Study Abroad Handbook for Postgraduate students
Lancaster Environment Centre

How to Apply

Grade requirement:
You are expected to have a GPA of 3.0, a credit or grade B average or equivalent in a related degree.

English requirements:
If you are a non-native English language speaker, you will need to submit your most recent Secure English Language Test (SELT) certificate equivalent to IELTS 6.5 (with at least 6.0 in each element). This is usually a B2-C1 CEFR.

Students who have IELTS 6.0 (with at least 5.5 in each element) or Pearson PTE Academic 55 overall (with at least 51 in each element) can opt to take part in the 4 week English for Academic Purposes course instead of retaking their tests.

If you are an Erasmus+ student and you hold EU/EEA/Swiss citizenship, who has not taken a formal language test, please provide a letter from your home institution confirming that you meet our English Language Requirements (B2 - C1 based on the CEFR). Please note that we may need to adjust the requirements depending on the Brexit outcome and immigration regulations after it.

You can study at Lancaster for:
- Michaelmas term (October - December)
- Lent & Summer terms (January - June)
- Summer term (April – June)
  *Only for selected partners and previously agreed with Lancaster
- Michaelmas & Lent term (October – March)

You are required to take:
- 24-30 ECTS credits during the Michaelmas term or Lent term
- 32-40 ECTS credits during Lent & Summer terms
- 48 ECTS credits during Michaelmas & Lent terms

Although we make every effort to ensure the accuracy of information about modules, there may be some unavoidable changes. At the stage of the application, you are only completing a provisional study plan and it will only be confirmed when you arrive in Lancaster. We recommend you to have a strong list of back-up options in case you need to make changes to your provisional study plan.

Please note that you can change your mind if you need to and switch modules during your first week at Lancaster.

Modules available to Erasmus+ students

LEC.400: Research Methods in the Social Sciences

Terms Taught: Michaelmas Term Only
ECTS Credits: 8 ECTS Credits
Pre-requisites: This module is only available to Postgraduate Erasmus+ students from selected partners

Module description

This module is designed to provide students with a critical understanding of the research process and the main approaches, methods and techniques which are typically used for research. The module is intended to enable students to undertake their own independent research as part of their Masters degree and to provide a solid foundation for PhD research.

Educational Aims

The module provides methods related knowledge and understanding applicable to social science at postgraduate level generally. In addition, the module provides training on communicating research outcomes.

On successful completion of this module, students should be able to:

- Situate decisions about methods through reference to the way science philosophies and existing literatures shape research design;
- Explain a range of ethical issues and dilemmas associated with research and ways of managing these issues and dilemmas;
- Use secondary data to develop original research;
- Describe the pros and cons of a range of methods for data collection and data analysis respectively
- Choose between a range of qualitative and quantitative research methods, when designing research, in a way that results in aims and objectives being effectively fulfilled.
- Write a research proposal
- Communicate research to different audiences

Outline Syllabus

- **Formulating a research project**
  - What is social science research?
  - How does ethics matter?
  - Positioning research in the literature
  - How to write a research proposal
  - How to plan a research project
- **Choosing and engaging with methods**
  - Collecting data by asking questions or observing
  - Analysing data quantitatively or qualitatively
- **Working on individual research proposals**
  - Supervision support available
- **Communicating research**

LEC.401/LEC.401b: Perspectives on Environment and Development

Terms Taught: Michaelmas Term Only
ECTS Credits: 8 ECTS Credits / 10 ECTS credits
Pre-requisites:

- This module is only available to Postgraduate Erasmus+ students from selected partners
Some experience of social science, human geography or development studies

Module description

This module aims to provide a theoretical foundation for the study of development and the environment from a geographical perspective. As such, it will focus on understanding the ways in which scholars have brought together development theory with the analysis of nature-society relations in the majority (i.e. ‘developing’) world. The intent of the module is to provide students with a critical understanding of the evolution of contemporary development discourses, and new ways of thinking about the relationships between environment and development. Some of the key topics that will be discussed are: theories of development, indigenous knowledge and development, biotechnology and food security, the political economy of natural resources.

Educational Aims

The module aims to enhance students’ academic skills in developing reasoned arguments through the analysis, interpretation and critical appraisal of complex evidence. The module is also built to deepen students’ understanding of the relationship between theory and practice. The module is also built to strengthen students’ skills in oral presentation and academic writing.

On successful completion of the module, students should be familiar with:

- A range of theoretical arguments about development, from modernisation theory to sustainable development to post-development
- Geographical approaches to the study of nature and society, including cultural ecology and political ecology
- Contemporary themes, considerations and case-studies in geographies of development

Outline Syllabus

- Sustainable Development
- Politics of the Earth? Mapping Green Discourses
- (Post)Development
- Development in times of Climate Change
- A Digital Turn in Environmental Governance?
- Food: from Colonial Biopolitics to Global Biotechnologies
- Ecosystem Services: Neoliberal Natures and Green Governmentality in the Global South?
- Can local knowledge deliver sustainable agro-ecological systems?
- Environmental Justice and Social Movements
- Final Discussion and Student Presentations

LEC.402: Geoinformatics

Terms Taught: Lent Term Only
ECTS Credits: 8 ECTS Credits
Pre-requisites: This module is only available to Postgraduate Erasmus+ students from selected partners

Module description

This course introduces students to the fundamental principles of GIS, remote sensing and simulation modelling and explores how these complimentary technologies may be used to capture, manipulate, analyse and display different forms of spatially referenced environmental data. This is a highly vocational module with lectures complimented by computer-based practicals (using state-of-the-art
software such as ArcGIS and ERDAS Imagine) on related themes. At the end of the module students are required to complete a project in which a functioning analytical environmental information system is generated for a given area from a variety of primary and secondary sources of data.

