



Ca' Foscari  
University  
of Venice

Department of  
Environmental  
Sciences, Informatics  
and Statistics

**Our  
research**

# The department

The Department of Environmental Sciences, Informatics and Statistics (DAIS), brings together several research areas: Biology and ecology, Chemistry (analytical, environmental, for risk and sustainability analysis, green, and for the conservation of cultural heritage), Computer science and engineering, Earth science, Environmental and civil engineering, and Statistics. Cross-cutting themes of the research are climate and the socio-economic effects of its mutations, complexity, cultural heritage conservation, monitoring, risk, security (environmental and computer science) and sustainability. Research is also developed in collaboration with public agencies and local businesses. Thanks to this synergy and multidisciplinary approach, DAIS ensures solutions for large-scale research.



# Research Area

## Biology and Ecology

Environmental science addresses the natural environment as a fundamental element of the anthroposphere and views humans as one of the main causes of changes in ecosystems. The research topics of the bioecological area span different spatial scales, cover different domains (terrestrial, marine-coastal, and transitional), and pay special attention to different temporal scales and thus to changes in ecosystems (climate change, landscape and habitat modifications, natural cycles, pollution and its impacts). This provides modeling, assessment and management tools of applicability in the territory in compliance with European Directives and National Regulations.

### Characteristics

The macro-area is characterized by a strong ecological footprint, which shapes the research topics. A foundational element is the use of multiscale approaches for the assessment of global changes and the development of methodologies applicable to natural, semi-natural and anthropogenic ecosystems in both marine and terrestrial settings for the solution of several environmental problems. All research groups actively collaborate with other disciplines.

### Impact

The complexity of the territory on which Ca' Foscari University focuses, with particular regard to Venice, its lagoon and hinterland, requires technical and management solutions uncommon to other territories. These peculiarities channel the energies of the research groups towards a close collaboration with all

local authorities and businesses, becoming a point of reference for the study of large-scale solutions, such as Porto Marghera and the construction projects that defend the city, and for interventions on a local scale but with a high socio-environmental value.

The research groups that make up the macro-area are widely recognized in their respective scientific-disciplinary fields, developing a wide network of collaborations and intense project work both internationally and nationally. The impact and importance on the territory arises from the implementation of the results of the different research projects in areas intended for conservation (e.g., parks and protected areas, wildlife protection), anthropogenic production and use, institutional monitoring of the Venice Lagoon, environmental restoration, resource management (fisheries, aquaculture, sediment) and pollution issues.

## Analytical Chemistry

The research themes of the Analytical Chemistry group relate to the development of analytical methodologies for the determination of organic micropollutants of both natural and anthropogenic origin, and trace elements. The application of such analytical methodologies in environmental matrices such as water, sediment, atmospheric aerosol, snow, ice, and biota, has made it possible to study chemical contamination on a global scale and to determine (a) the mechanisms of transport and transfer of pollutants between environmental compartments, (b) the processes and transformation cycles of chemicals present in or released into the environment. The group is

also involved in metabolomics analysis on matrices of interest to the agri-food and nutraceutical sector, using untargeted methodologies for the identification of compounds with biological activity.

### Characteristics

The research group is active as a leader and partner in numerous projects both nationally and internationally, and plays an important teaching and management role in the Bachelor's and Master's Degree Programs in Environmental Sciences, in the PhDs in Science and Management of Climate Change and Environmental Sciences.

### Impact

These analytical methodologies have also been applied to reconstruct the dynamics of environmental processes in areas significantly affected by varying degrees of anthropization such as the Venetian lagoon, the Mediterranean Sea, the North Pacific, the Alps, Everest, and even the polar regions. Finally, the analysis of both organic and inorganic molecular markers in well-preserved climate archives has made it possible to reconstruct aspects of past climate and environmental variability.

## Environmental Chemistry, Risk Assessment and Sustainability

The group's research topics include determination of organic pollutant compounds in environmental matrices; environmental behavior of emerging pollutants (engineered nanoparticles); contaminant transport models; human

health and ecological risk analysis; uncertainty and sensitivity analysis for environmental risk models; and decision support systems for environmental risk management.

### Characteristics

The group has developed a close network of international collaborations by participating in the development of a variety of European and international research projects (especially with China, Russia, and the USA). The research group also plays an important role in the teaching of the Bachelor's and Master's Degree Programs in Environmental Sciences and in the PhD in Science and Management of Climate Change.

### Impact

Research has applications in a variety of areas: decontamination and redevelopment of contaminated sites, environmental hazards from climate change and natural hazards, assessment and management of water resources, and nanomaterials and nanotechnology.



