

# Handbook ES 2012 - 2014

While UNESCO-IHE Institute for Water Education, Delft does its utmost to ensure that the programme will run as specified in this handbook, the content is subject to change. Certain modules or parts of modules may be changed, withdrawn and/or replaced by other modules. Due to logistical constraints or otherwise, participation of specified lecturers, whether from UNESCOIHE or from partner organisations cannot be guaranteed. No rights can therefore be derived from the programme as specified in this handbook.

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## **1 UNESCO-IHE**

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### **1.1 Introduction**

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UNESCO-IHE continues the work that was started in 1957 when IHE first offered a postgraduate diploma course in hydraulic engineering to practicing professionals from developing countries. Over the years, IHE has developed into an international education institute providing a host of postgraduate courses and tailor-made training programmes in the fields of water, environment and infrastructure; conducting applied research, implementing institutional capacity building and human resources development programmes, participating in policy development, and offering advisory services world-wide.

The Institute has gradually expanded its academic base to include disciplines such as sociology, economics, and environmental and management sciences. The range of activities has broadened accordingly, from identifying solutions to engineering problems to designing holistic and integrated approaches in the development and management of water and environmental resources, and urban infrastructure systems. The services of the Institute now also include integrated water resources management, effective service delivery and institutional reform, all of which aim to enhance full stakeholder involvement, equity, accountability and efficiency in water sector development and management.

In November 2001, UNESCO's 31<sup>st</sup> General Conference decided to make IHE an integral part of the Organisation. By March 2003, the necessary treaties and agreements between the IHE Delft Foundation, UNESCO and the Netherlands Government were signed, allowing for the entry into operation of the new UNESCO-IHE Institute for Water Education. UNESCO-IHE is governed by a thirteen-member Governing Board appointed by the Director General, and is managed by a Director and Deputy Director. The IHE Delft Foundation provides all other staff and facilities to UNESCO-IHE.

The mission of the Institute is to contribute to the education and training of professionals and to build the capacity of sector organisations, knowledge centres and other institutions active in the fields of water, the environment and infrastructure, in developing countries and countries in transition.

UNESCO-IHE is located in Delft, an internationally renowned centre of excellence in civil engineering and in water related sciences. The Delft University of Technology, the laboratories of WL/Delft Hydraulics, GeoDelft, and The Netherlands Organisation for Applied Scientific Research are situated nearby. UNESCO-IHE maintains intensive relations with national and international institutions to ensure a continuous exchange of knowledge and experience.

### **1.2 MSc Degree Programmes**

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The backbone of the Institute are the postgraduate programmes in the fields of:

- ⌘ Environmental Science
- ⌘ Municipal Water and Infrastructure
- ⌘ Water Management
- ⌘ Water Science and Engineering

Each year, these programmes are attended by hundreds of engineers, chemists, biologists, earth scientists, and other professionals from all over the world. The graduates are awarded a Master of Science degree. The programmes are subject to accreditation under Dutch law.

### **1.3 Research and PhD Programmes**

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UNESCO-IHE carries out scientific research, often in co-operation with universities and research institutes in developing countries. A number of positions are available for PhD research. The PhD programme has a nominal duration of 4 years and can be carried out either in Delft or in a sandwich

construction. The PhD degrees are awarded by UNESCO-IHE together with a Dutch university. Candidates should preferably hold a UNESCO-IHE MSc degree, but an equivalent degree from another reputed university may also be acceptable.

## **1.4 Organisation**

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The Rectorate of the Institute consists of a Rector, a vice rector Academic Affairs and a Business Director. The organisation is structured into departments, which are further subdivided into various sections. Within the organisation structure, three academic departments are distinguished:

- z Water Science and Engineering
- z Environmental Engineering and Water Technology
- z Integrated Water Systems and Governance

These departments have one or more academic cores in the major fields, each with a leading professor, who is assisted by academic staff and research fellows. Process management support units and a education bureau provide administrative support.

Besides the academic staff of UNESCO-IHE, education is provided by selected guest lecturers, who are experts employed by universities, research institutes, government agencies, consulting firms, international organisations, etc. in the Netherlands and abroad.

## **2 Programme framework**

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### **2.1 Introduction**

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#### **The Master of Science Degree Programmes**

The Institute provides the following Master of Science degree programmes:

- z the master programme in Environmental Science;
- z the master programme in Municipal Water and Infrastructure;
- z the master programme in Water Management; and
- z the master programme in Water Science and Engineering.

These programmes have a nominal duration of 18 months and are leading towards a Master of Science (MSc) degree in the respective field upon successful completion. Each programme has several distinct specialisations, in which students follow a programme curriculum best suited to their preference.

The minimum study load of the programmes is 106 credit points, expressed in units defined by the European Credit Transfer and Accumulation System (ECTS).

## 2.2 Academic Regulations

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The *Education and Examination Regulations* (separately included in this handbook) provide the basic data of the programme, including the major rules around the examinations and the rights of students to inspect the results of the examination assessment.

The regulations describe the precise details of how examinations are assessed and marked, the procedures and rules for re-examinations, procedures for appeal, and which results are required for awarding the Master of Science degree.

Students are strongly advised to familiarise themselves with these procedures at an early stage during their study.

## 2.3 Structure of the Programmes

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The programmes are conducted over a period of 18 months during two academic years. The general planning structure is shown in the *Academic Calendar*.

In the first year, the calendar is divided into 14 periods of three weeks, in which the components of the curriculum are presented as modules. After each second module, a separate week is reserved during which the examinations for the two modules take place. The first six months of the second year are reserved for completion of the MSc thesis research work.

Within each programme, the following generic components are distinguished:

- z ten taught modules of 5 credit points each;
- z fieldtrips and groupwork, total 10 credit points;
- z a special/research topics module of 3 credit points;
- z the thesis proposal preparation of 7 credit points;
- z the thesis research and examination, 36 credit points.

## 2.4 Curriculum Information

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All components of the programme curriculum are described by a syllabus (summary) in the programme-specific part of the handbook providing the following information, which is further detailed in the sections below:

- z the name and code of the subject;
- z the learning objectives;
- z the pre-requisite knowledge or skills;
- z the study load hours and credit points;
- z the lecture, exercise and examination contact hours;
- z the nature and weights of the examination parts;
- z the responsible lecturers/examiners;
- z a concise description of the contents and working methods; and
- z the required and recommended literature, and other materials.

## 2.5 Learning Objectives

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Each programme specialisation has a set of learning objectives that state the knowledge, insight and skills achieved by students who successfully complete the programme. A distinction is made between discipline-specific learning objectives, which are required by the field of study, and general academic skills, which are expected from university education graduates. The programme objectives for each specialisation are provided in the programme-specific part of the handbook.

Similarly, each component of the curriculum has a set of learning objectives, which detail the specific outcomes if the student completes that part of the programme. The individual subjects usually aim to achieve a further detailed subset of the overall learning objectives.

## 2.6 Working Methods

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The programmes are conducted using a combination of lectures, exercises, assignments and examinations. The latter are described separately in the next section.

Lectures serve one or more of the following functions:

- z to impart information;
- z to introduce and explore a topic;
- z to build-up complex structures step-by-step;
- z to clarify and illustrate concepts and ideas detailed in the literature or lecture notes; and
- z to provide a framework for further independent study and reading.

An exercise takes one of the following forms:

- z a design or practical exercise;
- z a computer or other workshop;
- z a laboratory session;
- z a fieldwork or fieldtrip; and
- z a groupwork discussion.

Assignments are carried out independently by the students and consist of all required activity to:

- z study or practice the lecture material;
- z prepare a report, thesis or presentation;
- z work out the results of an exercise;
- z conduct an experiment or test;
- z prepare for an examination; and
- z conduct a research or other study.

## 2.7 Examinations

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Examinations serve to test if students have achieved the learning objectives for a specific component of the programme, and ultimately those of the programme itself. The examination for a component may be composed of multiple parts. For example, a combination of a written or oral test and one or more assignments to handed in separately. Examination work can also be produced by (small) groups of students working together on an assignment, e.g. the groupwork report.

