SDC

The university partnership
Denmark – China

Master's Programme in

Water and Environment

Academic regulations

2017

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Legal Frame

Students enrolled in this programme are admitted as full-time students at University of Chinese Academy of Sciences.

The Academic regulations applies to students enrolled in the programme from 2017.

This master's programme is established within the framework of the following:

- Partnership Agreement between Graduate University of Chinese Academy of Sciences and University of Copenhagen (KU), Aarhus University (AU), University of Southern Denmark (SDU), Aalborg University (AAU), Roskilde University (RUC), Technical University of Denmark (DTU), Copenhagen Business School (CBS), IT University of Copenhagen (ITU), on the establishment of the Sino-Danish Centre for Education and Research, Graduate University of Chinese Academy of Sciences, signed on 12 April 2010
- Agreement between Graduate University of Chinese Academy of Sciences (GUCAS) and University of Copenhagen (KU), Aarhus University (AU), University of Southern Denmark (SDU), Aalborg University (AAU), Roskilde University (RUC), Technical University of Denmark (DTU), Copenhagen Business School (CBS), IT University of Copenhagen (ITU) concerning Master's Programmes at Sino-Danish Centre for Education and Research, Graduate University of Chinese Academy of Sciences, signed on 29 August 2011
- Agreement between Graduate University of Chinese Academy of Sciences and University of Copenhagen concerning Provision of the Master's Programme in Water and Environment at Sino-Danish Centre for Education and Research (SDC), Graduate University of Chinese Academy of Sciences, signed on 29 August 2011.

Students must observe and act accordingly to the following rules issued by the SDC Directors:

- Courses and Exams
- Exam regulations
- Thesis regulations 10 steps
- Avoid cheating on exams
- Student complaints

Students must also observe and act accordingly to Rules and Regulations for UCAS International Students.

Title and degree

The degree awarded by University of Copenhagen is Master of Science in Water and Environment.
The degree awarded by University of Chinese Academy of Sciences is Master of Environmental Science

Duration

The master's programme has a duration of two academic years equivalent to 120 ECTS points (European Credit Transfer System). 60 ECTS points correspond to one year of full-time studies.

When choosing thesis period *Danish/International students* must be aware of UCAS' 4 years limit for awarding diploma. UCAS' degree application procedure ***STEP 10 CN*** (see Thesis regulations 10 steps) has to be completed within 4 years from enrolment. This period includes leave of absence.

Admission requirements

To be admitted to the MSc programme in Water and Environment, you must have:

- A successfully completed bachelor's degree (or equivalent) or higher in a natural science field such as Agricultural Science, Biology, Environmental Sciences, Engineering or Natural Resources. The Bachelor's degree must as a minimum include basic courses in mathematics, chemistry, biology and statistics.
- High-level English language proficiency.

The following BSc programmes give direct access to the MSc programme in Water and Environment:

- BSc in Natural Resources, specialisation in Environmental Science
- BSc in Biology
- BSc in Biotechnology
- BSc in Agriculture, Food and the Environment, specialisation in Agriculture and the Environment
- BSc in Geology
- BSc in Environmental Technology

General programme regulations

The language of instruction in the SDC Master' s programmes is English. Teaching, supervision and assessment will be carried out in English.

Students will be graded according to both the Chinese and the Danish grading scale. However, for the Master' s Thesis, students will be graded according to the Chinese 4-point scale. See Thesis regulations 10 steps.

Leave of absence can be granted to students on the grounds of becoming a parent, illness, military service or exceptional circumstances.

Students who wish to complete degree programme elements at another university or institution of higher education in Denmark, China or abroad as part of their degree programme may apply the Teaching Committee for advance approval of transfer credit for planned subject elements.

Students can maximum be granted 30 ECTS credit transfer.

Either the Teaching Committee or the SDC Directors may grant exemptions to the Academic regulations or other SDC rules. Application for exemption shall be submitted to the SDC Secretariat.

DK	12	10	7	4	02	00	-3
CN	100-95	94-90	89-76	75-61	60	59-40	39-0

Qualifications

Purpose

The objective of the programme is to train graduates with the required expertise, quantitative understanding and solution-oriented skills to understand and research integrated use and safe management of world water resources at a high academic level.

The graduates possess a strong combination of knowledge within natural science, management and socioeconomic aspects and a profound insight into the sustainable use of water and management. This combination aims at employment within research, administration, consultancy, and project management requiring profound academic insight.