**Educational Aim**

On successful completion of this module a student will gain:

- An understanding of the fundamental principles and applications of GIS and Remote Sensing
- An appreciation of the strong linkages between these disciplines and their fusion to create meaningful spatially-referenced environmental information
- A critical appreciation of current and future potential applications
- Training in the use of advanced software packages including ArcGIS and ERDAS Imagine
- Project management skills through completion of a geoinformatics project

**Outline Syllabus**

The following topics will be covered in lectures:

- Geoinformatics – definitions, components and the nature of spatial data
- Principles of RS: physical basis, sensors, platforms and systems
- Applications of RS
- Principles of GIS
- Vector GIS
- Raster GIS and spatial modelling
- Data Integration and Metadata
- Geoinformatics project design
- The following topics will be covered in practicals:
  - Getting to know ArcGIS (ArcGIS)
  - Introduction to Image Processing (ERDAS)
  - Spatial Enhancement and Image Rectification (ERDAS)
  - Image Classification (ERDAS)
  - Building a Spatial Database (ArcGIS/ERDAS)
  - Data Sources and Geoprocessing (ArcGIS)
  - Data Comparison (ArcGIS)
  - Raster analysis: Simple Map Overlay (ArcGIS)
  - Cartography (ArcGIS)
  - Project Work (ArcGIS/ERDAS)

**Assessment proportions**

100% Coursework

**LEC.403/LEC.403b: Environmental Governance and Management**

**Terms Taught:** Michaelmas Term Only

**ECTS Credits:** 8 ECTS Credits / 10 ECTS Credits

**Pre-requisites:** This module is only available to Postgraduate Erasmus+ students from selected partners

**Module description**

This module provides students with a critical perspective on the underlying principles, approaches, tools and techniques associated with the management of natural resources and the environment. Particular attention is given to the challenges of dealing with change, complexity, uncertainty and conflict in the environment and the different strategies which can be deployed.
Educational aim
On successful completion of this module, a student will:

- Have a critical appreciation of the nature of resource and environmental management
- Be aware of the underlying characteristics and challenges associated with contemporary environmental problems
- Have knowledge of the different approaches and strategies which may be adopted for the management of natural resources and the environment.
- Be able to critique current environmental policies and develop proposals for future public policy

Outline syllabus
The following topics will be covered:

- The nature of resource and environmental management
- Futuristic methods
- Sustainable development
- Ecosystem and adaptive environmental management
- Environmental assessment
- Public participation
- Local knowledge systems
- Gender and resource management
- Conflict resolution
- Policy Implementation
- Environmental monitoring and evaluation

Assessment proportion
100% Coursework

LEC.404: Environmental Justice

Terms Taught: Lent Term Only
ECTS Credits: 8 ECTS Credits
Pre-requisites: This module is only available to Postgraduate Erasmus+ students from selected partners

Module description
This module critically examines environmental justice as a new agenda and discourse for environmental policy and politics. It considers how the environment and the practices of environmental management have equity and justice implications for different socio-economic groups and the research, policy debates and political action that have focused on questions of both distributive and procedural justice. The module is international in scope considering experience in the US, UK and Europe and environmental and risk issues that operate across local to global scales.

Educational aim
On successful completion of this module, a student will have:

- an understanding of core principles and concepts for environmental justice
- an understanding of the evolution of environmental justice discourse, politics and policy making in the US, UK and Europe
- an ability to critically evaluate evidence of patterns of environmental inequality and their causation and claims made for environmental justice at local through to global scales
an understanding of theoretical and practical issues of procedural (in)justice in the context of public participation in environmental decision-making

Outline syllabus

The following topics will be covered:

- Definitions and core concepts and theory
- Environmental justice and sustainability
- Distributive and procedural justice at different spatial scales
- Environmental justice in the US; evidence, politics and policy
- Environmental justice in the UK; evidence, politics and policy
- Environmental justice in Europe and the Aarhus convention
- Evidence of environmental inequality and the geographical distribution of environmental risk
- Public participation, access to information and equity/inclusion issues
- Policy appraisal and distributive analysis
- Case studies; waste management, transport, climate change
- Policy interventions and equity issues.

Assessment proportion

100% Coursework

LEC.405: Environmental Auditing

Terms Taught: Lent Term Only
ECTS Credits: 8 ECTS Credits
Pre-requisites: This module is only available to Postgraduate Erasmus+ students from selected partners

Module description

Environmental auditing has recently become a widespread activity in both the public and private sectors in the UK and internationally. The course is designed to introduce students to the principles of environmental auditing and to give them experience in the use of key methods and techniques. During the course, students will review company environmental policies, undertake an environmental audit and write and environmental policy for a client. This module has been designed to meet the professional requirements of the Institute of Environmental Management and Assessment.

Educational aim

On successful completion of this module, a student will:

- know about the origins and history of environmental auditing.
- understand the main drivers behind the emergence of this field
- understand and be able to apply key auditing tools and techniques
- be able to conduct on-site assessments and prepare audit reports for clients

Outline syllabus

The module will include the following topics:

- History of environmental Auditing
- Principles of Environmental Auditing
LEC.406: Climate Change and Society

Terms Taught: Lent Term Only
ECTS Credits: 8 ECTS Credits / 10 ECTS credits
Pre-requisites: This module is only available to Postgraduate Erasmus+ students from selected partners

Module description
This module aims to explore and reconfigure the ways in which climate change is understood through a focus on the social, rather than the scientific-environmental discourses that have dominated the policy and politics of climate change. This module offers students a wide-ranging and intensive introduction to the politics, cultures and theories of climate change research in the social sciences and humanities.

Educational aim
Students will be able to critically evaluate different theoretical perspectives on a range of climate change debates and present alternative arguments.

On successful completion of this module, students should be able to:

- Evidence a sufficient grounding in the theoretical, political and epistemological discourses of climate change;
- Critically analyse in writing and orally of different theoretical approaches to studying nature, society, and environmental change;
- Discuss the social theory of climate change, in particular, evidence how climate discourse is constructed, practiced, made, and deployed within a political and cultural context;
- Analyse the politics of climate change and discuss forms of cultural production on range of scales;
- Discuss the range of scientific, public, governmental, non-governmental and indigenous “cultures” within the climate change debate.
- Analyse a variety of practice-led, creative, alternative and indigenous societal responses to climate change.
- Evidence a familiarity with the theories and philosophies of risk theory, social theory and the literatures of climate change, environment and society, posthumanism, social practice.
- Evidence the ability to identify, analyse and evaluate a range of different societal interactions with climate.

Outline syllabus
The module will include the following topics:

- Climate Change and Society – Welcome to the Anthropocene
- “Human Dimensions” in climate policy and science
- Rethinking Climate Change and Society
- Climate change and uncertainty
- Climate Change and Risk
- Climate Change and Biopolitics
- Climate Change, Vulnerability and Ethics
- Anthropocene Governmentality
- The geopolitics of climate change or postpolitical politics?
- Living with environmental change or cultures of change?

**Assessment proportion**

80% Essay(s)
20% Presentation (Assessed)

**LEC.421: Food Security, Agriculture and Climate Change**

**Terms Taught:** Michaelmas Term Only
**ECTS Credits:** 8 ECTS Credits
**Pre-requisites:**
- This module is only available to Postgraduate Erasmus+ students from selected partners
- The exam will take place in January

**Module description**

Food security is achieved when all people have access to an adequate supply of safe and nutritious food. Currently there are almost one billion people who are inadequately fed, while a similar number suffer from diet-related illnesses caused by over-consumption! We consider the requirements of a healthy diet and ways in which those in the developing world can access sufficient nutrients (eg. fish consumption, crop biofortification). We address issues contributing to variation in food availability driven by local and global factors, the access that people have to food and the different ways in which food is utilised. The impact of the food production system on the environment is considered, along with the tensions arising from our quest for food security, energy security and water security. The approach to the study of these issues is interdisciplinary in nature. The course takes an international perspective on GFS (Global Food Security).