Assessment of examination material is carried out by appropriate examiners, which are usually the involved lecturers. Students who successfully complete a component of the programme will be granted the credit points for that component. Fieldtrips may require active participation instead of an examination in order to receive the credit points.

For each examination, students are informed about the assessment results via e-mail. When all examinations have been passed, the student has successfully completed the so-called programme examination and will be awarded the degree.

## **2.8 Study Load**

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All scheduled education activity taking place in the presence of a lecturer or an assistant is designated as contact time. All other time spent by students in relation to the study programme is designated as independent study time.

The study load for (a part of) a programme is the cumulative contact time and independent study time that is nominally required to successfully complete that (part of the) programme. Study load is expressed in whole ECTS credit points, where one ECTS credit point is equivalent to 28 working hours.

The study load credits for a curricular activity indicate the notional time spent by an average learner to achieve the required outcomes for that activity, as specified by the learning objectives. The nominal time expenditure for a 5 ECTS credit points module is therefore 140 hours.

Where study load involves scheduled class-based activity, one lecture period is taken equal to two hours of contact time.

## **2.9 Planning and Scheduling**

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Lectures and exercises taking place inside the Institute are, in principle, scheduled into 'periods' of two hours each, for which the following times are available:

Period 1 08:45 – 09:30 and 09:45 – 10:30

Period 2 10:45 – 11:30 and 11:45 – 12:30

Period 3 13:45 – 14:30 and 14:45 – 15:30

Period 4 15:45 – 16:30 and 16:45 – 17:30

Throughout the academic year, the student will receive the following information and materials:

- ⌘ schedules of the educational activities;
- ⌘ required lecture notes, textbooks and other course-related material;
- ⌘ announcements of examination planning details; and
- ⌘ statements on examination results and study progress.

## **2.10 Participation**

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Active participation and attendance by students is required for all curricular activities on the schedule. Students have to inform their programme coordinator as early as possible when they are not able to attend a scheduled programme activity.

## **2.11 Evaluation of the Programme by Students**

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As part of the quality assurance procedures of the Institute the programmes are routinely evaluated in order to obtain feedback from the students regarding the quality of the content and the performance of the lecturers. The evaluations are based on a module questionnaire, which the students complete in separate class sessions.

The questionnaire asks the students to provide a rating for achievement of the learning objectives, the study load feasibility, the contents of the subject matter, the balance between the various working and examination methods, the quality of the lecture materials, and the presentation by the lecturers. Furthermore, additional written comments and an overall rating for the module may be provided.

The module evaluations are carried after the examination, but before the results have been announced. Students can also request to address specific programme related issues in a group or individual discussion with the involved coordinator or lecturers.

Feedback on the programmes from the students is much appreciated. The Institute uses the results of the evaluations to improve the academic programmes where necessary, in order to maintain high standards of education.

## **3 Regulations**

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### **3.1 Exam regulations**

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Click here for the separate document:

[Education and examination regulation cohort 2012-2014 \(pdf\)](#)

### **3.2 Library regulations**

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#### **Fair use of on-line information resources at the UNESCO-IHE Library**

The UNESCO-IHE Library Services provides access to a large number of on-line information resources and databases. Access to these resources is provided to all computer users within the premises at Westvest and through remote authentication via the UNESCO-IHE portal.

By using these on-line resources you agree with the following conditions:

1) Systematic downloading of electronic journals articles using manual means is permitted only within reasonable amounts; no more than 50 downloads per user within 24 hours.

2) Programmatic downloading / 'web crawling' are not allowed. In addition to systematic downloading of files manually, the use of a spider (web crawler), the intention of which is to programmatically download data within a specific website, is prohibited.

3) Copyright/reproduction. It is prohibited to reproduce entire or parts of publications in your own publication without the consent of the publisher. You are obliged to provide a correct source reference of all of the material at all times.

4) Selling and providing material to third parties is strictly forbidden. The re-sale of material purchased subject to license to third parties is prohibited; this applies both within and outside of the Institute for which the materials have been purchased.

5) Permanent archiving. Large-scale archiving is not permitted on the local servers or your hostel personal computer nor is the continued use of these servers as an archive, in collaboration with third parties or otherwise. The temporary storage of archive material for personal use is permitted for a period not longer than 120 days.



6) Making changes to an original work. Infringing upon an original work by merging various original texts into a document or by amending original texts is prohibited. Processing materials in such a way is an infringement upon the copyright that is held by the publisher or the author him/herself.

**Infringement of one or all of the above mentioned stipulations will be considered as academic misconduct and will result in disciplinary measures, which will be proportionate to the seriousness of the infraction. The Rector will decide upon the disciplinary measures which will be taken. These measures may include temporary or permanent suspension from attending class.**

### **3.3 Code of conduct**

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#### **THE RECTORATE OF UNESCO-IHE**

In consideration of the need for rules and regulations concerning the safety and the proper use of the buildings, grounds and facilities of UNESCO-IHE by students and visitors;

In accordance with article 7.57h and article 9.2, first paragraph, of the Higher Education and Scientific Research Act of the Netherlands;

Having heard the Student Association Board;

#### **RESOLVES**

To establish the following Regulations:

##### **Article 1 Definitions**

##### **1.1 WHW**

Higher Education and Scientific Research Act of the Netherlands (Staatsblad Bulletin of Acts and Decrees 1992, 593);

##### **1.2 the Director**

The director of UNESCO-IHE

##### **1.3 the Rectorate**

The director and the deputy director

##### **1.4 Central services department**

The central services department of UNESCO-IHE

##### **1.5 Facilities**

The institute buildings, the interior and equipments as well as rented office and accommodation facilities

##### **1.6 Buildings**

The buildings of UNESCO-IHE, located at Westvest 7, Delft

##### **1.7 Student**

Anyone who is enrolled at UNESCO-IHE for the purpose of education provided by UNESCO-IHE

and who uses the educational and examination facilities of UNESCO-IHE for this purpose;

## 1.8 Visitor

Anyone who is not a student nor is employed by IHE-Delft as referred to in article 1.1 of the Collective Labour Agreement (CAO) for Dutch Universities.

### Article 2 Compliance requirement for rules, guidelines and instructions

2.1 Any student or visitor making use of the grounds, buildings or facilities of UNESCO-IHE is required to comply with all rules, instructions and/or directions issued by the Rectorate and delegated staff with regard to maintaining order and proper social conventions of the host country within the buildings and on the grounds. According to the in the institutes code of undesirable behaviour the following is considered to be undesirable behaviour: sexual harassment, aggression, or violence, both verbal and non-verbal towards course participants, staff, visitors or contracted staff. Furthermore all participants, staff, visitors and contracted staff are to observe and comply with the rules and regulations with regard to appropriate and legitimate use of the facilities of UNESCO-IHE scrupulously and without delay, and is required to deport him or herself such that:

a. he or she does not cause direct or indirect damage to UNESCO-IHE or to other persons who are present on the grounds or in the buildings of UNESCO-IHE or who make use of the facilities of UNESCO-IHE, nor that he or she causes nuisance or annoyance;

b. he or she does not infringe on the rights of UNESCO-IHE or of other persons who are present on the grounds or in the buildings of UNESCO-IHE or who make use of the facilities of UNESCO-IHE;

c. he or she does not act contrary to statutory obligations;

d. he or she does not act contrary to appropriate and proper social conventions with regard to people or property.

2.2 It is prohibited to wear clothing that covers the face or to wear other clothing and/or accessories that severely interfere with communication between teaching staff and students or between students themselves or between members of the teaching staff. When sitting an examination it is prohibited to wear clothing that covers the face or to wear other clothing and/or accessories that severely limit the ability to establish the identity of the person in question.

2.3 The Head of the Central Services department may, on behalf of the Rectorate, issue instructions and directions for the purpose of ensuring the smooth and proper use and functioning of buildings and grounds of UNESCO-IHE entrusted to him/her.