Qualification Profile

During the programme, the students must acquire the following knowledge, skills and competences within the disciplines of the programme:

Knowledge

- Describe and demonstrate general knowledge of hydrology; hydrogeology; biogeochemistry; freshwater ecology; sustainable land use; restoration ecology and technology; modelling; statistics, data treatment and legislation and management
- Demonstrate knowledge of the fundamental principles and processes of the fate of contaminants in soil, water and air
- Quantify and describe key elements and processes, which are relevant for water resources and water quality management
- Reflect critically on international original specialist literature on water resources, hydrology, modelling, environmental chemistry, ecotoxicology, management and governance
- Describe and quantify the processes in soils, plants, animals etc. affecting carbon, nitrogen, phosphorus and pollutants cycling and greenhouse gas emissions from ecosystems and the measures for reducing greenhouse gases
- Describe and demonstrate general knowledge of the governing processes of the hydrologic cycle and formulate hydrological processes in mathematical terms
- Describe the properties and discuss the fate of a given contaminant in the environment
- Explain the fundamental ecotoxicological principles
- Understand experimental design and choose proper statistical models
- Analyse and apply international scientific literature on water resources aspects

Skills

- Ability to acquire knowledge of the use of equipment and analysis methods for environmental monitoring, ecotoxicity and quantification of contaminants
- Apply and demonstrate the use of a catchment hydrology and nutrient transport and surface water quality model
- Quantify the effects of various management strategies on water resources and surface water quality
- Set up mass and energy flows and quantify substance transformations, in particular the transformation of pollutants, using modern models and be able to validate model predictions
- Be able to integrate components of the hydrological cycle in a water resource assessment
- Conduct a scientific evaluation of the environmental and ecotoxicological effects of a contaminant
- Use the most important databases on chemical, microbiological and toxicological substances in relation to pollutants
- Evaluate the critical variables and methods that may be used to quantify a contaminant's distribution, transformation rates, transport and biological effect in the soil-water-air system
- Identify relevant tools and models that can quantify interactions between climate forcings, land use, water resources and surface water quality
- Ability to apply theory and methodological approaches to solve simple problems in the field as well as propose solutions to more complex problems
- Solve problems related to water resources development and transport phenomena
- Apply basic scientific principles in connection with the analysis of large data volumes
- Assess, discuss and propose how various management scenarios may influence water resources and water quality
- Communicate complex information to a wide range of national as well as international audiences using modern and appropriate information and communication tools

Competences

- Collect, combine, handle and evaluate complex data and information from different sources
- Diagnose the processes critical for the paths of important contaminants and select the tools for analysis and evaluation of the critical paths

- Explore complex relationships between the basic scientific aspects of environmental problems and the economic, social and political obstacles that have to be overcome in order to implement solutions on a national and international scale
- Handle and solve complex environmental issues in specific work situations or in relation to research
- Cooperate with fellow students on preparation and completion of a written report
- Assess the impact of new technology on current values and ethics and take this into account when involved in research, risk and uncertainty assessments or the introduction of new technologies
- Work independently and effectively on an individual basis, as well as in project teams and interdisciplinary environments, cooperate with relevant partners, discuss solutions and reach consensus
- Engage in national as well as international research
- Apply life-long learning as a principle to independently assess and structure learning processes and assume responsibility for continuous academic development

Structure

Semester	Course / Programme element	Exam	Grading	Examiners	ECTS
1	Hydrology, Freshwater Ecology and Biogeochemistry	Assignments and written	7/100 scale	Internal	15
	Pollutants and Pollution Control	Assignments, oral and written	7/100 scale	Internal	15
2	Statistics, Modelling and Global Change	Written	7/100 scale	Internal	15
	Integrated Water Management and Legislation	Assignments and written	7/100 scale	Internal	15
3	Thesis	Assignment and oral	7/4 scale	External	60
4					

The programme contains the following elements

All programme elements are mandatory.

The first two semesters provide the common core of the programme. In the 3rd and 4th semester, the student will write the thesis.

Course and Exam Descriptions

Hydrology, Freshwater Ecology and Biogeochemistry
15 ECTS

CONTENT

The overall aim of the course is to give a general overview of freshwater systems, based on hydrology; i.e. input and output of water, and processes related to transport; ecological mechanisms and interactions along the soil-water continuum and in freshwater systems, including biogeochemical cycles and interactions between sediment/soil and water.