**Educational aims**

On completion of this module a student should be able to:

- Understand the component parts and the interdisciplinary basis of the food system
- Detail the challenges facing global agricultural production as a result of climate change
- Understanding of the shortage of key resources for food production
- Understand the issues affecting peoples’ access to food
- Have some understanding of factors impacting food safety and food quality
- Detail the problems posed for plants growing in dry soil, at high temperature and in high ozone concentrations
- Demonstrate how basic plant physiology can inform both plant breeding and agronomy to increase the sustainability of agriculture.
- Familiarity with several current/impending crises in global food security
Outline syllabus

Lectures

- The interdisciplinary basis of Food Insecurity and the shortage of resources for food production. Food Sovereignty
- A fair and just food system
- Food Production I  Food production systems: local and global
- Food Production II Plant Breeding/Crop Improvement for yielding under drought
- Food safety and quality

Workshop sessions include consideration of

- The Food Security Challenge.
- The Royal Society report on Science for Enhancing Food Production/Foresight Report on Food and Farming.
- Food Systems: factors impacting food availability, access and affordability. Food Chains.
- Novel crop and resource management systems
- Interviews with those working in the food chain, researchers, policy makers and NGOs

Assessment proportion

- 50% Exam
- 50% Coursework

LEC.424: Using the National Vegetation Classification

Terms Taught: Summer Term Only
ECTS Credits: 8 ECTS Credits
Pre-requisites: This module is only available to Postgraduate Erasmus+ students from selected partners

Module description

This module aims to provide a thorough grounding in the principles and practice of the vegetation survey including Phase 1 Survey and National Vegetation Classification (NVC). The module will consider the use of NVC for the description and understanding of plant communities and its application for vegetation survey, assessment and monitoring. The module is taught intensively within one week.

Educational aims

On completion of this module a student should be able to:

- Plan and execute a vegetation survey of a site
- Identify a range of plant communities
- Appreciate the complex relationships between vegetation and climate, soils and human impacts
- Assess vegetation in local, regional and national contexts
- Understand the potential and limitations of the NVC as a monitoring, management and design tool
Outline syallabus

Lectures/workshops

- **Plant species identification** – Using vegetation keys to identify plant species.
- **Phase 1 habitat survey** – conducting phase1 habitat surveys and mapping vegetation types
- **Introduction to the National Vegetation Classification** – An outline of the origin and purpose of the NVC as a systematic and comprehensive survey of the plant communities of natural, semi-natural and major artificial habitats in Britain.
- **The NVC survey methodology** – Basic technique of recognising boundaries and homogeneous strands, of locating sample quadrats and recording essential features of the composition and structure of the vegetation and its relationship to the habitat.
- **Using keys to identify plant communities** – Assembling field data into floristic tables, understanding the concepts of frequency and abundance to identify plant communities encountered in the field.
- **Understanding floristic tables of vegetation data** – Using these results to understand the basic style of phytosociological floristic tables; the concepts of communities and sub-communities; constant, associate, differential and preferential species.
- **Applications of the NVC for vegetation monitoring and management** - Using the data and results from the above in case studies to demonstrate descriptive and predictive applications of the NVC for vegetation monitoring, management and landscape design.

Several of the above sessions include practical field exercises involving data collection from a range of vegetation types with subsequent analysis, evaluation and interpretation.

**Assessment proportion**

100% Coursework

**LEC.425: Habitat Management**

**Terms Taught:** Lent Term Only  
**ECTS Credits:** 8 ECTS Credits  
**Pre-requisites:** This module is only available to Postgraduate Erasmus+ students from selected partners

**Module description**

This module aims to develop students’ understanding of the ecological principles of habitat management for biodiversity conservation, and how these can be applied for effective management of a range of priority habitat types in the UK. The module will also critically examine the construction of habitat management plans.

Students will gain experience in writing such a plan, in which conservation objectives are specified, threats identified, and management actions defined, taking into account the dynamic nature of ecosystems and conflicts of interest in land use. The course is taught by a mix of Lancaster staff and external lecturers who are directly involved in the application of ecological principles to habitat management. Much of the module is field-based, with excursions designed to exemplify the material presented in class.

**Educational aims**
On completion of this module a student should be able to:

- discuss the principles underlying the management of habitats for conservation
- describe how those principles can be applied in specific habitat types
- construct an effective conservation management plan

Outline syllabus

Lectures

The lecture material will be delivered by the module convener and several external contributors. Topics covered will include:

- Introduction - habitats and their conservation.
- Ecological principles of community assembly and succession, and their implications for habitat management.
- Conservation grazing and grassland management.
- Woodland and wetland management
- Conservation in the wider countryside – farmland and uplands

Excursions

There will be three excursions to sites of conservation interest, led by external contributors and the module convener.

Workshops

- Conservation Management Planning
- Ecological theory and its utility in management planning

Assessment proportion

- 50% Exam
- 50% Coursework

LEC.427: Wildlife Population Ecology

Terms Taught: Michaelmas Term Only
ECTS Credits: 8 ECTS Credits
Pre-requisites:

- This module is only available to Postgraduate Erasmus+ students from selected partners
- Some elementary mathematics, e.g. Secondary-level Maths or equivalent
- The exam will take place in January

Module description

The module takes a step-by-step approach to understanding wildlife population ecology, from the basics up to more complex interactions between species. The practical element of the module includes laboratory practicals and modelling assignments. After taking this module, students will appreciate the factors that contribute to population change, be able to construct life tables from birth and death data, and be able to apply quantitative models of population ecology to applied situations. Knowledge of these processes is vital for people working in the fields of conservation or management of natural
resources, such as harvesting of fish stocks, infectious disease control, and pest management, examples of which are scattered throughout the module.

Educational aims
The module will provide opportunities for students to develop generic skills in data collection, data management (using Excel), modelling (using free software) and presentation skills (using Powerpoint).