### **Article 3 Disciplinary Measures**

The Rectorate may take the following measures against any student or visitor who fails to comply with the contents of these Regulations, with due observance of the procedure described in these Regulations:

- a. excluding the student or visitor from the buildings and grounds of UNESCO-IHE or from one or more parts of UNESCO-IHE, with the provision that a student may only be excluded from buildings or grounds in whole or in part for a period not to exceed one year;
- b. excluding the student or visitor from the use of the facilities of UNESCO-IHE;
- c. fining the student if such fine has been agreed on or follows from the statute;
- d. issuing a written reprimand;
- e. retribution for damages to properties and or facilities.

### **Article 4 Exclusion Order by the Rectorate**

4.1 The Rectorate may immediately issue an exclusion order for the buildings or grounds, or for parts of those buildings or grounds, to a student or visitor who commits an infringement on these Regulations or the rules referred to in article 2, or it may issue an exclusion order for the institute facilities.

4.2 Anyone who is subjected to measures as referred to in the first paragraph will be given the opportunity for a subsequent hearing as soon as possible by or on behalf of the Rectorate if this was not previously possible due to the urgent nature of the matter at hand.

4.3 The exclusion order will contain at least the following:

- a. an indication of the buildings and/or grounds or the parts of the buildings and/or grounds of UNESCO-IHE and/or the facilities or use of the facilities of UNESCO-IHE to which the exclusion order applies;
- b. the duration of the exclusion order;
- c. the reasons for the exclusion order;
- d. any conditions which will result in the effectuation of the exclusion order in case of non-compliance.

### **Article 5 Termination of the exclusion order**

5.1 The Rectorate may, of its own accord or in response to a request by a person who is subject to a disciplinary measure in the form of an exclusion order as referred to in these Regulations, choose to terminate the exclusion order or alter its scope before it has elapsed if there is sound reason to do so according to the judgement of the Rectorate.

5.2 The Rectorate may attach special conditions to the termination or alteration of the exclusion order.

5.3 If in the judgment of the Rectorate the person subject to the exclusion order, and on behalf of whom a proposal to terminate said order has been forwarded, has not met the special conditions set by the Rectorate, then the original exclusion order will once again be put into force; the period of time that has passed since the termination or alteration of the exclusion order will not be deducted from the originally specified period in this case.

### **Article 6 Entry into force**

These Regulations enter into force on October 1st 2007

**Article 7 Method of Citation**

These Regulations may be cited as “Regulations for the use of buildings, grounds and facilities by students and visitors of UNESCO-IHE”.

Approved in the rectorate meeting of September 25<sup>th</sup> 2007

## 4 ES Programme

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### 4.1 Introduction ES Programme

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#### *Problems and challenges*

Unsustainable management of natural resources hampers the development of mankind and contributes to the unequal distribution of economic welfare. Pollution, depletion of resources and disintegration of ecological functions are of global, regional and local concern. Considering the anticipated economic development and increase in standards of living in developing regions, these issues will become even more urgent in the future. Thus it is not surprising that wise management of our precious (water) resources, environmental conservation, alleviation of poverty and sustainable development are high on the agenda of global concerns [1] .

It is now widely acknowledged that, to prevent continued environmental degradation and the decline of human society, interactions between man and the environment have to be sustainable. Sustainability depends on the delicate balance between the use and the conservation of our environmental resources. The challenge to sustainable development, then, is to stimulate further expansion of living standards worldwide while minimising and counteracting the negative impacts on the environment.

#### *Aim of the programme*

The aim of the Environmental Science programme is to provide professionals with the knowledge and skills necessary to contribute, directly or indirectly, to the conservation and wise-use of natural resources for the benefit of society. Successful participants will (i) develop the capacity to carry out independent scientific and technical research and assessments on environmental issues, (ii) learn to analyse and assess environmental systems and problems, (iii) be able to propose sustainable solutions to environmental problems and (iv) contribute to the development of policies and strategies for environmental planning.

#### *Our Approach*

To address environmental problems and find sustainable solutions, we must understand the processes that sustain the natural systems, how the systems function and how they interact with each other and with human society. A thorough understanding of how natural systems respond to human actions and interventions is crucial. Through knowledge of the dynamics, functioning and processes of natural systems and an appreciation of the delicate balance between the use and the conservation of our natural resources, improvement of quality of life for human society and sustainable development can be achieved. To equip professionals with the required capacities, the Environmental Science programme offers a systems approach that investigates different subsystems and the interactions between them at the global, regional and local scale, but without losing sight of the overall picture. In exploring the complexities of the human-environmental system the programme seeks a balance between the disciplines taught and the added value of bringing these disciplines together in one coherent programme.

Furthermore, the approach of UNESCO-IHE is problem-oriented with a primary focus towards developing countries. This means that the value of the achieved knowledge and skills is measured in terms of applicability of the science, technology, engineering, planning and policies to environmental management. Planning and good policy-making in Environmental Science is based on an understanding of how ecosystems work, how they respond to defined human actions and what remediation actions may be taken to reinvigorate the dynamism of sustainability and biodiversity conservation. As the concept of sustainable development needs its own unique elaboration in contexts where living conditions of large populations are in a critical stage and environmental protection is seen as a luxury, the programme provides tailored approaches and specific knowledge to serve these conditions.

In environmental science education, the development of knowledge together with skills is essential. In the UNESCO-IHE approach, lectures by experts in the field are complemented by assignments,

exercises, laboratory and fieldwork and group-work. Innovative distance learning and electronic interactive educational tools support the programme, while further innovations and developments to link up with UNESCO-IHE's global network of partner institutions are ongoing.

#### *Scope of the programme and specialisations*

Environmental Science is a broad field; any Master Programme in this field is necessarily limited. The UNESCO-IHE Master Programme in Environmental Science provides an overview of the field with emphasis on aquatic and wetland ecosystems and water related issues such as water quality management, nutrient cycles, water pollution control, natural systems for wastewater treatment, and the functioning and use of wetlands. Within this scope the programme offers six specialisations that lead to a Master of Science (MSc) Degree.

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[1] World Summit, Johannesburg 2002; World Water Vision, The Hague 2000; UNCED Conference, Rio de Janeiro 1992; UN Conference on the Human Environment, Stockholm 1972.

## **4.2 Learning objectives for the programme**

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After successful completion of the ES programme, graduates will be able:

### **Knowledge & theory**

- ⌘ to demonstrate knowledge and understanding of the physical, chemical and biological processes of the environment, of the socio-economic concepts underlying the functioning and exploitation of environmental systems, and of the complex inter-relationship between the protection and wise use of environmental resources;
- ⌘ to describe the rationale for an integrated and interdisciplinary approach for the sustainable management of water and environmental resources;

### **Methods, techniques & tools**

- ⌘ to design, optimise and interpret environmental monitoring and assessment schemes (including statistics and modelling) in order to gain an understanding of problems, trends, causes and effects;

### **Analysis, synthesis & integration**

- ⌘ to critically analyse and evaluate a range of options and alternatives for the prevention or remediation of environmental problems, under different socio-economic, cultural and legal contexts, and under often data-poor conditions;

### **Research/General academic skills**

- ⌘ to conduct research, independently or in a multidisciplinary team, including the formulation of research questions and hypotheses, the selection and application of research methodologies and techniques and the formulation of well-founded conclusions and recommendations;
- ⌘ to communicate, debate and defend, clearly and systematically, findings and generated insights, and provide rational underpinning of these in oral and written presentations to a variety of audiences;
- ⌘ to demonstrate academic attitude and learning skills (including thinking in multidisciplinary dimensions and distinguishing main issues from minor ones), to enhance and keep up-to-date the acquired knowledge and application skills in a largely independent manner.

## **4.3 3. Specializations**

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The Environmental Science programme has the following specialisations:

- ⌘ Environmental Science & Technology (EST)
- ⌘ Environmental Planning & Management (EPM)
- ⌘ Water Quality Management (WQM)
- ⌘ Limnology & Wetland Management (LWM)
- ⌘ International Master of Science in Environmental Technology and Engineering (IMETE)
- ⌘ International Master in Environmental Technology for Sustainable Development (ETSuD)

#### **4.4 EST**

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##### **Objectives**

- ⌘ To provide an integrated course for scientists, technologists and engineers who have an interest in research and development, with the knowledge and skills to address environmental problems and interact with stakeholders, managers and policy makers for appropriate remedial actions.