The Hydrology sub-module provides an introduction to the different components of the hydrological cycle, their governing physical equations, the measurements and sensors used and relevant modeling approaches used to estimate those components, with emphasis on novel data sources. The course is structured around three main topics:

(1) Land- atmosphere interactions with the study of atmospheric water and precipitation, evaporation and actual evapotranspiration.
(2) Surface processes describing soil water infiltration, rainfall runoff processes and river routing.
(3) Hydrogeology focused on groundwater recharge, evaluation of groundwater resources and effect of abstractions on groundwater level and stream discharge.

The aim of the Freshwater Ecology sub-module is to introduce the student to the fundamental conditions of freshwater ecosystems; the use of resources such as nutrients, carbon and light, the complexity and dynamics of the freshwater system including physical, chemical and biological mechanisms and interactions controlling flora and fauna dynamics (the biological structure) and the important role of macrophytes in the systems. There will be focus on interactions in food chains, impacts of human activity, and interaction with the catchment by including the functional role of wetlands as buffer zones.

The aim of the Biogeochemistry sub-module is to present the biogeochemical cycles of the most important elements (C, N, O, S, P, certain metal cations), describing the sources, pools and flows including transformations of matter in the different spheres with integration on a global scale. The significance of the most important processes such as oxidation/reduction, weathering/precipitation and sorption/desorption processes including their microbial and inorganic contributions will be demonstrated. Particular focus will be given to interaction between the sediment and water in lakes and how the internal loading of phosphorus impacts the overall water quality. It will be discussed to

what extent the global cycles are being perturbed by human activities, and how global climate change causes perturbation of the global element cycles of C, N, P and S.

The Hydrology sub-module consists of lectures in combination with practical tutorials and assignments with real-world hydrological problems. Notes, lecture slides and supporting material will be provided.

The Freshwater Ecology and the Biogeochemistry sub-modules consist of lectures in combination with colloquiums including student presentations and discussions and calculation exercises. Besides field sampling will be demonstrated and exercises will be performed to test the methodologies learned.

Lectures will be based on a combination of textbooks and peer reviewed manuscripts pin-pointed as key papers in respect to the course content. Lectures will be combined with colloquiums, where students will present the content of relevant papers followed by a discussion on the content and its conclusions. Exercises will be a combination of practical and theoretical exercises. Practical exercises will have focus on sampling techniques, sample handling and handling in the laboratory; basic elements in order to get high quality data. The practical part will be performed during a 1 day excursion. The theoretical exercises will run parallel with the relevant topics presented in the lectures, and will include calculations on physical properties in streams, calculations on nutrient dynamics and practical data analysis in freshwater and terrestrial systems.

LEARNING OBJECTIVES

The objectives of the course are:

- To learn how the hydrological cycle works and of what components it consists, to learn physical hydrological equations and how measurements and sensors are relevant in modeling approaches used to estimate components in the hydrological cycle.
- To learn how freshwater systems function in respect to biological, physical and chemical aspects, to get insight into how microbial loops are part of freshwater systems, and to understand how freshwater systems are affected by human impact and catchments.
- To learn how elements distribute between the different spheres, to get an overview of which biogeochemical processes govern distribution, transfers and transformations of the elements, to describe the interactions between the cycles of the different most important elements in different ecosystems, and to learn how human activities perturb the biogeochemical cycles on a global scale.

Knowledge

After completing the course, the student should have knowledge on:

- The governing processes of the hydrologic cycle including exchange processes between atmosphere and soil surface, surface water runoff, and groundwater flow.
- Describing hydrological processes in mathematical terms and the limitations of hydrological data.
- Analysing problems related to water resources development including groundwater and surface water.
- Understanding mechanisms in freshwater systems, in respect to biological interactions, the impact of nutrient and to nutrient dynamics.
- Understanding how and why freshwater systems are affected by changes in the use of catchments.
- Having knowledge on how human impact can affect both physical and biological elements in freshwater systems.
- The cycling of nutrients between sediment and water in lakes, especially regarding the retention and biogeochemical transformation of phosphorus.
- The biogeochemical cycles of major biologically active elements and the main biological and abiotic processes governing the distribution and flows of elements between the different spheres.
- Methods to quantify biogeochemical processes at different scales.
- How human activities perturb the cycling of key elements at both local and global scales, and how systems react to perturbations.