### **Organic and Green Chemistry**

The group's research topics are: biorefinery, green solvents, green metrics for assessing process sustainability, and new reaction pathways for organic molecules.

#### **Characteristics**

The group has developed a close network of international collaborations by participating in the development of a variety of European and international research projects. It also plays an important role in the teaching of the Bachelor's and Master's Degree Programs in Environmental Sciences and in the PhD in Science and Management of Climate Change.

#### **Impact**

Research finds application in a variety of areas as also demonstrated by the various patents developed in the area of new green and sustainable synthetic strategies (ingredients for the perfume industry, new bio-monomers for polymers, new plastics).

### **Chemical Sciences and Technologies for Cultural Heritage**

The research group is active at a national and international level in the study of the materials of art (traditional, modern and contemporary), archaeology and architecture, in the evaluation of natural and anthropic impacts on artifacts - with particular reference to coastal environments - and in the implementation of methodologies for conservation and degradation prevention.

#### **Characteristics**

Particular attention is devoted to the theme of sustainability in conservation, declined through the use of materials and methodologies with reduced impact on the environment and the health of the operators. As a point of reference for public and private institutions in the area, the group collaborates, among others, with Fondazione Musei Civici, the Superintendency, the Municipality of Venice, and several companies in the area to develop specific methodologies for the study and protection of cultural heritage.

#### **Impact**

The research group also has an important role in the teaching of the Bachelor of Science in Sciences and Technologies for Cultural Heritage and Master of Conservation Science and Technology for Cultural Heritage and within the new program for National Doctorates in Heritage Science.

### **Computer Science and Engineering**

The research carried out by the department's faculty covers many sub-areas of the discipline of Computer Science and Engineering, which can be grouped into three areas: Artificial Intelligence, Data Engineering and Data Science, Software Development and Engineering, and Cybersecurity.

#### **Characteristics**

The area of Artificial Intelligence, Data Engineering and Data Science is the most numerous in terms of faculty, who conduct research in machine learning and deep learning, with a special emphasis on computer vision, text and web mining, and information spreading and consumption in digital media. Another line of research investigates algorithms for genetic type data and decision support systems in clinical settings. Finally, the research also focuses on the design and development of new human-computer interactions and information representations.

In the area of Software Development and Engineering, research activities are aimed at both the study of models, algorithms and software for distributed systems and telecommunications

networks, and the design and application of methods for the specification and verification of reliability and security of software systems.

In the Cybersecurity area, faculty members conduct research in different areas of cybersecurity: applied cryptography, network and web security, software security, embedded systems security, security and usability, misinformation spreading and countermeasures.

#### **Impact**

Research is conducted in a rigorous and formal manner, with several international collaborations with universities, research centers and companies. The high quality of research translates into technological spillovers to the local area, with several collaborations with local industry and the birth of several spin-offs, particularly in the areas of Software Verification and Cybersecurity.

### **Earth Sciences**

The area develops and uses multidisciplinary approaches to address research topics of great interest to the Environmental Sciences. The common goal is the study of the flows of energy and matter occurring on Earth, the processes that distributed them in space and time, and the natural and anthropogenic materials in the Earth's different spheres (lithosphere, atmosphere, hydrosphere, cryosphere, pedosphere, and biosphere).

The area is divided into three research groups that actively interact with each other and with researchers in other areas and disciplines both within the Uni





versity and through close collaborations with national and international research institutes, environmental protection and prevention agencies, public institutions and private entities.

### **Characteristics**

The geochemistry group deals with paleoclimatic reconstructions obtained from isotopic and chemical study of ice cores and surface snow. The application of complex techniques allows for very high resolution in ice chemical analyses for optimal interpretation. The research group is also concerned with the application of the principles of isotopic and environmental geochemistry for the study of the hydrological cycle, air pollution, and aerosol from the chemical and physical point of view, identifying and quantifying local and remote sources of pollutant emissions, the impacts of environmental policies, and assessing population exposure to pollution.

The geomorphology and sedimentology group analyzes geological features of coastal and deep-sea environments to understand their evolution over time. In particular, the group studies temporal changes induced by external processes, coastal hydrodynamics and its evolution, and coastal flood hazards. The study of deep-sea sediments is aimed at investigating the role of ocean circulation in past climate changes by reconstructing the evolution of temperatures and volume of ice masses, marine productivity, and the carbon cycle.