##### **Subjects**

- ⌘ Introduction Environmental science (natural processes, human dimensions, analytical tools), Environmental Systems Analysis, Environmental Engineering, Environmental Monitoring & Modelling, Cleaner Production & the Water Cycle, International Fieldtrip, Aquatic Ecosystems, Solid Waste Management, Group work, MSc Preparatory course, MSc Proposal Writing, MSc Thesis.

Additional learning objectives for Environmental Science & Technology

*After successful completion of the specialisation graduates will be able:*

##### **Knowledge & theory**

- ⌘ to identify the impacts of human activities on the environment, under different levels of environmental stress and in different socio-economic contexts;
- ⌘ to name and explain concepts, instruments and technologies for pollution prevention and remedial actions in a national and international context;

##### **Methods, techniques & tools**

- ⌘ to apply general methods (including statistics and modelling) in scientific and technological approaches, concepts and interventions;
- ⌘ to contribute as a flexible and creative member in interdisciplinary teams in developing solutions for prevention or remediation of environmental problems, by linking scientific knowledge to engineering interventions and to management decisions in different cultural and socio-economic contexts, and using different levels of available knowledge and information.

#### **4.5 EPM**

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##### **Objectives**

- ⌘ To provide scientists and engineers who wish to specialise in environmental planning and management with the know-how and skills for strategic development, policy-making and decision-making in the environmental arena.

##### **Subjects**

- ⌘ Introduction Environmental science (natural processes, human dimensions, analytical tools),

Environmental Systems Analysis, Environmental Policy Making, Environmental Planning, Water and Environmental Law & Institutions, International Fieldtrip, Aquatic Ecosystems, Watershed & River Basin Management, Group work, MSc Preparatory course, MSc Proposal Writing, MSc Thesis.

### **Additional learning objectives for Environmental Planning & Management**

*After successful completion of the specialisation graduates will be able:*

#### **Knowledge & theory**

- z to understand the environmental policy cycle and planning process and to analyse and prepare environmental policy strategies, taking into account the impact that society has on water and environmental resources;
- z to name and explain principles, concepts and instruments of major national and international water and environmental legislation and common and desired institutional and management arrangements;

#### **Methods, techniques & tools**

- z to apply general scientific methods (including statistics and environmental modelling) to processes of water and environmental resources allocation and use at different scales in order to gain an understanding of problems, trends, causes and effects;
- z to apply environmental scientific methods (including environmental impact assessment, policy analysis, resource valuation, environmental economics) and models for institutional development with emphasis on policy development, functional decentralisation and good governance;
- z to design and facilitate consultation- and decision-making processes between stakeholders, users and their representatives, water managers, politicians and other decision-makers..

#### **Analysis, synthesis & integration**

- z to identify and critically assess the different ecological and socio-economic functions and values of the environmental system and the, often competing, interests of the various stakeholders;
- z to design comprehensive environmental resources policies and strategies that aim to enhance the sustainable use of the environment especially focusing on water, and that include a suitable combination of technical, legal, administrative and financial measures.

### **4.6 WQM**

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#### **Objectives**

- z To provide an integrated course for scientists and engineers responsible for water quality maintenance/improvement in the catchment, urban and rural environments, with the technical knowledge and management skills for decision-making and environmental planning.

#### **Subjects**

- z Introduction Environmental science (natural processes, human dimensions, analytical tools), Water Quality Assessment, Wetlands for Water Quality, Environmental Planning, Water and Environmental Law & Institutions, International Fieldtrip, Aquatic Ecosystems, Watershed & River Basin Management, Group work, MSc Preparatory course, MSc Proposal Writing, MSc Thesis.

### **Additional learning objectives for Water Quality Management**



*After successful completion of the specialisation graduates will be able:*

### **Knowledge & theory**

- ε to identify the impacts of human activities on aquatic ecosystems;
- ε to name and explain principles, concepts and instruments of main national and international water and environmental legislation and common and desired institutional and management arrangements;

### **Methods, techniques & tools**

- ε to interpret, design and optimise water quality monitoring and assessment schemes in the watershed;
- ε to apply experimental, statistical and modelling tools for interpreting and designing water quality management programmes;

### **Analysis, synthesis & integration**

- ε to contribute as a flexible and creative member in interdisciplinary teams in developing solutions for water quality management problems in different cultural and socio-economic contexts, and using different levels of available knowledge and information;
- ε to critically analyse and evaluate alternative water quality management programmes in the watershed under different socio-economic and legal contexts, often in data-poor conditions.

## **4.7 LWM**

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### **Objectives**

- ε To provide scientists and engineers, interested in aquatic research and development, with a knowledge and understanding of the structure and functioning of aquatic and wetland ecosystems for their management and wise use, and interact with stakeholders, managers and policy makers for the development of best practices.

### **Subjects**

- ε Introduction Environmental science (natural processes, human dimensions, analytical tools), Environmental Systems Analysis, Wetlands for Water Quality, Lake Ecology, Stream and River Ecology, East-African Wetlands for Water Quality, Fisheries and Aquaculture, Microbial Communities & Ecosystem Functioning, Conservation and Restoration Ecology, Group-work: IWRM & Management of Aquatic Ecosystems, Water Quality Monitoring & Bio-indicators, MSc Preparatory course, MSc Proposal Writing, MSc Thesis.

### **Additional learning objectives for Limnology & Wetland Management**

*After successful completion of the specialisation graduates will be able:*

### **Knowledge & theory**

- ε to identify the impacts of human activities on freshwater ecosystems in different socio-economic contexts;
- ε to demonstrate knowledge and understanding of the international water quality guidelines;
- ε to name and explain concepts, instruments and technologies for protection and remedial actions of freshwater ecosystems;

### **Methods, techniques & tools**

- ε to design, optimise and interpret environmental monitoring and assessment schemes for

- freshwater ecosystems;
- ⌘ to apply general scientific methods (including statistics and environmental modelling) for the development and application of scientific and technological approaches, concepts and interventions to address problems of freshwater ecosystems;

### **Analysis, synthesis & integration**

- ⌘ to critically analyse and evaluate a range of options and alternatives for the prevention or remediation of problems related with freshwater ecosystems, under different socio-economic and legal contexts, and under often data-poor conditions;
- ⌘ to contribute as a flexible and creative member in interdisciplinary teams in developing solutions for prevention or remediation of freshwater ecosystems problems, by linking scientific knowledge to engineering interventions and to management decisions in different cultural and socio-economic contexts, and using different levels of available knowledge and information.

## 4.8 IMETE

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### Objectives

- ⌘ The IMETE programme will educate a new generation of environmental scientist and engineers that can provide adequate and state-of-the art environmental technology and engineering solutions to tackle complex, multidisciplinary environmental issues, such as today's global environmental pollution problems.

### Subjects

- ⌘ Introduction Environmental science (natural processes, human dimensions, analytical tools), Environmental Microbiology, Environmental Engineering, Wastewater Treatment, Sludge Management, Atmosphere Protection Technology, Waste Management and Treatment, Clean Technology, Environmental Fate and Management of Heavy Metals and Metalloids, Microbial Re-use Technology, Research Methodology, Elective Project, MSc Proposal Writing, MSc Thesis.

### Additional learning objectives for International Master of Science in Environmental Technology and Engineering (IMETE)

*After successful completion of the specialisation graduates will be able:*

#### Knowledge & theory

- ⌘ to identify the way polluted water, waste, gas, soils and sediments can be treated;
- ⌘ to identify the way ecosystems and the atmosphere can be protected from pollution.
- ⌘ to identify the way to prevent environmental pollution through resource management and application of re-use technologies.

#### Methods, techniques & tools

- ⌘ to be able to develop, design and apply technologies for the prevention and remediation of environmental pollution by searching scientific information, by conducting scientific research in the field of environmental technology and engineering and by reporting their findings by means of scientific reports and papers;
- ⌘ to communicate effectively in English and transferring knowledge to both the scientific and non-scientific world through oral presentations and media communications.