Skills

After completing the course, the student should be able to:

- describe the governing processes of the hydrologic cycle including exchange processes between atmosphere and soil surface, surface water runoff, and groundwater flow.
- formulate hydrological processes in mathematical terms and work with and recognize the limitations of hydrological data.
- demonstrate and give an overview of the complexity in freshwater ecosystems, especially the importance of submerged macrophytes to the other biological elements; applying how human activity can affect this complexity; demonstrate the general principles of freshwater chemistry, particular in respect to nutrients (nitrogen and phosphorus).
- understanding the cycling of nutrients in lakes and how this interacts with the biological structure.
- delineate the major biogeochemical cycles from molecular to global scales and identify process variables critical to the cycles.
- calculate distribution of elements and flows at ecosystem scales based on the processes taking place, and to take interactions between elements into account.

Competences

After completing the course, the student should have the competences to be able to:

- extract useful knowledge from primary literature while maintaining a critical view on same literature.
- interpret data from different sources. Extract the most important information from these data.
- present methods, data and conclusions from the curriculum, to fellow students.
- make the relevant hypothesis and suggest a methodology which can be used to respond to the hypotheses, when presented with a given problem.

EXAMINATION

The exam comprises

- three assignments during the Hydrology part
- a 2-hour written midterm exam following the Hydrology part;
- colloquiums with presentations for fellow students in the Freshwater Ecology part.
- a 4-hour written exam covering Freshwater Ecology and Biogeochemistry.

There will be one common grade for Module 1, where assignments and colloquiums count 30 % and the written examinations 70 %.

The assignments in Hydrology are individual or group assignments with individual evaluation. Each group consists of 2-3 members and the topics are fixed. The assignments are focused on the main learning objectives in Hydrology:

- Water balance; effect of deforestation on catchment water balance in a specific study site (including data collection during a two-day field trip) – duration 7 days (Graded)
- Ecohydrological modeling using VIP model – duration 13 days (Graded)
- Groundwater flow – duration 7 days (Graded with pass/fail).

For all assignments, all necessary information and calculations must be included in the assignment and handed in as a pdf file. Assignments and participation in the field trip are mandatory for attending the written sub-examination (see below).

The written sub-examination of the sub-module Hydrology is a 2-hour written presence examination based on short questions all related to the topics and learning objectives of the course. Questions require short text (1-3 lines) answers and calculations. All aids including laptop/tablet are allowed, but internet access is prohibited. Phones and communication during the examination is prohibited.

The assessment is made by the teachers.

In Freshwater Ecology colloquiums are held during the course. Colloquiums are a group based (2-3 members) presentation of an appointed peer reviewed paper. The group is expected to read, discuss and present the content for their fellow students, followed by a general discussion of the paper in class. Participation in colloquiums, fieldtrips and laboratory exercises are mandatory for attending the final written exam.

There are no colloquiums in the Biogeochemistry sub-module.

The written examination of the two sub-modules Freshwater Ecology and Biogeochemistry is a 4-hour written presence examination based on short questions all related to the topics and learning objectives of the course. Questions require short text (1-3 lines) answers and/or small calculations. All aids including laptop/tablet are allowed, but internet access is prohibited. Phones and communication during the examination is prohibited.

Individual assessment is made by the teachers.

RE-EXAMINATION

A 6-hour written presence examination based on questions related to all topics and learning objectives of Hydrology, Freshwater Ecology and Biogeochemistry. Questions are requiring short text (1-3 lines) answers and calculations. All aids including laptop/tablet are allowed, but internet access is prohibited. Phones and communication during the examination is prohibited.

GRADING

One final grade is given according to the Danish 7 step and the Chinese 100 points grading scales.

Pollutants and Pollution Control

15 ECTS

CONTENT

The aim of the course is to introduce the fate and processes of the contaminants, the current status of the soil and water pollution and the techniques for the pollution control and water treatments.

The aim of the first sub-module Pollutants – fate and processes is to give a fundamental introduction to the abiotic and microbial processes as well as pollutant physicochemical properties that govern the fate of pollutants. Physicochemical properties, sources, distribution, speciation, and transformation processes and selected microbial effects of natural and anthropogenic contaminants in soil and water are introduced.

The sub-module includes the following topics:

- Pollutants and their retention in soil: Pollutant properties, soil and water characteristics, sorbent characteristics and sorption reactions, redox transformations, soil solution composition, metal speciation, hydrolysis and photo degradation, degradation kinetics
- Simple methods for equilibrium computation and QSAR estimations
- Environmental microbiology including microbial ecology, metal transformations and effects, degradation pathways and kinetics, antibiotic resistance

The teaching comprises sessions of combined lectures and theoretical exercises involving discussions, calculations and small computer-exercises.