The climate physics, oceanography and climatology group studies the physics of climate, with particular reference to the mechanisms that generate variability in the ocean and atmosphere at interan-

nual to multidecadal scales. One region of particular interest is the Mediterranean. Research activities focus on: impact of natural forcing in the paleoclimatic context, numerical modeling involving small-scale and mesoscale phenomena in the oceans, modes of climate system variability and their predictability, impact of climate variability on sea level in the Venice lagoon area, analysis of observed data in the ocean and atmosphere.

### **Impact**

Paleoclimatological and paleoceanographic studies help understand current climate variations by placing them in a broader temporal context. Isotopic hydrology helps determine aquifer recharge areas for vulnerability studies and helps understand how the water cycle is changing due to climate change. Air pollution studies help identify the emission sources that impact air quality the most, assessing the effectiveness of air pollution mitigation policies and helping governments make effective choices for the future. Geomorphological studies are basic to an organic understanding of increased anthropogenic impacts and the consequences of sea level changes. Oceanographic studies provide a deeper understanding of physical phenomena underlying ocean circulation, while climatological studies serve to reveal the origins of climate variability and thus better understand the present climate and its possible future evolution.

## **Environmental and Civil Engineering**

Research in the Engineering area has been established several decades ago in the field of environmental science and later on also with building physics topics. The activities aim at studying and developing approaches, processes, and technologies that can reduce the environmental impact and promote sustainability. The topic of energy is investigated, both in terms of production from renewable sources and in terms of optimization and reduction of consumption of the built environment. In the field of civil and environmental engineering in the Department there are two research groups: one focused on the physical, energetic, and ergonomic part of buildings, and another one that targets the issues of synthesis and recovery of high value-added materials (such as bioplastics, nutrients for agronomic use, biomethane, and green hydrogen) from waste and/or secondary industrial matrices.



### **Characteristics**

Technology transfer is one of the key element of the area. The analyzed processes are studied at different scales, from small preliminary laboratory tests and simulations, up to pilot at large scale, using machines and approaches equal to those of full-scale plants. This results in information sets that are directly transferable, and thus immediately applicable in design, planning and management. Overall, then, this area of disciplines is characterized by the practicality and direct quantitative applicability in actual reality, whether in biorefineries, wastewater treatment (environmental engineering), or advanced control technologies and logic for the built environment (civil engineering). After the laboratory or the energetic simulation, the research is transferred in case studies monitored at full scale.

### **Impact**

A consequence of this approach is the strong presence at European level, with projects won in the V, VI, VII Framework Program, H2020, and the current Horizon Europe, as well as important programs promoted by local authorities and companies. The latter find at DAIS a valuable support both in terms of feasibility study, design, evaluation, and monitoring.

### **Statistics**

Research topics of the statistical methodology group include time series analysis, quality control methods, spatial statistics, extreme values, nonparametric statistics and computational statistics. The areas of applications, often in collaboration with experts from other disci-

plines, include climatology, epidemiology, hydrology, medicine, environmental science, economics, sociology and sports.

### **Characteristics**

Traditionally, research groups in statistics within Italian universities turn their attention to applications in the economic and social fields. The research group at DAIS is one of the few sizeable teams in Italy that instead is particularly active in applications in the environmental and climatological fields and, in general, in scientific applications. As a testimony to the breadth of the applicability of statistical approaches, members of the group teach in a variety of undergraduate and postgraduate courses in the University.

### **Impact**

The statistical methodology developed at DAIS is strongly inspired by applications in different fields and often developed directly in collaboration with experts from other disciplines who can directly use the new methodologies. Examples of recently developed applications include:

- The quantification of the impact of climate change on flood risk and river flooding;
- The study of vaccination inclination during the COVID-19 pandemic;
- The study of the relationship between global warming and the reduction of Arctic sea ice;
- The impact of family violence on women's choices and behavior in Colombia;
- The prediction of peak temperatures in the Veneto region.



# PhD Degrees

## Computer Science

The objective of the PhD program is to prepare students with the formal tools necessary for rigorously implementing and developing research, allowing them to become experts in the methodologies for planning and evaluation of systems and computer systems. The program is taught entirely in English. The duration is 3 years.

### Research themes

- Bioinformatics;
- Artificial vision and pattern recognition;
- Evaluation methods of performance and system simulation;
- Data and web mining;
- Parallel and distributed systems and algorithms;
- Formal methods of computer science;
- Fundamentals of programming languages;
- System security;
- Multimedia and information systems;
- Man-machine interaction;
- Analysis and verification of programs;
- Web technologies.

## Polar Sciences

The objective of the PhD program in Polar Sciences is to prepare students with in-depth scientific competences and original and innovative research activities for becoming experts on topics related to recent and past environmental and climate changes of the polar regions and of the glaciated areas of high altitude/low latitudes sites. The state of the art of scientific knowledge will be made available for the students for building a robust scientific understanding of the processes regulating the climate changes occurring in the polar regions with an interdisciplinary approach. The program is taught entirely in English. The duration is 4 years.