#### Analysis, synthesis & integration

- ⌘ to demonstrate creativity and critical, multidisciplinary thinking for problem-solving and decision-making;
- ⌘ to demonstrate responsibility and own initiative;
- ⌘ to demonstrate capacity to work in an international, multi-cultural team.

## 4.9 ETSuD

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### Objectives

- ⌘ The ETSuD programme offers students the possibility to study at two renowned institutes for international postgraduate education: AIT and UNESCO-IHE. The coursework part of the programme starts at AIT in Bangkok in August, where students follow a number of courses until the second half of December. In early January, they move to Delft where they join students in UNESCO-IHE's Environmental Science programme for six modules and group work. Students then move back to Bangkok for their individual thesis research work with involvement of UNESCO-IHE counterparts.

### Subjects

- ⌘ Environmental Chemistry and Laboratory, Air Pollution Engineering and Management, Solid Waste Management, Environmental Impact Assessment, Wastewater treatment, Drinking Water Treatment, Environmental Health and Sanitation, Design of Water Supply and Wastewater Systems, Air Pollution Modelling and Applications, Hazardous Waste Technology and Management, Design of Air Pollution Control Systems, Membrane Technology in Water and Wastewater Treatment, Waste Reduction and Recycling, Applied Microbiology and Laboratory, Advanced Processes for Wastewater Treatment, Reuse and Recycle, Analytical tools in Environmental Science, Environmental Systems Analysis, Wetlands for wastewater treatment, Cleaner Production, Foreign Fieldtrip + Fieldwork, Aquatic Ecosystems, Group Work, Research Methodology, Elective Project, MSc Proposal Writing, MSc Thesis.

### **Additional learning objectives for International Master in Environmental Technology for Sustainable Development (ETSuD)**

*After successful completion of the specialisation graduates will be able:*

#### **Knowledge & theory**

- ⌘ to identify the impacts of human activities on the environment, under different levels of environmental stress and in different socio-economic contexts;
- ⌘ to name and explain concepts, instruments and technologies for pollution prevention and remedial actions in a national and international context.

#### **Methods, techniques & tools**

- ⌘ to apply general methods (including statistics and modelling) in scientific and technological approaches, concepts and interventions;
- ⌘ to contribute as a flexible and creative member in interdisciplinary teams in developing solutions for prevention or remediation of environmental problems, by linking scientific knowledge to engineering interventions and to management decisions in different cultural and socio-economic contexts, and using different levels of available knowledge and information.

#### **Analysis, synthesis & integration**

- ⌘ to demonstrate creativity and critical, multidisciplinary thinking for problem-solving and decision-making;
- ⌘ to demonstrate responsibility and own initiative;
- ⌘ to demonstrate capacity to work in an international, multi-cultural team.

## **5 Facilities**

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### **5.1 Location**

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The UNESCO-IHE buildings and facilities are located on a single compound at the Westvest 7 in the centre of Delft. The buildings provide a pleasant and efficient atmosphere for optimal learning and creativity, direct communication with lecturers and other staff, as well as meeting with fellow students. The building is open during the following times:

Monday to Friday 07:30 – 20:00

Saturday 08:00 – 12:30

### **5.2 Student Affairs (office)**

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The Student Affairs office provides non-academic support to students. The SA office takes care of student applications and student registration. The new students are also assisted with formalities such as applications for residence permits, insurance, bank accounts, and fellowship issues. Housing arrangements in one of the hostels are being made immediately upon arrival.

Throughout their study period, students can contact the staff during office hours for information or questions related to health, religion or other issues related to the student's well being. Personal matters can be discussed with the student counsellor and will be dealt with strictly confidential.

During the entire academic year, SA organizes a number of social and cultural activities including the weekly movie night, social evenings and the annual Christmas dinner. Other activities include cultural excursions to interesting cities and places in the Netherlands and other countries in Europe.

Furthermore, the students are given opportunity to actively practice sports on a regular basis. From October to May, the Institute arranges accommodation in Delft for such sports as soccer, volleyball, basketball and badminton. The SA office organizes sports events and tournaments, in which the teams can compete internally, but also against players from other international institutes.

### **5.3 Student Association Board**

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The Student Association Board (SAB) is composed of representatives who are elected by the students in annual elections that take place some four weeks after the opening of the academic year.

The SAB provides a forum through which students can share their experiences, problems and general issues on study-related matters. If necessary, the SAB will bring these matters forward in discussions with the executive levels of the Institute. The board can be contacted directly via its members or the general e-mail address [sab@unesco-ihe.org](mailto:sab@unesco-ihe.org).

The SAB closely co-operates with the Student Affairs office in organizing social and sporting events. The board also publishes its own magazine *The Informer*, in which the rich variety of contributions are entirely derived from, and produced by, the student community.

### **5.4 ICT services**

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UNESCO-IHE provides modern computing (IT) facilities for education and research. A local wired- and wireless network is available in UNESCO-IHE's building. Through UNESCO-IHE's networks all computers have access to a fast Internet connection. Besides that, participants have unlimited access to Internet in all hostels provided by UNESCO-IHE.

All UNESCO-IHE desktop and laptop PCs are Intel based with Microsoft Windows operating system. The UNESCO-IHE laptop PC will be provided in order to get access to the IT-facilities. The laptop is on loan for use during studying at UNESCO-IHE. At the end of the study, UNESCO-IHE offers the possibility to buy the laptop. The contract given clearly states the terms and conditions for

borrowing the laptop. Bringing one's own laptop is allowed; however, laptops other than the UNESCO-IHE laptop might not give access to all the required IT-facilities and might not be supported by IT-service desk.

A wide range of software packages is available, ranging from standard PC-software, like Microsoft Office (Word, Excel, etc.) to special modelling software used for the educational programmes. All participants will get a free UNESCO-IHE web-based e-mail box. A web-based E-learning and collaborative system is accessible for all participants to exchange learning information and documents.

For specific applications during the thesis study, it may be possible to use specialist software packages on the laptop PCs. This is, however, dependent on the particular type of licence agreement that the Institute has with the supplier. Enquiries for specific software should be made at the computer helpdesk.

## **5.5 General Facilities in the Building**

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In the reception area of the building, students have their own locker for the distribution of schedules, lecture notes and other study-related papers, and private mail. Last-minute changes in schedules are indicated on the announcement board near the entrance. Two monitor screens opposite the reception desk are regularly updated with news or information on events taking place at UNESCO-IHE.

Private telephone calls can be made from card-operated phone booths located next to the reception desk. Photocopy services are available to students. There is also a facility to recharge chip-cards, which students receive from the bank to pay for small purchases without using cash. Furthermore, the building contains a meditation room, which is located on the third floor.

The restaurant provides a wide variety of reasonable-priced multicultural meals and beverages during lunchtime. The meals can be paid using the chip-card or cash. Coffee, tea and soft drinks can be obtained from machines throughout the day.

The building houses a number of fully-equipped lecture rooms and theatres, which can accommodate groups of all sizes from 15 to 300 persons. Rooms for facilitating computer classes and workshops are present and can be used freely by students outside class hours. Furthermore, the Institute has its own printing and reproduction facilities and also contains an in-house distance learning and video conferencing centre. The library, computer facilities and laboratory are described in detail below.

## **5.6 UNESCO-IHE Library and Information Services**

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UNESCO-IHE's Library provides access to over 35,000 printed titles, among which the complete collection of UNESCO-IHE Master thesis and PHD dissertations. Furthermore the collection contains over 8.000 online journals. The online journals collection is accessible on the network at the Westvest premises or through remote authentication through the UNESCO-IHE portal. For more information please visit the Library's Internet page <http://www.unesco-ihe.org/library>

The library is open to all UNESCO-IHE participants and staff, and to visitors by appointment. The services provided by the library include lending out books, requesting articles and other materials through the inter-library loan system and providing assistance in searching the electronic catalogue.

### **Membership**

Upon registration UNESCO-IHE participants receive a registration card which can also be used to borrow items from the library collection.