The objective of the sub-module Pollution Control and Water Treatment is to train the students in basic principles for the treatment of wastewater in conventional wastewater treatment systems and nature-based and environmentally friendly technologies for wastewater treatment and management.

This sub-module will provide the students with:

- understanding of processes of importance for the transformation and removal of selected pollutants from wastewater and contaminated surface water.
- training in the use of process modelling in activated sludge systems.
- tools to prepare conceptual designs of treatment systems capable of achieving specific treatment goals.

The teaching comprises lectures, process modelling exercises, preparation using reading material, student assignments done using peer-coaching groups; oral presentation (in group).

The overall objective of the last sub-module Soil and Groundwater Pollution is to give the student a platform for a professional assessment of soil and groundwater contamination from diffuse sources and contaminated sites, and remediation of contaminated sites.

Content and Perspective:

- Sources to soil and groundwater pollution.
- Transport, mixing, attenuation and degradation of pollutants in soil and groundwater.
- Diffuse source (arsenic, pesticides) contamination in aquifers.
- Soil and groundwater chemistry of heavy metals, creosote compounds, petroleum hydrocarbons related to contaminated sites.
- In situ and ex-situ technologies for remediation of polluted soil and groundwater.

The teaching comprises lectures, theoretical and practical exercises, hands-on tutorials on groundwater transport codes, article reading and group presentations.

LEARNING OBJECTIVES

When the sub-module Pollutants – Fate and Processes is finished, the student should be able to:

Knowledge

- explain the fundamental principles and processes that influence the fate of pollutants in soil and water.
- understand the soil and water properties that are critical to the fate of pollutants.
- obtain insight into models that can be used to perform metal speciation, equilibrium computation and to predict properties of organic pollutants.
- describe the physicochemical properties of a given pollutant in the environment, and how these properties affect the fate.
- describe the variables and processes that are critical for the sensitivity of the ecosystem to natural and anthropogenic stress.
- quantify a specific pollutant speciation, availability, mobility, and transformation by use of standard calculations.

Skills

- compute and evaluate physicochemical properties, speciation, and fate of natural and anthropogenic pollutants from environmental data.
- identify and evaluate the critical variables and methods that may be used to quantify pollutant sources, distribution, retention, transformation and degradation rates, and metabolilte formation in soil and water.
- critically evaluate scientific papers within pollutant chemistry and microbiology.

Competences

- combine information from literature/databases predictions, model calculations and general knowledge on pollutant properties, soil and water properties as a basis for exposure calculations.

Following the successful completion of the sub-module Pollution control and water treatment, the students will be able to:

Knowledge

- describe the main inorganic and organic pollutants in domestic wastewater and their influence on choice of treatment processes, and how they are analysed.
- summarise typical effluent standards.
- describe the main degradation and removal processes of suspended solids, organic matter and nutrients in activated sludge systems.
- describe the main processes for the treatment of industrial wastewaters.
- describe the main processes for sludge treatment and disposal.
- describe different types of ecotechnologies used for the treatment of domestic wastewater and agricultural runoff with focus on wetland systems.
- describe and characterize the key processes of importance for nutrient removal in wetlands.
- describe the functional roles of different types of plants in wetlands.
- characterise the hydraulics of treatment wetland systems.

Skills

- evaluate removal processes of organic matter and nutrients in activated sludge, constructed wetland systems.
- prepare conceptual designs of activated sludge and constructed wetland systems based on loading characteristics, site-conditions and effluent standards.
- compute the expected removal and effluent quality of activated sludge and wetland systems using accepted biokinetics models.

Competences

- combine information from different sources to propose a suitable wastewater/sludge treatment process based on wastewater characteristics and discharge requirement

Following the successful completion of the sub-module Soil and Groundwater Pollution the students will be able to:

Knowledge

- acquire a good understanding of soil and groundwater pollution.
- distinguish between diffuse pollution sources and contaminated sites and identify important contaminants.
- demonstrate conceptual understanding of hydrogeological and hydrogeochemical properties controlling contamination in soil and groundwater.
- describe important elements in risk assessment of contaminated sites.
- calculate and select parameter values (for instance sorption, hydrodynamic dispersion or degradation constants) which govern transport and fate of contaminants and relate results to risk assessment.
- identify and acquire basic hands-on experience with relevant computer based evaluation tools for flow and transport in aquifers.
- demonstrate overview over selected remediation technologies and understanding of their strengths and weaknesses.
- identify design parameters for selected remediation technologies based on conceptual process understanding.
- select the most suitable remediation technologies in relation to actual hydrogeological, geochemical and compound data.