- Demonstrate a knowledge of basic population concepts, such as density-dependence, trade-offs, competition, predation, parasitism, etc.
- Generate a life table using demographic (birth and death) data.
- Demonstrate a knowledge of the fundamentals of population models, such as the Logistic and Lotka-Volterra models, and appreciate the use of population models in applied ecology

Outline syllabus

Lectures
- Introduction: what is wildlife population ecology and how do we study it?
- Population growth: from water fleas to blue whales
- Life tables I: quantifying survival and death rate - humans, sheep and fruit flies
- Life tables II: quantifying reproduction and birth rate - mussels, moose and mice
- Density-dependence I: scramble and contest competition - from beetles to grouse
- Density-dependence II: intra-specific competition and the route to chaos
- Interactions between species I: inter-specific competition - a tail of two squirrels
- Interactions between species II: predator-prey interactions - the lynx and the hare
- Pests, parasites and pathogens I: biological control, parasitoids and rats
- Pests, parasites and pathogens II:: rabies, foot-and-mouth and nematode worms

Practicals and Workshops
- Mark-release-recapture methods: laboratory practical
- Constructing life tables: data collection in the field and Excel practical
- Collecting population data: seed beetle density-dependence
- Population modelling: computer simulation practical using Populus
- Case studies in applied population ecology; presentation and workshop

Assessment proportion
50% Exam
50% Coursework

LEC.428: Wildlife Monitoring Techniques

Terms Taught: Michaelmas Term only
ECTS Credits: 8 ECTS Credits
Pre-requisites: This module is only available to Postgraduate Erasmus+ students from selected partners

Module description
Fieldwork skills are essential for ecologists and conservation biologist in both research and applied contexts. The module will teach a range of taxonomically-based field skills that will combine identification, sampling and other methods used to quantitatively monitor or assess populations. Components will include sessions on birds, mammals and invertebrates.
Educational aims
The module will provide students with a range of generic skills such as team working, report writing, critical observation and accurate data recording and interpretation.

On completion of this module a student will be able to:

- Demonstrate identification skills with the key taxa used on the module
- Identify appropriate sampling methods and apply them in the field
- Outline the fundamentals of sampling bias and distinguish how they are associated with different trapping, recording and sampling methods
- Explain how surveys are used at different scales.

Outline syllabus
The module will have five sections, each delivered with one or two lectures and including a field component in campus or away. Section content will be determined by staff skills and may vary from year to year in relation to availability, but examples of key components include:

- Bird census techniques. Identification of key groups, such as waders or woodland birds using plumage and song.
- Mammal census techniques. Small mammal trapping and marking, issues of sample bias, camera traps, indirect methods.
- Terrestrial Invertebrate sampling methods. Identification of key taxa to various levels of detail, trapping methods (e.g. pitfall, sweep netting, suction sampling).
- Measuring and representing species diversity (computer based session using EstimateS software).

Assessment proportions
100% Coursework

**LEC.430: Sustainable Soil Management**

**Terms Taught:** Lent Term Only  
**ECTS Credits:** 8 ECTS Credits  
**Pre-requisites:** This module is only available to Postgraduate Erasmus+ students from selected partners

Module description
The aim of this module is to introduce students to key issues surrounding the ability of the soil to produce crops, and the agricultural / economic consequences of failing to manage this resource properly. Most agricultural production is dependent on the soil not only to anchor plants, but to supply their hydraulic and nutritional needs. Furthermore, the rhizosphere (soil adjacent to the root surface) is a biological hotspot comprising micro-organisms that can directly or indirectly assist crop nutrient acquisition (rhizobia, mycorrhizae and plant growth promoting rhizobacteria) or cause disease. Increasingly, the soil is being recognised as a global resource to aid carbon sequestration (even in agricultural systems) and/or act as repository for waste derived from other industries.

Educational aims
On completion of this module a student should be able to:

- Apply soil hydraulic measurements to manage irrigation
- Understand the links between irrigation management and rootzone salinity
- Understand soil and plant-based crop nutrient management
- Evaluate the impacts of plant-microbe interactions on crop disease and nutrient status
- Appraise the impact of soil erosion on water body pollution
- Compare and contrast soil carbon stocks in agricultural / non-agricultural land and evaluate methods to raise soil carbon status

Outline syllabus

Lectures
- Soil management through the ages – Sustainability vs Disaster
- Irrigation management: Micrometeorology (FAO) Approach
- Irrigation management: Soil moisture sensors
- Irrigation management: Plant Stress Sensing
- Soil salinity (dryland / irrigation / waste water use)
- Fertiliser Management: Global issues
- Fertiliser Management: Farm-scale
- Organic Agriculture
- Soil Biology: Nutrient inputs (rhizobia / mycorrhizae)
- Soil Biology: Managing soilborne disease
- Soil Biology: Stimulating plant growth
- Managing Tillage and Compaction (No till systems)
- Soil Erosion and its prevention
- Soils and diffuse pollution
- Soil carbon sequestration

Practicals/Workshops
- How to make an effective scientific presentation
- Irrigation Scheduling using soil moisture & plant sensors
- Student presentations on a range of topics
- Visual Soils Assessment
- Visit to Broadbalk long-term experiment at Rothamsted Research

Assessment proportions
- 50% Exam
- 50% Coursework

LEC.432: Lake Ecology

Terms Taught: Michaelmas Term Only
ECTS Credits: 8 ECTS Credits
Pre-requisites:
- This module is only available to Postgraduate Erasmus+ students from selected partners
- Basic Ecology knowledge

Module description
This module aims to introduce the principles of lake ecology, an area with an acknowledged national lack of expertise. The course presents a holistic approach to the drivers and internal interactions that control water quality in lakes. The course will teach basic ecological principles, elucidated using lake ecology, introduce application of state-of-the-art techniques and provide essential background information for anyone dealing with EU Directives such as the Water Framework Directive in the future.

**Educational aims**

On successful completion of this module students will be able to:

- Identify the processes leading to nutrient inputs to lakes
- Demonstrate a knowledge of the effects of climate change on lakes
- Identify the factors controlling fish populations
- Understand the potential and limits of state-of-the-art techniques in lake ecology
- Appreciate the principles and uses of lake and catchment modelling

**Outline syllabus**

- Major drivers of lake ecology
- Overview to the structure and rationale of the course
- Introduction to lakes and their role in the landscape and global cycling
- Nutrient sources to lakes
- Lake physics & atmospheric drivers
- Changing lakes
- Sediments as a record of change
- Acidification & recovery
- Records of long-term change
- Methods of sampling lakes: field trip on Windermere
- Trophic interactions
- Zooplankton Fish biology
- Trophic interactions & alternative stable states
- Approaches to lake management
- Molecular methods in freshwater ecology
- Lake modelling
- Multiple stressors & the Water Framework Directive
- Use of high-frequency lake measurements to estimate physical factors & response to climate forcing Identification of plankton using microscopy & overview of modern techniques
- Methods of sampling lakes: field trip to Windermere (as above)
- Modelling lake responses to external forcing

**Assessment proportions**

- 20% Presentation (Assessed)
- 80% Report

**LEC.444: Catchment Hydrology and Assessment**

**Terms Taught:** Michaelmas Term Only
**ECTS Credits:** 8 ECTS Credits
**Pre-requisites:**

- This module is only available to Postgraduate Erasmus+ students from selected partners
Module convenor approval required to study this module

Module description

This module will cover:

- Hydrological processes operating at a catchment scale (including groundwater) with a focus on behaviour during hydrological extremes (flooding) within a UK context.
- Different types of hydrological data available, their uncertainties and basic principles and practical limitations of hydrometric methods applied in the UK. This will include rainfall, river flows and levels, soil moisture data, snow depth, groundwater level data.
- When hydrological estimation and modelling techniques need to be applied in the absence of local data.
- Different estimation methods, their strengths and weaknesses and range of applicability. This will cover data-driven methods such as design statistics based on multivariate analysis, as well as physically based approaches such as rainfall-runoff models.
- Application of estimation methods from first principles, comparison of results from different estimation methods and how to judge their appropriateness.
- Standard techniques for flood design studies, including the use and application of Flood Estimation Handbook (FEH) methodology approach to flood estimation.