### **The catalogue**

The library collection is accessible through an electronic catalogue, which is searchable by author,

title (word) and subject, as well as by Boolean operators. Please visit <http://www.unesco-ihe.org/library> for more information.

### Borrowing library items

A maximum of ten items may be borrowed from the library at any one time. The maximum loan period is 21 days, renewable up to a maximum of 42 days. Renewals can be made online, <http://www.unesco-ihe.org/library> by using the borrower information function within the catalogue or by email ([library@unesco-ihe.org](mailto:library@unesco-ihe.org)). Please note that the loan period can be extended only if the items have not already been reserved by another person.

Reference works, M.Sc theses, bound and non-bound periodicals and materials bearing a green sticker may not be borrowed. By using their library card to borrow items from the library, borrowers agree to be responsible for those items, including the cost of replacing lost or damaged items.

### Opening Hours

Monday 09:00–18.30

Tuesday-Friday 09:00–19.00

Saturday 09:30–12:30

Please note that the Library opening hours are subject to change. Visit the Library webpage for regular updates.

From July 2011 until December 2011, the Library spaces are being renovated. Most of the printed collections and the reference desk have been relocated to A2 a/b on the first floor and on account of missing the reading room, the opening hours have been changed to Monday-Friday 09-15-17.30

For further information please contact the library reference desk.

Email: [library@unesco-ihe.org](mailto:library@unesco-ihe.org)

Tel: +31 (0)15 215 1714

Fax: +31 (0)15 212 2921

## 5.7 Laboratories

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Modern educational and research laboratories are available in the fields of chemistry, process technology, microbiology, aquatic ecology and soil science. A wide range of standard analytical tests can be performed for chemical, physical and microbiological water, air and soil quality analyses.

Elemental analyses, various kinds of microscopy and analytical techniques such as spectrophotometry, gas- and ion chromatography, and atomic absorption can be carried out. A wide range of laboratory and bench-scale reactors, temperature and light controlled growth chambers, and various constant temperature rooms are available for research in one of the departmental research programs, including waste water management using aquatic macrophytes and wetlands, the adsorption and/or (an-)aerobic degradation of micropollutants, self-purification in drains and filtration. Through close co-operation with the Delft University of Technology and other educational and research institutions, research possibilities are quite extensive.

In addition to the in-house facilities, the laboratory has a range of instrumentation and equipment available for field instruction and for conducting hydrological or environmental field experiments and measurements.

## 5.8 Study Materials

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Study materials such as textbooks, lecture notes and hand-outs are provided by the Institute. Students receive the lecture notes in their personal locker before the start of the involved lecture series. Additional material can be provided by the lecturers in the form of hand-outs. Reference works are available from the Institute library or the library of the Delft University of Technology (see above).

A number of supporting materials, such as for example PowerPoint presentations or exercise materials used by the lecturers, can be accessed or downloaded from the electronic repository. Students can login to the electronic repository from any location via the Internet web page located at <http://km.ihe.nl>.

Students are expected to provide other materials, such as stationary, electronic calculators and language dictionaries on their own account.

## 5.9 English support courses

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### Introduction

A variety of academic writing courses are offered to students during the first 12 months of study. Students are allocated a place on these courses according to their language level, not their specialization. Writing courses are available from 'lower-intermediate' to 'advanced' level, consisting of about 20 hours contact time. These courses run parallel to scheduled lectures, and are not limited to one programme specialization or module.

### Placement Test for everyone

**Every student must take the English Placement Test. Based on the result, the student may be required to follow an academic writing course.**

Placement tests are held in October and January. Participants with weakest English skills are strongly advised to take the test in October, as they will receive support courses first. All remaining participants will be tested in January. Places on writing courses are allocated according to the student's placement test score. A student cannot join a writing course unless s/he has taken the placement test.

Students whose test score is at A1, A2 or B1 level CEFR (The Council of Europe's *Common*



*European Framework of Reference (CEFR) for Languages* is a basis for recognising language qualifications. A1-A2 = Basic; B1-B2 = Intermediate; C1-C2 = Advanced), are obliged to attend a support course: attendance is required. Students whose test score is B2 are strongly recommended to attend a course. If students who score B2 choose to take a support course, regular attendance is required. Those with score levels C1 and C2 are exempt from academic writing courses.

### **Scheduling and attendance**

Academic Writing courses are given throughout the year, with the first courses starting in October and the last courses ending in August/September. Students are assigned a course based on their Placement Test performance.

English support courses usually consist of about 20 hours contact time, approximately 13 or 14 lectures. English support courses are always scheduled at the following times:

- ⌘ Tuesdays 3.45pm-5.30pm
- ⌘ Thursdays 8.45am-10.30am

Occasionally classes are given on Saturday mornings. In special cases, evening classes may be necessary.

A Certificate of Attendance will be provided on completion of an academic writing course, provided attendance requirements have been met.

If a student does not turn up for the allocated course without giving notification of absence, s/he forfeits their place on the course. An alternative course is not provided.

### **Summary descriptions of writing courses**

#### ***First Steps in Academic Writing: lower intermediate***

based on textbook '*First Steps in Academic Writing*', Longman

This course provides low-intermediate students with essential tools to master basic academic writing. It focuses on paragraph organization, sentence structure, and grammar. Students are guided through the writing process to produce well-organized, clearly developed paragraphs. Simple explanations are supported by clear examples to help students through typical rough spots, and numerous practices help students assimilate each skill.

#### ***New Headway Academic Skills: intermediate***

Based on textbook '*New Headway Academic Skills*', Oxford University Press

This course combines reading, writing, and study skills, and is suited to those who have reasonable English but have not studied for a while. It aims to refresh and consolidate existing language through practice, as well as to learn new language. There is guided writing practice and relevant grammatical structures are explained. In addition, skills and strategies which develop good vocabulary learning and recording are included.

#### ***Academic Writing: upper intermediate***

based on textbook '*Focus on Academic Skills for IELTS*', Pearson-Longman

- Focuses on academic writing skills
- Includes vocabulary building and reading techniques relevant to research.
- Specific writing skills include: collocations; useful phrases and language of research; the language of change (increase, decrease, etc); interpreting and comparing information from diagrams;

presenting arguments and opinions; justifying solutions (modal verbs, conditionals) and much more to improve academic writing.

· Life-long learning. This textbook offers systematic preparation for the IELTS exam, hence it can help any student who wishes to gain this internationally-recognised certificate, or improve their existing score.

***Advanced Academic Writing: advanced***

based on textbook '*Academic Writing, A Handbook for International Students*' Routledge

- ⌘ Specifically aimed at improving key academic writing skills, this is a very practical and thorough course.
- ⌘ Three main areas are covered: The Writing Process – from making an outline to proof-reading; Elements of Writing – writing skills such as making comparisons, describing results and paraphrasing; Accuracy in Writing – to improve common problems, eg articles, passives, prepositions.

The above courses follow a workshop approach and are designed to provide maximum hands-on practice. There is a strong emphasis on collaborative writing activities for students, with the lecturer adopting the role of facilitator.

***MSc Thesis Writing: for all participants.*** A reader is provided.

In August/September a series of lectures is given, open to all MSc participants, on thesis writing. The lectures aim to make participants aware of the conventions and structures used to write a proposal, literature review and thesis, and how to present their judgements in a persuasive and reasoned argument. Topics will include proposal writing, literature review, thesis chapters, argument structure, paragraph writing, editing skills, etc.

## **6 Academic Calendar**

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# ENVIRONMENTAL SCIENCE

## MASTERS PROGRAMME

Academic Year: 2012-2014  
 Specialization: Core Programme  
 Module Coordinator: H.J. Lubberding, PhD, MSc

### Module Sheet

Module Name		Module Code	Credits
Week 1 + Introduction to environmental science 1		ES01	10
Target Group	Prerequisites		
Programme target group	Programme prerequisites		

### Learning Objectives

Upon completion of the module participants will be able to..