Skills

- identify and apply the theory on contaminant properties, subsurface hydrology and hydrogeochemistry to examine and solve subsurface pollution problems.
- acquire a sound understanding of methods for site investigation and risk assessment at contaminated sites.
- identify and critically evaluate different soil and groundwater remediation technologies.

Competences

- General knowledge and understanding of contaminants fate and transport in the subsurface.
- Quantification of key hydrogeological, hydro geochemical and contaminant properties controlling contaminant transport.
- Understanding soil and groundwater remediation technologies and their applicability.
- Hands-on experience with conservative and reactive transport analytical and numerical codes.

EXAMINATION

The exam comprises

- three assignments during the course, where the students are required to submit at least two out of the three assignments and the two best of these assignments will each account for 15% of the grade.
- a written examination which accounts for 70 % of the grade.

The assignments are group assignments with individual oral presentation and questions. Each group consists of 3-4 members, and the topics are fixed.

The assignments are focused on the three main learning objectives of the sub-module Pollution Control and Water Treatment:

- Evaluate removal processes of organic matter and nutrients in activated sludge, constructed wetland systems.
- Prepare conceptual designs of activated sludge and constructed wetland systems based on loading characteristics, site-conditions and effluent standards.
- Compute the expected removal and effluent quality of activated sludge and wetland systems using accepted biokinetics models.

The students will present their findings orally and will be evaluated individually on this basis.

The assignments are:

- Engineering Wetland Systems
  Number of standard pages 12. Duration 6 days.
- Activated Sludge Processes
  Number of standard pages 17. Duration 4 days.
- Treatment processes
  Number of standard pages 10. Duration 4 days.

The written examination is a 3-hour written presence examination based on short questions related to the learning objectives, requiring short text answers and/or calculations. The questions cover the first sub-module Pollutants – Fate and Processes and the last sub-module Soil and Groundwater Pollution.

All aid incl. PC/tablet is allowed but internet access is prohibited.

The assessment is made by the teachers.

RE-EXAMINATION

4-hour written presence examination based on short questions related to the learning objectives, requiring short text answers and/or calculations. The questions cover the full module.

All aid incl. PC/tablet is allowed, but internet access is prohibited.

The assessment is made by the teachers.

GRADING

One final grade is given according to the Danish 7 step and the Chinese 100 points grading scales.

Statistics, Modelling and Global Change

15 ECTS

CONTENT

The objective of this course is to provide students with knowledge and tools to:

- understand and apply frequently used data analysis and statistics, which are necessary for their future work and research.
- understand and - through simulation models - quantify the interactions between climate forcing, land use, water resources and surface water quality.
- understand and quantify the processes of carbon and nitrogen flows in ecosystems (soils, plant communities and animals) and the resulting effects on greenhouse gas emissions.
- understand and apply GIS-based geospatial analysis for geospatial ecology and environmental geographical analysis at small to large spatial scales.

The course comprises a combination of out-of-class and in-class activities, including lectures, theoretical exercises and computer exercises. Computer exercises will be based on topics and case-studies presented at lectures.

LEARNING OBJECTIVES

After completion of the course the students should be able to

Knowledge

- understand the logic underlying commonly used statistical procedures, including regression models and analysis of variance
- identify relevant tools and models that can quantify how climate forcing (e.g., CO2, temperature, precipitation and irradiance) and land use influence water resource availability and surface water quality
- describe and explain the effects of climate variability and climate change on biodiversity and ecosystem functioning at different spatial scales (ranging from plant, ecosystem to global)
- describe and explain theory from geospatial ecology, and to apply it to global change problems
- describe and explain general methodological approaches and their problems in GIS-based geospatial data handling and modelling, as well as spatial statistical analysis

Skills

- apply frequently used data manipulation and statistical procedures, such as regression models, analysis of variance and graphical presentations
- apply and demonstrate the use of eco-hydrological models for river basin water resources management and scenario simulations
- be able to quantify measures for reducing greenhouse gas emissions from agriculture and forestry with respect to efficiency, including the accounting of possible side effects on the environment and ecosystem services
- apply tools and statistical analysis for GIS-based geospatial data handling relating to geospatial ecology and environmental geography

Competences

- collect, handle and analyse datasets at small to large spatial and temporal (time) scales, in relation to describing and understanding river basin dynamics, geospatial ecology and global changes.
- asses, discuss and propose how various management scenarios may influence water resources and water quality.
- describe and discuss measures for adapting managed and natural ecosystems to climate change and describe the possible consequences of such measures.
- asses and discuss the methodological approaches used in GIS-based geospatial data handling, modelling as well as spatial statistical analysis.