Educational aims

On successful completion of this module students will be able to:

- Critically assess the main hydrological assessment and modelling techniques.
- Apply the FEH methodology to estimate flood risk.
- Use hydrological data and be able to deal with uncertainty in a real world situation.
- Deal with the absence of local data and know which estimation or modelling technique to choose.

Outline syllabus

The module brings together the latest methods and applied techniques in catchment hydrology and modelling. It will provide students with a solid foundation in the key concepts in hydrology, hydrometrics and basic hydrological processes operating at a catchment scale.

Teaching will focus on the practical application of skills and industry standard techniques in the context of the latest legislation, guidance and policy. The module will introduce commercially available models and allow students to critically apply these models in a range of worked case studies and examples.

The syllabus will cover:

- Hydrological processes.
- Hydrological data: collection, validation and manipulation.
- Hydrological Estimation 2: Rainfall runoff modelling techniques, including time series modelling and design event models.
- Rivers and rainfall as a hazard: how they need to be managed.

Assessment proportions
LEC.446: Integrated Systems for Sustainable Surface Water Management

Terms Taught: Summer Term Only
ECTS Credits: 8 ECTS Credits

Pre-requisites:
- This module is only available to Postgraduate Erasmus+ students from selected partners
- Module convenor approval required to study this module

Module description

This module will cover:
- Flood risk policy and legislative context and the need for flood risk assessment and FRM concepts
- What is required of an FRA and how to undertake one
- Standard techniques for estimating design flows in urban drainage systems
- Capabilities and application of the commercially available hydraulic models (e.g. Microdrainage, MUSIC) and relative advantages/disadvantages of each plus the data requirements
- Performance and key features of SuDS schemes, including surface water management train infiltration devices, swales and filter strips, permeable surfaces, ponds, basins and wetlands
- How to plan, design, construct and manage a SuDS scheme

Educational aims

On successful completion of this module students will be able to:
- Demonstrate the skills and knowledge required to undertake a Flood Risk Assessment
- Select and apply the best techniques and models for estimating design flows in urban drainage systems
- Efficiently plan, design, construct and manage SuDS schemes in accordance with the relevant legal and regulatory framework

Outline syllabus

Surface Water Management, SuDS and Flood Risk Assessment will provide students with an introduction to flood risk management in the context of UK policies, legislation and spatial planning. It will provide a grounding in flood risk related responsibilities and the key concepts in urban hydrology and sustainable drainage systems (SuDS). Practical application of SuDS in the context of the emerging guidance and legislation will be covered using case studies and examples of SuDS use in a variety of situations. The course will cover the design of SuDS systems, from outline design concepts to assessment of performance, estimation of flow and water quality loading.

The syllabus will delivered over 5 days of teaching supplemented by directed background/pre-reading.

The topics covered will include:

Day 1: Flood risk responsibilities and assessment
- the Flood Risk Management hierarchy
- planning policy and guidance (in England)
- UK legislation and the adoption of SuDS infrastructure
- Flood Risk Assessment
- concepts, methodologies, content and requirements
- worked case study

Day 2: Urban hydrology
- conceptual models of urban and rural runoff processes
- urban drainage runoff estimation techniques and limitations

Day 3: SuDS 1: Introduction
- key concepts, features and performance of SuDS systems
- practical application of SuDS in the context of the emerging guidance and legislation
  designing and planning SuDS
- obtaining consents

Day 4: SuDS 2: Design, construction and management
- water sensitive urban design
- surface water management train infiltration devices, swales and filter strips, permeable
  surfaces, ponds, basins and wetlands
- the CIRIA SuDS manual

Day 5: Hydraulic modelling for drainage and SuDS
- key concepts, methods and principles
- introduction to industry standard modelling software (Microdrainage, MUSIC, Infoworks
  CS/ICM) and strengths/weaknesses.
- case studies based on application of software (including a demo of WinDes and InfoWorks)
  and how to interpret the output

Assessment proportions
- 100% Coursework

LEC.447: Forecasting and Extreme Event Response

Terms Taught: Lent Term Only
ECTS Credits: 8 ECTS Credits
Pre-requisites:  
- This module is only available to Postgraduate Erasmus+ students from selected partners
- Module convenor approval required to study this module

Module description

This module will cover:
- The concepts, processes and components of flood forecasting (meteorological and
  hydrological) and their limitations including: Difference between simulation modelling and
  real time modelling: inputs that change over time and data assimilation (error correction);
  How these data flows and hierarchies are managed by a forecasting system; Predictive
models: for runoff generation, flow routing and hydrodynamic effects; Forecast rainfall inputs; Observed inputs of rainfall and river level/flow

- Different types of forecast, their strengths and weaknesses and suitability for different applications: Types of rainfall forecast: radar-based; numerical weather prediction; ensembles; Models to: predict runoff from rainfall; route flow; calculate water level;

Choosing an appropriate approach: data availability, catchment size, particular features (hydraulic and hydrological)

- Concepts of uncertainty, variability and accuracy in the context of both short term forecasting and long term climate predictions including: intrinsic model performance; model performance in the context of real time use, with time varying inputs; sensitivity of forecasts to changes in input data and the effect of data assimilation

- How flood forecasting is applied during extreme event response and management.

- How to interpret forecast results and what action to take

Educational aims

On successful completion of this module students will be able to:

- Critically assess commercially available models for real time flood forecasting and warning systems
- Critically assess the different types of forecast and be able to select the most appropriate model for different applications.
- Demonstrate understanding of how key agencies respond to extreme events in the UK

Outline syllabus

Forecasting and Extreme Event Response will provide students with an introduction to the latest hydrological and meteorological forecasting methods and a solid foundation in the concepts and processes involved in flow forecasting. It will introduce commercially available models for real time flood forecasting and warning systems and the concepts of variability, uncertainty and accuracy in short term forecasting. It will also introduce longer term climate prediction and the concepts and principals of uncertainty.