### Research themes

- Glaciology;
- Ice core sciences;
- Ice sheet Modeling;
- Polar Biology;
- Polar Oceanography;
- Paleoclimate;
- Paleoceanography;
- Polar Climate;
- Remote Sensing;
- Polar Geography and Geopolitics;

- Spectral Methods for Climatic Time Series;
- Data Mining.

## Environmental Sciences

The PhD program is designed to research solutions to the many global issues (environment, ecology, social development) with the aim of promoting an interdisciplinary approach. The main objective is to prepare experts able to examine and develop knowledge of the environmental system dynamics through improving the quality of the available data and refining the understanding of the processes in place via experimental and modeling techniques. The program is taught entirely in English. The duration is 3 years.

### Research themes

- Environmental and Earth Science;
- Biology and Ecology;
- Environmental chemistry;
- Green chemistry;
- Environmental reclamation and technologies;

- Microbiology;
- Environmental biotechnology;
- Remote sensing techniques.

## Science and Management of Climate Change

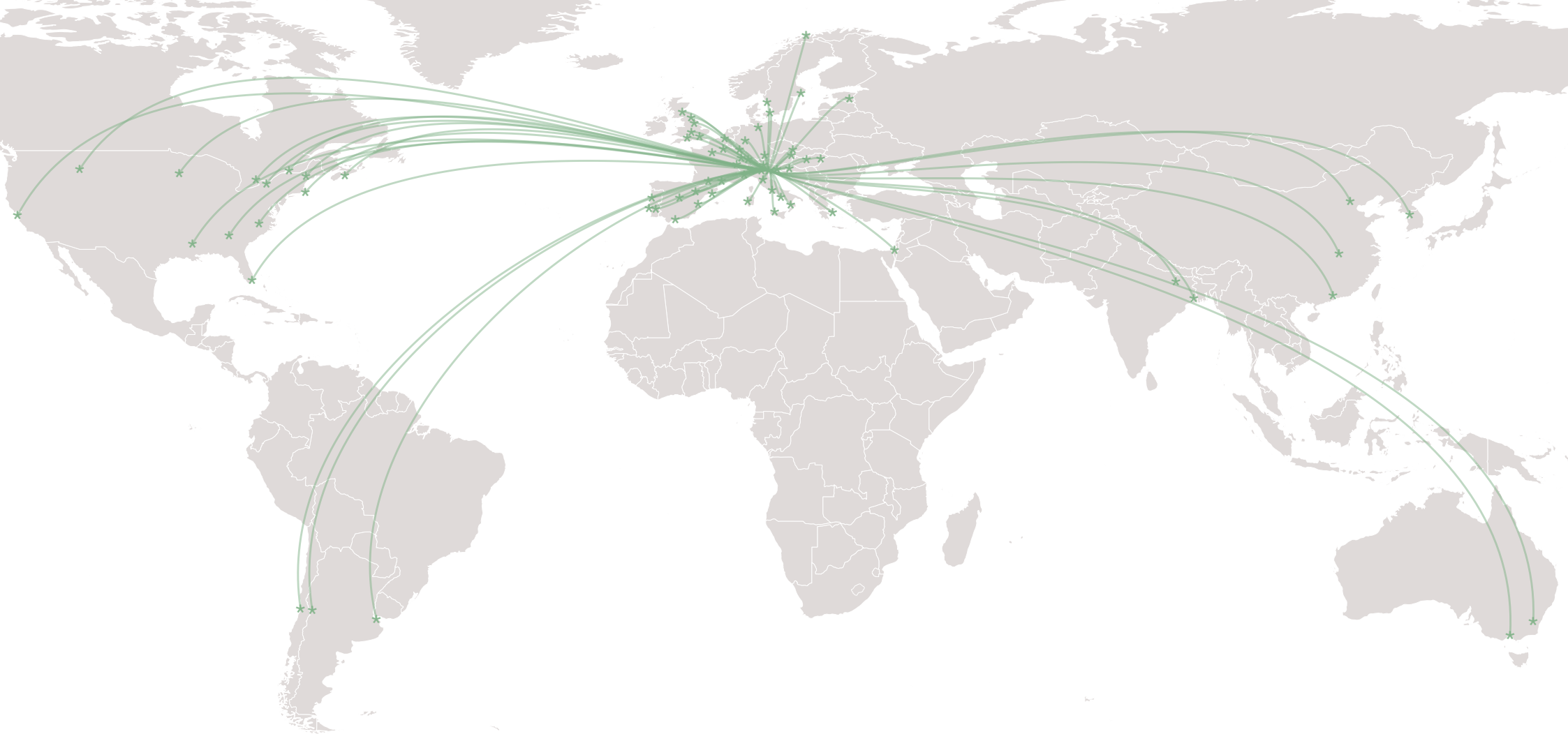
The PhD program in Science and Management of Climate Change is a joint initiative of Ca' Foscari University of Venice and the Euro-Mediterranean Center on Climate Change (CMCC), a national and global leader in international climate change research. The main objective is to prepare experts with a broad and solid scientific background in economics in addition to a solid foundation of original and innovative research on topics concerning the dynamics of climate change and the methodologies and techniques used in its assessment and management in terms of adaptation and mitigation measures and policies. The program is taught entirely in English. The duration is 4 years.