EXAMINATION

The exam is a 3-hour written multiple choice exam with 40 questions of equal weight.

Only calculator is allowed at the exam.

The assessment is made by the teachers.

RE-EXAMINATION

The re-exam is subject to the same regulations as the ordinary exam.

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales.

Integrated Water Management and Legislation

15 ECTS

CONTENT

The objectives of the module are to:

- train the students to be skilled in how external nutrient reduction affects streams, lakes and reservoirs in different climate zones.
- provide a basic understanding of physico-chemical and biological restoration methods for streams and lakes/reservoirs.
- understand basic concepts of crop water relations, water productivity and strategies for efficient water and nutrients (mainly N and P) management in agro-ecosystems.
- provide an overview and understanding of water legislation, policy and planning in China and the EU.
- provide a basic understanding of urban water systems, and how nature-based approaches to current freshwater challenges may contribute to climate resilience and sustainable urban development.

The course will give you in depth knowledge of the following subject areas:

Freshwater Ecosystem Management

- Basic introduction to the effects of reduction in nutrient loading to streams, lakes and reservoirs in different climate zones. Included are the effect on nitrogen and phosphorus cycling and retention; response of primary producers and consumers, water quality issues.
- Basic introduction to physico-chemical and biological lake/reservoir restoration methods, including methods that reduce internal loading in lakes/reservoirs and reinforces a shift to a clear-water state (biomanipulation).
- Basic introduction to stream restoration methods, including effects of re-meandering stream, that improve the physical variations in streams and reduce plant harvesting.

Agricultural Water and Nutrients Management

- Water dynamics in the soil-plant-atmosphere continuum (SPAC).
- Water balance in the field, crop water productivity and irrigation strategies.

- Plant nutrition functions, plant nutrient deficiency diagnosis.
- Soil fertility concepts, turnover of N and P in soil and effect on plant nutrient availability.
- Fertilization strategies and farming systems, methods to improve nutrient use efficiency, reduce N and P losses, improve crop yield and quality.
- Modelling water, N and P dynamics in the soil-plant systems and losses to the environment.

Water Legislation and Policy

- General introduction to water legislation in China and the EU
  The challenge of sustainable management – why do we need to regulate the use of resources?
  The institutional set-up and main pieces of water legislation in China as part of the evolving national water policy with a particular view to water quality
  The institutional set-up in the EU and the main elements of EU water policy and legislation with a particular focus on the EU Water Framework Directive and integrated water resource management
- Water Policy and Implementation
  Policy instruments in general: Command-and-control-regulation, economic instruments, information/voluntary instruments. Pros and cons.
  Implementation. Potential difficulties in fulfilling policy aims; potential obstacles during the implementation process – for instance at target group level and organisational level?
  Water policy instruments– lessons from Europe. Primary focus will be on European experiences with economic policy instruments in water (currently analysed in a European Union research project called ‘EPI Water’). Evaluation of environmental policies.
- Water Planning
  Spatial planning principles and water management.
  Top-down and bottom-up approaches in water management.
  Management challenges in common-pool resources (such as water).
  Comprehensive cross-sectorial planning - policy integration in relation to water management.

Urban Water Management

- General introduction of urban water systems, challenges and trends in solutions, including water supply and treatment systems, urban drainage and conventional stormwater management.

- Stormwater quantity conveyance, detention and retention; stormwater quality, control and re-use options.
- Ecosystem services; non-conventional stormwater management; aquatic ecological restoration in inland urban lakes.
- General introduction on what a city is, urban development and how to manage transitions towards sustainable development.

The teaching comprises lectures, theoretical exercises and project work in combination with visits/tours to ongoing projects on urban water and agricultural water and nutrients management. The topics of the theoretical exercises run in parallel with the topics presented in the lectures. Each project is done in groups of students and is presented as a report and an oral presentation.