- Make a critical analysis of the global and national agendas and policies for "Water and Environment" in the context of sustainable development;
- Identify and describe the major global, regional and local environmental problems;
- Identify and describe the basic chemical, hydrological and socio-economic processes in relation to the environment;
- Analyse dynamic interactions between human development and environmental changes;
- Explain the concept of sustainable development;
- Explain basic environmental concepts, such as ecological footprint.

### Topics and Learning Activities

#### Water, environment and sustainable development (week 1)

Week 1 will provide an introduction to the global agendas and policies for water and environment. Participants will be introduced to key documents in these fields (World Water Vision, Vision21, Earth Summit on Sustainable Development, WWF-3). The concept of IWRM will be explained and illustrated by examples.

#### **Learning Activities:**

Week 1 will consist of lectures, exercises, workshops, video-conferencing sessions, and role play sessions.

#### (Environmental) chemistry

(Environmental) chemistry will first discuss electrolytes in water, solubility and redox systems. Subsequently emphasis will be given to sources and fate of micro-pollutants in water and sediments.

#### **Learning Activities:**

The lectures in chemistry are supported by laboratory sessions.

#### Key environmental problems

In key environmental problems relevant environmental issues will be assessed in discussion with the participants

#### **Learning Activities:**

Key environmental problems are in the form of a group discussion and an excursion.

#### Principles of sustainable development

The subject of sustainable development is introduced by involving the students in four major ongoing debates in the field: (1) "Limits to Growth", about resource limits and its implications for development; (2) "Tragedy of the Commons", about the unwise use of public resources; (3) "Spread of Pollutants", about the impacts of wastes and options for closing nutrient cycles at different scales and about the three stages of pollution prevention and control; and (4) "Global Trade and the Environment", about the positive and negative impacts of global trade.

#### **Learning Activities:**

Lectures, discussion

#### Case study environmental problem: eutrophication

#### **Learning Activities:**

The case study eutrophication consists of laboratory activities.

#### Group dynamics

Group Dynamics will provide some tools and techniques for having in-depth debates.

#### continued under module ES2

#### Lecturing Material

- Lecture notes, laboratory notes

Cunningham & Cunningham, Environmental Science, a global concern. 11th ed.

**Assessment**

- 75%: Written Exam (closed book)
- 25%: Assignment

2012/2014-ES01: Week 1 + Introduction to environmental science 1											
Nr	Course/Topic	Lecture	Assignment	Workshop Case study Role play Exercise Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM: contact hours	SUM: studyload hours	Lecturer(s)	
	Water, environment, sustainability		15	20				20	35	several	
	Environmental quality	10				4		14	34	van Bruggen	
	Chemistry	12		12				24	48	Slokar and Kelderman	
	Hydrology	10						10	30	Wenninger and Nonner	
	Lab eutrophication			12				12	12	Irvine, Kelderman and de Ruyter	
	Demography	4		8				12	20	Visser	
	Economy, natural resources	11		8				19	41	Bijlsma	
	Public Health	4		12				16	24	Hamel	
	Sustainable Development	3	6	3				6	18	Irvine	
	Fieldtrip Delfland					6		6	6	Lubberding	
	Retrieving of literature			4				4	4	Darvis	
	Group dynamics			4				4	4	Sturrock	
	Exams		5						5		
	<b>Total</b>	<b>54</b>	<b>26</b>	<b>83</b>		<b>10</b>		<b>147</b>	<b>281</b>		
<b>MSc module - UNESCO-IHE</b>											

# ENVIRONMENTAL SCIENCE

## MASTERS PROGRAMME

Academic Year: 2012-2014  
Specialization: Core Programme  
Module Coordinator: H.J. Lubberding, PhD, MSc

### Module Sheet

Module Name Introduction to environmental science 2		Module Code ES02	Credits 10
Target Group Programme target group	Prerequisites Programme prerequisites		

### Learning Objectives

Upon completion of the module participants will be able to..

- See under module 1

### Topics and Learning Activities

#### Hydrology

In hydrology the main items will be precipitation and collection of meteorological data, evaporation, soil moisture, geo-hydrology and the hydrodynamics of ecosystems.

#### **Learning Activities:**

Lectures

#### Demography

In demography the components of demographic change (fertility, mortality, migration, population models) will be discussed in relation with sustainable development.

#### **Learning Activities:**

Demography consists of lectures and group discussions, culminating in an assignment (analysis and presentation of gathered information).

#### Environmental economics with special focus on use and scarcity of natural resources

The subject of use and scarcity of natural resources starts with reviewing resource and scarcity concepts and mechanisms leading towards and away from scarcity. In a second part, the cases of specific resources are treated: food, wood, fish, biodiversity, water and energy.

#### **Learning Activities:**

Lectures + simulation game

Cunningham & Cunningham, *Environmental Science, a global concern*. 11th ed.

#### Human health

In human health the relation between environmental pollution and human diseases is discussed.

#### **Learning Activities:**

Human health consists of lectures and group discussions, culminating in an assignment (analysis and presentation of gathered information).

### Lecturing Material

#### Assessment

- 60%: Written Exam (closed book)
- 25%: Assignment
- 15%: Assignment



**2012/2014-ES02: Introduction to environmental science 2**

Nr	Course/Topic	Lecture	Assignment	Workshop	Case study	Role play	Exercise	Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM: contact hours	SUM: study/load hours	Lecturer(s)
<b>Total</b>														
<b>MSc module - UNESCO-IHE</b>														

# ENVIRONMENTAL SCIENCE

## MASTERS PROGRAMME

Academic Year: 2012-2014  
Specialization: Core Programme  
Module Coordinator: H.J. Lubberding, PhD, MSc

### Module Sheet

Module Name		Module Code	Credits
Fundamental processes in Environmental Science		ES03	5
Target Group	Prerequisites		
Programme target group	Programme prerequisites		

### Learning Objectives

Upon completion of the module participants will be able to..

- Identify and describe the basic natural processes in relation to the environment;
- Understand and explain the relations between physical, chemical and biological processes in the environment;
- Explain basic environmental concepts, such as feedback mechanisms, ecosystem dynamics, carrying capacity, nutrient cycling;
- Identify and describe the basic toxicological processes in relation to the environment;
- Apply the principles of the scientific method to the design and development of a research project and to develop and present the background, problem statement, research objectives and methodology for a research project;

### Topics and Learning Activities

#### Microbiology

The basic aspects of natural processes in relation to the environment will be discussed. In microbiology the (micro-)biological actors in the cyclic processes of the most important elements (C, N, P, S) will be discussed. The lectures in microbiology are supported by laboratory sessions

#### **Learning Activities:**

Lecture and laboratory sessions

#### Ecology

In ecology basic ecological concepts will be discussed in relation to the structure and function of major ecosystems. Interactions between ecosystems and human activities will be analysed. Human beings always affect the environment.

#### **Learning Activities:**

Lectures

#### Soil science

Basic aspects of soil science are discussed

#### **Learning Activities:**

Lectures + excursion

#### Methodology

The methodology subject is given in the form of introductory lectures by /debate between experts in four themes. Subsequently, there is an assignment per group of three: read a number of relevant papers in one theme, prepare brief review papers concluded with a number of recommendations for action. Finally, there is a presentation and debate among participants and experts.

#### **Learning Activities:**

The methodology subject is given in the form of introductory lectures by /debate between experts in four themes. Subsequently, there is an assignment per group of three: read a number of relevant papers in one theme, prepare brief review papers concluded with a number of recommendations for action. Finally, there is a presentation and debate among participants and experts.

### Lecturing Material

- Lecture notes
- Laboratory notes
- Cunningham & Cunningham, Environmental Science, a global concern. 11th ed.

