to establish the impact of plastic pollution on marine biodiversity using a multidisciplinary approach. It will be considered the evaluation of selected coastal areas affected by various plastic contamination degrees. The first step of the project will be the evaluation of faunal and floral aquatic biodiversity using both traditional and innovative methods, as UVC, BRUVS and eDNA. Simultaneously, plastic litter presence and abundance will be evaluated in water, sediment and selected aquatic species. Once obtained preliminary data, microcosm experiments will be performed on model organisms (i.E.Microalgae, zooplankton, fish) for the evaluation of different biological effects caused by virgin and environment-derived nano and microplastics.

The correlation of all obtained data will be useful for the definition of a standard protocol to establish the degree of biodiversity loss risks in MPA and other coastal areas.

Research team and environment

TEAM

Prof. Nunziacarla Spanò

Prof. Gioele Capillo

Prof. Serena Savoca

Laboratories

Department of Biomedical and Dental Sciences and Morphofunctional imaging

Department of Chemical, Biological, Pharmaceutical and Environmental Sciences

University of Messina

Stazione Zoologica Anton Dohrn - Messina

Suggested skills for this research topic

The candidate must have sampling experience at sea. In addition, he / she must have at least 1 year of experience in laboratories specialized in researching plastics in marine organisms

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Curriculum: 6. Health and Ecosystems

Active and Healthy Ageing for Sustainability

Reference Person: Vercelli Alessandro (alessandro.vercelli@unito.it)

Host University/Institute: University of Torino

Research Keywords:	Brain
	Muscle
	Green environment
Reference ERCs:	LS5_11 Neurological and neurodegenerative disorders
	LS5_15 Neuroimmunology, neuroinflammation
	LS2_3 Epigenetics
Reference SDGs:	GOAL 3: Good Health and Well-being

Description of the research topic

The costs of age-related clinical care is increasing in the gray economy. Ageing is associated with physical, cognitive, psychological and social frailties which impair the autonomy of elderly people which is no more sustainable by our society. This project will aim to underline the multilevel (molecular, cellular and system) impact of nature on the prevention of frailty, on muscular weakness, on depression and on neuroinflammation in order to promote independent living of the elderly. The effects of different molecules released by trees (such as fitocides, therpens and therpenoids) will be studied in the blood of the elderly. The same molecules will be tested in vitro and in animal models of disease to study their effect on neuroinflammation, muscle trophism and autophagy. For the study in human subjects, it is under examination by the local ethical committee: it involves elderly subjects which will be administered several cognitive and psychological tests and blood samples will be collected after living in a green (park) environment. Blood samples will be screened for complement, IL-6, IL-10, TNFŒ±, cortisol, BDNF (brain derived neurotrophic factor) and serotonin. Moreover, epigenetic modifications in terms of acetylation/deacetylation and methylation of histones induced by living in a green environment will be studied in PBMCs (peripheral blood mononuclear cells). Molecules known to be effective in this environment will be tested in vitro in different types of cells (muscle cells, neurons, astrocytes) and in vivo in mouse model of disease (sarcopenia and neurodegenerative diseases). The readout will be the different morphological and behavioral parameters, and the involvement of autophagic process to remove cellular debris in neurodegenerative diseases.

This project could demonstrate a role of exposure to nature, whether green or blue, in neuropsychiatric diseases. There is already reasonable evidence that this may hold true, and

we intend to demonstrate its epidemiological aspects on the one hand and some biological mechanisms on the other. This project could open new horizons in the field of green economy, one of the founding themes of the next framework program of the European community.

The results of this project could have a major impact in inspiring the urban planning principles of the future, and in involving the various stakeholders (public bodies, architects, builders) involved in urban planning. Furthermore, it could give new pathogenetic and unconventional therapeutic indications, which allow to reduce the dosages of neuropsychiatric drugs.

The results will be shared with the scientific community at meetings and published on peer-reviewed journals, and disseminated to the public: to this aim, the group is already collaborating with the Mountain Museum of Turin.

Research team and environment

The research team works at the Neuroscience Institute Cavalieri Ottolenghi of Torino (https://www.Nico.Ottolenghi.Unito.It/eng) of which AV is scientific director. The main goal of NICO research center is to study the fundamental biological mechanisms of nervous system function, whose knowledge is essential for the development of innovative therapeutic approaches for neurodegenerative diseases and psychiatric disorders. The team is large (https://www.Nico.Ottolenghi.Unito.It/eng/Research/Research-Groups/Brain-development-and-disease), and is involved in two University spinoffs. The team, belonging to the Department of Neuroscience of UNITO, has many collaborations with clinicians. We study the development of the central nervous system from the embryo to the aged, and the common neurobiological mechanisms and molecular pathways which lead to normal development and to neurodegeneration. We believe that basic and applied neuroscience are strongly interconnected. Since many neurobiological molecular mechanisms can be studied at different levels, we use cell cultures and in vivo models, from simple organisms to rodents.

We are interested in the molecular pathways leading to neurogenesis and neuronal cell death, which we study in development and in experimental models of transient/permanent cerebral ischemia, acute/chronic glaucoma, epilepsy and Alzheimer's disease. Finally, we are studying the immunomodulatory, neuroprotective and growth promoting roles of cell therapy in SMA, ALS and spinal cord injury, particularly related to neuroinflammation.

Suggested skills for this research topic

The candidate should have a degree in Medicine & Surgery, Medical Biotechnology, Molecular Biotechnology, Neuroscience, Biology or Biomedical Engineering

He/she should have an experience in a biomedical laboratory, including molecular biology and histology, possibly of the nervous system.

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