LEARNING OBJECTIVES

Following the successful completion of the course, the students will be able to describe, structure, explain, integrate, apply and critically evaluate:

- how lakes/reservoirs and streams respond to nutrient loading reduction in different climate zones.
- methods applied for reducing the nutrient loading to surface.
- waters including the fate of nutrients.
- methods that can be used to speed up recovery of lakes/reservoirs and to improve ecosystem quality of lakes and streams.
- summarise, explain, analyse, critically discuss, and generalise based on primary literature (scientific papers) in the field.
- describe, explain, integrate relevant environmental data from restoration and management case studies, as well as critically discuss limitations.
- understand the basic concepts of crop water relations and water dynamics in the soil-plant-atmosphere continuum.
- analyse crop water productivity and to evaluate water-saving irrigation strategies.
- describe the biological and chemical processes affecting plant availability of N and P in fertilisers, manures and other soil amendments used in agriculture.
- describe crop nutritional physiology, nutrient function and the effects of fertilization and soil fertility management on crop yield and quality and losses to the environment.

- understand and explain the main legal principles governing the management of water resources in their own jurisdictions and make some comparisons with other jurisdictions in both China and the European Union.
- identify relevant legal, policy and planning mechanisms in water management and use relevant materials in problem-solving.
- comment critically on the legislation, policy and plans relevant to a particular problem of water resources management that was the focus of the assignment, e.g. by comparing law and policy with the experiences in the European Union.
- analyse urban water systems and their current challenges based on literature, open source data and interviews, including urban water supply and storm water management systems, urban water quality and treatment technologies.
- understand urban water management and urban development, including the role of green infrastructure and green technologies, and apply this knowledge for suggesting environment friendly solutions for urban water issues.
- understand the concept of urban ecosystem services, and apply it to assess the conventional water systems versus potential alternative water systems.

EXAMINATION

The exam comprises

- two assignments during the course, where each assignment will account for 15% of the grade
- a written examination which accounts for 70 % of the grade

The two assignments are group assignments with individual oral presentation and questions. Each group consists of 3-4 members, and the topics are fixed. 2-4 standard pages.

The assessment is made by the teachers.

Beside these two assignments, a third assignment has to be completed and submitted as a pre-requisite for taking the written examination.

The written examination is a 3-hour written presence examination based on short questions related to the learning objectives, requiring short text answers and/or calculations. The questions cover the full module.

No aid is allowed.

RE-EXAMINATION

The re-exam is a 4-hour written presence examination based on short questions related to the learning objectives, requiring short text answers and/or calculations. The questions cover the full module.

No aid is allowed.

The assessment is made by the teachers.

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales.

Thesis

60 ECTS

CONTENT

The student should work independently with a research topic at a suitable research laboratory under the supervision of a Chinese and a Danish supervisor. The student should prepare a dissertation, which will be assessed together with an oral presentation of the work.

The dissertation should contain the same sections as a scientific paper, say:

- Preface
- Acknowledgement
- Abstract
- General Introduction
- Objectives
- Literature Review
- Research hypothesis
- Materials and Methods
- Results
- Discussion
- Conclusion
- Perspectives
- References

LEARNING OBJECTIVES

After having completed the thesis the student should have:

Knowledge about:

- Scientific problems and state-of-the-art in the thesis subject area.
- Theories and practical solutions supporting the thesis subject area.

Skills to:

- Identify scientific problems and formulate scientific hypothesis within the study programme' s subject area

- Apply research methodologies including modelling tools to conduct his/her work within the thesis subject area with a high degree of independence
- Discuss theories/methods in relation to his/her thesis subject area and the state-of-the-art of the programme' s subject area
- Assess the extent to which the production and interpretation of research findings/material depend on the theory/methodology chosen and the delimitation chosen.

EXAMINATION

The thesis is an individual written assignment. The thesis has a length of a minimum of 50 and a maximum of 80 standard pages, excluding references. Students should add a summary to the thesis in English.

The oral examination (defence) consists of 20 minutes oral presentation of the project followed by 30 minutes questions from the examiners.

The grade awarded must reflect an overall assessment of the written thesis and the oral defence.

The assessment is made by the Thesis Defence Panel which includes an external examiner.

RE-EXAMINATION

The same as the ordinary exam attempt. For more information, see Moodle' s 10-step guide.

GRADING

For the Danish/international students, grades are given according to the Danish 7 step and the Chinese thesis grading scales.

For the Chinese students, grades are given according to the Danish 7 step grading scale only.

The details of the thesis procedure are described in SDC Thesis Regulations 10 Steps.

Commencement

Effective as of 01.09.2017

Changes to the Academic regulations

No changes yet.