The course will include a simulated flood response exercise to enable students to understand how forecasting is applied and how uncertainty and variability in forecasting is dealt with in a real world context. This will utilise JBA’s Exercise Management System software which simulates hydrometric data, displaying rainfall and river level information, automatic alarms, radar imagery and exercise injects to test response to realistic flooding scenarios.

The syllabus will delivered over 5 days of teaching supplemented by directed background/pre-reading. The topics covered will include:

- Introduction to flood forecasting - the concepts, processes and components of flood forecasting (meteorological and hydrological) and concepts and principles of uncertainty in forecasting.
- Meteorological forecasting, rainfall run-off modelling concepts
- Real time flood forecasting methods and models – methods, applications, interpretation of results and limitations.
- Emergency planning and response to extreme events – simulated flood response exercise
- Long term climate forecasting - concepts, principles and implications for flood risk management

Assessment proportions
LEC.461: Data Analysis and Interpretation

Terms Taught: Lent Term Only
ECTS Credits: 8 ECTS Credits
Pre-requisites:
- This module is only available to Postgraduate Erasmus+ students from selected partners
- College-level Maths or equivalent

Educational aims

On completion of this module a student should be able to:

- design a sensible experiment or sampling scheme; perform and interpret an exploratory analysis of the data;
- decide on a sensible statistical analysis, including a choice between parametric and non-parametric testing, if relevant;
- perform that analysis in SPSS and interpret the results.
- realise when the analysis that they need to perform is beyond the materials covered in the course, and that they should therefore consult a statistician.

Outline syllabus

Lectures:
- Data types, summaries, graphs, statistics, parameters
- Estimation and testing
- Continuous response with categorical covariate
- Continuous response with continuous covariate
- Continuous response - the general linear model
- Categorical response with categorical covariate
- Sampling strategy and design of experiments
- Discrete binary response: logistic regression
- Discrete count response: log-linear regression
- Class test

Assessment proportions

- Coursework: 70%
- Module test: 30%

LEC.462: Data assimilation and integration

Terms Taught: Michaelmas Term Only
ECTS Credits: 8 ECTS Credits
Pre-requisites:
- This module is only available to Postgraduate Erasmus+ students from selected partners
- College-level Maths or equivalent
- Familiarity with Microsoft Excel

Module description
Making cutting-edge advances in the environmental sciences increasingly involves using a wide variety of data, collected using different sensors or instruments. Successful integration of such large and diverse data sets is facilitated by modern digital techniques, but must be underpinned by a rigorous scientific approach. This module aims to teach the fundamentals of accessing, annotating, analysing and interpreting heterogeneous digital data, whilst considering the potential errors and pitfalls involved. Everyday problems in data collection, both avoidable and unavoidable will be demonstrated, together with techniques that minimise their impact. Concepts such as identifying errors, dealing with missing data and data visualisation run throughout the module. Using a practical, hands-on approach, students develop data manipulation and visualisation skills with a variety of sources and software. Specialist software, such as ArcGIS and Matlab, will be introduced and an awareness of available tools to maximise the data utility will be developed. Datasets from across the environmental sciences will be used and the techniques and benefits of integrating different data streams illustrated.

**Educational aims**

On successful completion of this module students will be able to:

- Identify and overcome difficulties in the analysis of real and incomplete datasets
- Define metadata requirements for specific data types
- Assess the applicability of non-standard data sources
- Appropriately combine results from disparate datasets
- Discuss the strengths and weaknesses of a range of observational techniques
- Make appropriate use of visualisation tools

**Outline syllabus**

- Remote sensing and metadata (I): data availability, source system properties, measurement tradeoffs, analysis tools, processing multi/hyperspectral products, visualisation, data users
- Time series: tools and techniques for collection, analysis, visualisation and interpretation of time series data, issues requiring annotation, including non-stationarity, long range dependency, missing data
- Ground-based techniques: transducers, sensors and wireless sensor networks, cost versus accuracy, analysis and manipulation tools, geo-referencing and co-ordinate systems
- Databases, data mining and metadata (II): large data volumes and use of databases for storage, access and analysis; concepts behind data mining and metadata for disparate sources and observation types
- Historical and other data sources: historical data and non-conventional sources, accuracy and annotation issues, citizen-science and multi-scale integration

**Assessment proportions**

- 100% Coursework

**LEC.467: Catchment Protection (field course)**

**Terms Taught:** Lent and Summer Terms Only  
**ECTS Credits:** 8 ECTS Credits

**Pre-requisites:**

- This module is only available to Postgraduate Erasmus+ students from selected partners  
- Undergraduate Hydrology module or relevant work experience  
- Limited places available on this module

**Module description**
Catchments are increasingly understood to be complex and highly interconnected systems. This presents significant challenges for those who manage catchments, but also a range of novel and timely research opportunities. In this context, the module aims to provide students with understanding and practical experience of key research and management challenges facing the future management of catchments. The module will take the Eden catchment as a case study, and draw on the latest land and water management framework, derived from the Water Framework Directive, as a basis for discussion. After analysing this framework and identifying significant challenges, students will use a combination of field, laboratory and data analysis techniques to investigate research questions related to biophysical processes within catchments. These investigations will lead to an appreciation of the limits to current knowledge and the opportunities for future research.

Educational aims

On successful completion of this module students will be able to:

- analyse management frameworks relevant to sustainable water management, and identify and justify linked research and management challenges that emerge from these frameworks
- apply relevant field, laboratory and data analysis techniques to investigate these challenges, and describe the limitations and potential sources of error in these techniques
- critically appraise the current state of knowledge related to these challenges, and plan and justify future research activities to address gaps in knowledge

Outline syllabus

The module will be run as a series of linked project days. The content of the week will provide students with experience of:

- Interaction with Environment Agency/Water Company/Rivers Trust staff
- Links between land use and sustainable water management
- Assessing morphological conditions in rivers
- Water resources management and river discharge gauging
- Pollutant sources, pathways and impacts in receiving waters

Assessment proportions

- 100% Report

LEC.468: Modelling Environmental Processes

Terms Taught: Lent Term Only
ECTS Credits: 8 ECTS Credits
Pre-requisites:

- This module is only available to Postgraduate Erasmus+ students from selected partners
- Secondary-level Maths, Physics or equivalent, preferably College-level

Educational aims

On completion of this module students should be able to:

- Be able to individually undertake some simple modelling tasks and to analyse experimental data.
- Evaluate the principles and problems of computer aided modelling of environmental systems.
- Use contemporary industry standard numerical software to analyse and simulate environmental systems.