### Research themes

- Dynamics of Climate Change;
- Climate Change in the Past;
- Analysis of national and international mitigation and adaptation policies in the context of sustainable development;
- Risk assessment and decision support system for environmental climate impacts;
- Assessment of biophysical and socio-economic impacts of climate change and adaptation strategies;
- Other topics concerning the study of climate change and the management of associated environmental and socioeconomic processes.



# Network



- Queen Mary University of London
- The University of York
- Università La Sapienza Roma
- Italian Institute of Technology
- Ben-Gurion University
- McGill University
- Wuhan University
- Technical University of Munich
- South China University of Technology
- Zurich University of Applied Sciences
- University of Bonn
- Instituto Superior Técnico
- Vienna University of Technology
- Masaryk University
- CISP Helmholtz Center for Information Security
- Università degli studi di Udine
- Gran Sasso Science Institute
- Dalhousie University
- Hogeschool Rotterdam
- Libera Università di Bolzano
- Politecnico di Milano
- Université Toulouse III - Paul Sabatier
- Università di Brescia
- Università di Torino
- Università Politecnica della Catalogna
- University of Newcastle
- Northeastern University of Boston
- L'Institut de microbiologie de l'Université de Lausanne
- Ecole Normale Supérieure Paris
- ETH Zurich
- University of Calcutta
- University of Patna
- Università di Cagliari
- Università di Ferrara
- University of Debrecen
- University of Northampton
- Macroecology working Group
- Università di Maribor
- Università di Pisa
- Università degli studi di Scienze Gastronomiche
- Università di Bologna
- Università degli Studi di Firenze
- Universitat Autònoma de Barcelona
- Emory University School of Medicine
- Università degli studi di Palermo
- NOAA's National Marine Fisheries Service
- UiT The Arctic University of Norway
- Centro de Investigación y Tecnología Agroalimentaria de Aragón (CITA)
- Universidad Autónoma de Madrid
- York University
- Università di Lubiana
- Swedish Environmental Research Institute
- Università di Zagabria
- Università degli studi della Tuscia
- Università dell'Insubria
- Università di Trieste
- Montana State University
- Universidad de Playa Ancha
- Australian National University
- University of Antwerp
- Universidad de Concepción
- University of Minnesota
- Herriot Watt University e Institute of Occupational Medicine
- Électricité de France
- EMPA Materials Science and Technology
- Universitat Rovira i Virgili
- US Army Engineer Research and Development Center
- Gothenburg University
- Fraunhofer Institutes
- Beijing Normal University
- Sun Yat-sen University
- AgroParisTech
- Leuphana University
- Institute on Membrane Technology
- Universidad Nacional de La Plata
- Universidad de Málaga
- Università di Salerno
- University of Aveiro
- Universitat Politècnica de València
- Stanford University
- Politecnico di Atene
- Università di Evora
- Université Paris-Saclay
- University of Rochester Medical Center
- CNR-IAS
- Istituto Nazionale di Geofisica e Vulcanologia (INGV)
- Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS)
- University of Barcelona
- University of Cambridge
- University of Miami
- École polytechnique fédérale de Lausanne
- Swiss Federal Institute of Aquatic Science and Technology
- Duke University
- Technical University of Denmark
- Università di Padova
- Korea University
- RMIT University
- Università di Verona
- INRAE PACA
- Université de Montpellier
- Universidad Adolfo Ibáñez
- University of Bath
- University of Warwick
- Bocconi Institute for Data Science and Analytics
- University of Edinburgh
- Alfréd Rényi Institute of Mathematics
- London School of Hygiene & Tropical Medicine
- City University of London
- Harvard T.H. Chan School of Public Health
- Pompeii Archaeological Park



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