Outline syllabus

Lectures

- Throughout the course case studies and examples will be used to illustrate the material. Guest lecturers may be invited to contribute depending on availability.
- Scope of the course; Scientific methodology and modelling: Introduction to modelling as a process;
- Approaches to modelling: the role of data and perceptions in the modelling process; the problems of badly defined systems in the context of modelling environmental processes; problems of scale (temporal and spatial) and uncertainty in quantifying environmental systems.
- The concept of dynamic system. First order linear systems, with the Nicholson blowfly dynamics and the Aggregated Dead Zone (ADZ) model of dispersion in a river used as practical case studies. Transfer function models, steady state gain and time constant; serial, parallel and feedback connections of first order systems. Block diagram analysis.
- Muskingum-Cunge, Lag and Route, and General Transfer Function models of flow in a river system
- Second order linear systems with the predator-prey equations and a climate model as practical examples; natural frequency and damping ratio; higher order systems
- Linear vs. Nonlinear systems – basic introduction

Practicals/workshops

- Blowfly population modelling and simulation (Matlab/Simulink package)
- Aggregated Dead Zone (ADZ) modelling (Matlab/Simulink package)
- Predator-Prey population dynamics modelling and Gilliland Climate model
- Modelling river flow

Assessment proportions

- Coursework: 50%
- Exam: 50%

LEC.474: Geological Hazards

Terms Taught: Lent Term Only
ECTS Credits: 8 ECTS Credits
Pre-requisites: This module is only available to Postgraduate Erasmus+ students from selected partners

Module description

This module takes a broad look at geological hazards, covering contemporary events, to those that have shaped the Earth over geological time. Specific hazards addressed are: 1) earthquakes and tsunamis, 2) terrestrial and sub-marine landslides at a variety of differing scales, landslide triggering and principles of run-out, 3) volcanic hazards (eruption styles, plumes and pyroclastic flows) and 4) extreme events which civilisation has yet to witness. The module explores in depth the fundamental processes involved, and to what extent events can be predicted, and how they might be predicted.
Case histories of national and international disasters will be used to illustrate these hazards, with the inherent risks and potential mitigation measures discussed. More numerate skills are a key focus. The module develops a sense of human-place in the geological world, promoting an understanding of how the geological world impacts human society, and what can be done to limit that impact.

**Educational aims**

On completion of this module students will be able to:

- Describe and explain the concepts and foundations of geological hazards
- Apply and report on the methods of prediction and mitigation strategies of geological hazards
- Apply simple principles of analysis of slope failure using a variety of natural hazard situations
- Demonstrate and elaborate an understanding of geological processes responsible for the occurrence, recurrence and magnitude of hazards.
- Apply simple prediction scenarios of geological hazard occurrence, using geological data sets.
- Explore and gather date from landslide hazards in the field

**Outline syllabus**

**Lectures (2 hr):**

- How faults rupture and earthquake prediction
- Records of earthquakes, tsunamis, forecasting and hazard mapping
- Mitigation of earthquake & tsunami hazards
- Hazardous slopes and landslides and monitoring landslides
- Methods of landslide prediction
- Landslide risk mitigation, Landslide scaling and big landslides
- The rheology of landslides and volcanic flows
- Volcanic hazards & volcano monitoring
- Major & extreme events

**Practicals (3 hrs each):**

- Probabilistic forecasting of earthquakes
- Landslide prediction, based on inventory maps
- Hekla hazards
- Fieldtrip to assess the Falls Foot landslide and associated CW assessment

**Seminars (each 2hrs long):**

- Seismic Hazards.
- Application of landslide modelling.
- Volcanic risk

**Assessment proportions**

- 100% Coursework

**LEC.475: Data Analysis and Programming Skills**
Terms Taught: Summer Term Only
ECTS Credits: 8 ECTS Credits
Pre-requisites:

- This module is only available to Postgraduate Erasmus+ students from selected partners
- Basic numeracy skills required (e.g. Microsoft Excel)

Educational aims

On completion of the course the student should be able to:

- Design, modify, run and debug simple MATLAB programs; with a potential to use MATLAB as a comprehensive programming language
- Relate the concepts of serial, parallel and feedback connections to processes in the environment
- Formulate and use Simulink block diagram representations of simple environmental systems

Outline syllabus

This module consists of 24 2-hour interactive computer based workshops followed by on-demand drop-in sessions focused on dissertation projects

- Introduction; Aims of programming; Course aims; Basic definitions; The scientific method; Programming languages: development, common features, application areas
- Starting and using Matlab; scripts; toolboxes; search paths; variables and expressions; programmer's tools: editor/debugger; Program control: loops and nested loops
- The concept of a dynamic system, transfer function, ADZ model of dispersion in a river
- Introduction to graphical simulation systems: Simulink, block diagrams analysis
- More program control: Conditional statements. Functions and subroutines
- Simulink: second order system examples: Gilliland climate model; feedback connections
- First module test (appr. week 24)
- Matlab and general defaults handling; error handling. Files and data input and output;
- Computer graphics and visualisation with handle graphics
- Advanced visualisation (multivariable data) – continued from ENV201
- Program design, libraries; program development and debugging
- Summary and revision workshop. End of module test (appr. week 27)
- Case studies and dissertation data processing clinics

Assessment proportions

- 50% Coursework
- 50% Test

LEC.476: Volcanic Process Field Course

Terms Taught: Full Academic Year
ECTS Credits: 8 ECTS Credits
Pre-requisites: This module is only available to Postgraduate Erasmus+ students from selected partners

Module description

During an intensive week-long field course to an active volcanic region, students will explore many of the complex processes that take place both on the surface and beneath volcanoes. Through observing
features over scales varying from millimetres to kilometres, interpretations will be made of processes such as lava flow emplacement and explosive dynamics. Geological evidence for the volcano's constructional (eruptive) history as well as for destructive (collapse) events will be considered in terms of contemporary hazard analysis and mitigation efforts. This problem-based learning module covers two levels of problems: the higher-level problem (e.g. understanding the plumbing system of a complex volcano or the role of ‘volcano spreading’ or slope instability in the evolution of volcanoes) will occupy the entire module. Lower level problems will be solved at a number of key localities where students will be expected to unravel the processes involved.

Educational aims

On completion of this module students should be able to:

- Systematically observe and interpret field evidence for emplacement processes of volcanic rocks
- Describe the intrusive, effusive and explosive processes that take place during volcanic eruptions
- Recognise the role of regional tectonics, gravitational deformation of the volcano and major slope instabilities on the evolution of basaltic volcanoes
- Explain the problems of dealing with volcanic hazards on heavily populated active volcanoes

Assessment proportions

- 100% Coursework

LEC.477: Global Change and the Earth System

Terms Taught: Michaelmas Term Only
ECTS Credits: 8 ECTS Credits
Pre-requisites:

- This module is only available to Postgraduate Erasmus+ students from selected partners
- Previous knowledge of climate and weather; willingness to engage in some Maths, Chemistry and Physics
- The exam will take place in January

Module description

The module begins with the underlying concepts that shape the Earth’s climate (energy transfer, the greenhouse effect, atmosphere and ocean circulation) before considering natural and human drivers of climate change, such as volcanoes, solar output, greenhouse gases and land use change. In addition, it will also introduce the computer models and global observation networks that scientists use to understand the Earth system as well as the IPCC process.

Educational aims

On completion of this module a student will be able to:

- Explain the major parts of the Earth system and how they interact
- Describe what an Earth system model is and evaluate their strengths and weaknesses
- Summarise the components of the global energy balance and greenhouse effect
- Identify and describe the major human and natural causes of global climate change

Outline syllabus
Overall, the lectures will cover:

- Science fundamentals of climate and Earth system science
- Atmospheric composition and climate
- Earth system components and feedbacks
- Earth system models and observation platforms

Other:

- Radiative balance of the atmosphere at Hazelrigg Field Station
- Workshop on climate interactions and feedbacks Fieldtrip to Manchester Museum of Science and Industry
- Student presentations

Assessment proportions

- 50% Exam
- 50% Coursework

**LEC.478: Physical Volcanology**

**Terms Taught:** Full Academic year  
**ECTS Credits:** 8 ECTS Credits  
**Pre-requisites:**

- This module is only available to Postgraduate Erasmus+ students from selected partners  
- No formal pre-requisites, but Mathematics at College level recommended

**Module description**

This module aims to provide a broad understanding of volcanoes and volcanic systems, and is based on an understanding of the properties and behaviour of volcanic materials gained through laboratory, theoretical and field study. The interaction of volcanic processes with the biosphere, atmosphere and hydrosphere are discussed, together with the hazard presented to current human activity.

**Educational aims**

On successful completion of this module students will be able to:

- Recognise different types of volcanic activity.
- Understand why volcanoes behave in different ways.
- Appreciate the role volcanoes have played in the biosphere, atmosphere and hydrosphere over geological time.
- Be able to quantify volcanic processes and risk.
- Recognise volcanism as present on many solar-system bodies.

**Outline syllabus**

- History of volcanology, introduction to volcanic terminology, VEI, structure of Earth, what volcanoes represent (gravity driven planetary cooling/degassing mechanism, source of primitive atmosphere), study approaches (fieldwork, numerical simulation, laboratory characterization and models).
- Physics and chemistry of magmas. Volatiles (what are they, where do they come from, how do they behave), phase diagrams of temperature, pressure and composition (heating,
cooling and degassing), rheology (temperature, pressure, chemical composition, phases, viscoelasticity),

- Volcanism from below. Where does molten rock come from (mantle melting, interaction with crust). How does heat get transported (advection, convection, conduction, diapirs, dikes, crustal plumbing and storage systems).
- Volcanism from above: effusive (lavas), extrusive (domes) and explosive (significant atmospheric interaction) eruption modes.
- Volcanic hazards, risk assessment and monitoring.
- Volcanoes, climate change and mass extinction (end Permian example).
- Volcanic systems on other solar-system bodies.

Assessment proportions

- 100% Essay(s)

LEC.479: Environmental Sampling and Analysis for Trace Organics

Terms Taught: Lent Term Only
ECTS Credits: 8 ECTS Credits
Pre-requisites:

- This module is only available to Postgraduate Erasmus+ students from selected partners
- College level Mathematics and Chemistry

Module description

This module is designed to provide both theoretical and importantly ‘hands-on’ practical experience of analytical chemistry techniques used to obtain environmental data. It will help to prepare students for their MSc dissertation research or for a professional career in research, management or policy where analytical techniques are used or data from these techniques need to be interpreted. Particular attention is paid to the entire sampling-analytical system and the fundamentals of common analytical techniques in environmental analysis like mass spectrometry and chromatography. Students will also consider what steps/techniques are required to ensure the high quality of the analytical results allowing statistical interpretation etc. Lectures on principles of organic analytical chemistry are complemented with practical laboratory exercises in small groups working in the LEC research laboratories. The students will be given hands-on opportunities familiarize themselves with both classical and instrumental methods employed routine and research analytical chemistry.

Educational aims

On completion of this module students will be able to:

- demonstrate and summarize topics related to environmental organic chemistry and environmental chemical fate
- describe the theory of sampling techniques, preparation for environmental analysis and the principles and the operation of some of the main environmental analytical techniques
- be aware of current issues and trends in environmental analytical chemistry

Outline syllabus

Basics of Environmental Sampling and Analysis:

- Concentration units, accuracy, precision, calibration curves, etc.
- Essential Environmental statistics
Knowledge of Environmental regulations

Environmental Sampling Techniques
- Environmental Sampling design
- Sampling matrices and analytes
- Technique for sampling various media: practical approaches and tips

Methodology and quality assurance/quality control of environmental analysis.
- Selection of analytical methods based on target compounds
- Field quality assurance/quality control
- Analytical quality assurance/quality control

Fundamentals of sampling preparation for environmental analysis (lectures+practicals)
- Overview of sample preparation
- Extraction of organic chemicals from liquid of solid matrices (or samples)
- Post-extraction ‘clean-up’ of extracts
- Sampling preparation for instrumental analysis

Chromatographic methods for environmental Analysis (lectures+practicals)
- Introduction to low and high resolution chromatography
- Instruments for chromatographic analysis (GC, LC, HPLC)
- Common detectors used in analytical chemistry in mass spectrometry
- Applications of chromatographic methods in environmental analysis
- Internal standards, calibration curves and sample quantification

Assessment proportions
- 50% Exam
- 15% Essay(s)
- 35% Report

LEC.500: Dissertation Project (Exchange students)

Terms Taught: Michaelmas, Lent or Summer terms
ECTS Credits: 15 ECTS Credits
Pre-requisites:
- This module is only available to Postgraduate Erasmus+ students from selected partners
- Module Convenor approval required to undertake dissertation project

Module description
100% on a final 5,000 word report. An academic supervisor is appointed to each project providing guidance on the definition of the research question, identification of the appropriate methodology and feedback on the Progress Report, Poster and draft sections of the thesis. The Progress Report and Posters are formative assessments because the student requires feedback but invariably the project is still evolving to such an extent that this feedback should not count toward their final mark for this element. The summative assessment is on the 5,000 word dissertation where it belongs.

Educational aims
On successful completion of this module students will be able to develop specialised, master level knowledge and experience in a specific areas of research.