### Assessment

- 75%: Written Exam (closed book)
- 25%: Assignment

**2012/2014-ES03: Fundamental processes in Environmental Science**

Nr	Course/Topic	Lecture	Assignment	Workshop Case study Role play Exercise Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM:		Lecturer(s)
								contact hours	study/load hours	
	<b>Microbiology</b>	12		12				24	48	Lubberding
	<b>Ecology</b>	10						10	30	De Ruyter
	<b>Toxicology</b>	4		4				8	16	van Gestel
	<b>Methodology</b>	5		5				10	20	Irvine
	<b>Soil Science</b>	6				4		10	22	Mantel
	<b>Exam</b>		3						3	
	<b>Total</b>	37	3	21		4		62	139	

**MSc module - UNESCO-IHE**

# ENVIRONMENTAL SCIENCE

## MASTERS PROGRAMME

Academic Year: 2012-2014  
 Specialization: Core Programme  
 Module Coordinator: J.J.A. van Bruggen, PhD, MSc

### Module Sheet

<b>Module Name</b> Analytical tools in environmental science		<b>Module Code</b> ES04	<b>Credits</b> 5
<b>Target Group</b> Programme target group		<b>Prerequisites</b> Programme prerequisites	

### Learning Objectives

Upon completion of the module participants will be able to..

- process scientific data in a statistically sound way by applying basic statistics;
- apply basic environmental tools, such as modelling.

### Topics and Learning Activities

#### Data analysis and statistics

Data processing and presentation using standard software packages; statistical analysis and hypothesis testing.

#### Learning Activities:

Lectures and exercises

#### Environmental modelling

Development of models of lakes, streams, algal growth, eutrophication and organic pollution will be discussed. Equilibria, stability and feedback in model systems are discussed.

#### Learning Activities:

Lectures, selfstudy, computer exercises

### Lecturing Material

- Lecture notes
- Data sets

### Assessment

- 60%: Written Exam (closed book)
- 40%: Assignment

2012/2014-ES04: Analytical tools in environmental science												
Nr	Course/Topic	Lecture	Assignment	Workshop Case study	Role play Exercise	Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM: contact hours	SUM: studyload hours	Lecturer(s)
2	GIS			1						1	1	
3	Environmental Modelling	10							8	18	54	van Dam/Hes
4	Presentation skills			8						8	8	Sturrock
6	Exam		2								2	
<b>Total</b>		26	11	27					8	61	140	
<b>MSc module - UNESCO-IHE</b>												

# ENVIRONMENTAL SCIENCE

## MASTERS PROGRAMME

Academic Year: 2012-2014  
 Specialization: Core Programme  
 Module Coordinator: J.J.A. van Bruggen, PhD, MSc

### Module Sheet

Module Name Lake ecology		Module Code ES05bL	Credits 5
Target Group Programme target group	Prerequisites Programme prerequisites		

### Learning Objectives

Upon completion of the module participants will be able to..

- Characterise lakes based on formation, morphometry, mixing types and chemical composition of water;
- Describe the composition and production of plankton and benthic communities
- Evaluate factors influencing trophic interactions in lakes
- Evaluate climate change and anthropogenic impacts on lake ecosystems; generate suitable methods for their protection and management.
- Overall objective

At the end of this course the participants should be able to demonstrate the understanding of the structure and functioning of lake ecosystems, the interaction of physical, chemical and biological processes in lakes for their wise use and proper management.

### Topics and Learning Activities

#### Physical limnology and limno-chemistry

introduction to formation and structure of different lake ecosystems; lake morphometry; physical, chemical and biological characteristics of lake ecosystems; interactions of geomorphology and physico-chemical characteristics;

#### **Learning Activities:**

*lectures, laboratory work, field-work, group discussions, assignments and data analysis*

#### Plankton and benthic community composition & ecology

Plankton community composition (a. Phytoplankton composition and biomass estimation; b. Zooplankton composition (Rotifera, Cladocera, Copepoda)), macrophytes and macrozoobenthos composition; and biomass estimation:

#### **Learning Activities:**

*lectures, laboratory work, field-work, group discussions, assignments and data analysis*

#### Production (Primary and secondary production) and trophic relationships(energy flow) in lakes

Production in lakes: Primary (phytoplankton, macrophytes and periphyton) and secondary production. trophic relationships and energy flow in lakes; Role of microbes, zooplankton, fish and other organisms in trophic interactions;

#### **Learning Activities:**

*lectures, laboratory work, field-work, group discussions, assignments and data analysis*

#### Lake Management Strategies and Impact of Climate Change on Lakes

Climate change and anthropogenic impacts on lake ecosystems. Lake restoration and management strategies. Role of lakes in livelihoods: Case studies (L. Victoria, L. Baringo, L. Bogoria, L. Naivasha).

#### **Learning Activities:**

*lectures, laboratory work, field-work, group discussions, assignments and data analysis*

### Lecturing Material

- Lecture notes, laboratory manuals, reference materials (text books, scientific publications)

**Assessment**

- **60%: Written Exam (closed book)**
- **20%: Presentation**
- **10%: Lab Report**
- **10%: Assignment**

**2012/2014-ES05bL: Lake ecology**

Nr	Course/Topic	Lecture	Assignment	Workshop Case study Role play Exercise Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM: contact hours	SUM: study/load hours	Lecturer(s)
1	Module introduction	1						1	3	various lecturers
2	Lake formation, morphometry, types and classification	1						1	3	
3	Physical characteristics of lakes I: Temperature and L. Mixing types	1						1	3	
4	Physical characteristics of lakes II: Light attenuation	1						1	3	
5	Chemical characteristics of lakes I: Oxygen concentration	1						1	3	
6	Chemical characteristics of lakes II: Carbon systems	1						1	3	
7	Nutrients dynamics in lakes	1						1	3	
	Introduction to lake community structure	1						1	3	
	Fieldtrip Laker Naivasha: Preparation of reagents and equipment					1		1	2	
	Sampling L. Naivasha					4		4	4	
	Samples processing			2				2	2	
	L. Naivasha samples analysis				5			5	10	
	Lake Naivasha data presentation			3				3	3	
	Phytoplankton composition	1						1	3	
	Phytoplankton characteristics and biomass	1						1	3	
	Factors influencing phytoplankton growth, composition and distribution	1						1	3	
	Lake Sampling techniques	1						1	3	
	Phytoplankton identification and biomass (Chl-a) analysis				1			1	2	
	Phytoplankton biovolume analysis				2			2	4	
	Zooplankton composition	1						1	3	
	Zooplankton characteristics and biomass	1						1	3	
	Sampling techniques for zooplankton study	1			1			2	5	
	Zooplankton identification and biomass analysis				2			2	4	
	Primary production	1			2			3	7	
	Primary production measurements				2	2		4	6	
	Secondary production	1						1	3	
	Trophic relationships and energy flow in lakes	1						1	3	
	Climate change and Anthropogenic impacts on lakes	1						1	3	
	Lake restoration and management strategies	1						1	3	
	Case study I: Limnology of Lake Victoria	1						1	3	
	Case study II: Kenyan Great Rift Valley lakes	1						1	3	
	Lake Baringo and Bogoria				10	8		18	28	
	Examination		3						3	
	<b>Total</b>	<b>22</b>	<b>3</b>	<b>5</b>	<b>26</b>	<b>14</b>		<b>67</b>	<b>140</b>	

**MSc module - UNESCO-IHE**

# ENVIRONMENTAL SCIENCE

## MASTERS PROGRAMME

Academic Year: 2012-2014  
 Specialization: Core Programme  
 Module Coordinator: A.A. van Dam, PhD, MSc

### Module Sheet

Module Name Environmental systems analysis		Module Code ES05TM	Credits 5
<b>Target Group</b> Participants in the Environmental Science MSc-programme at UNESCO-IHE	<b>Prerequisites</b> BSc in a topic appropriate for admission to UNESCO-IHE Environmental Science MSc-programme (e.g., biology, agronomy, animal science, etc.) Modules 1-4 of Environmental Science programme		

### Learning Objectives

*Upon completion of the module participants will be able to..*

- List and describe environmental systems analysis (ESA) concepts and methods, and in particular the Ecosystem Services framework
- Perform a problem analysis and stakeholder analysis for a given environmental system
- Perform an analysis of ecosystem functions and services and their drivers of change for a given environmental system
- Construct a simple dynamic simulation model of an environmental system
- Discuss critically the strengths, weaknesses, missing information, advantages and disadvantages of the analyses
- Communicate effectively the methods, results and conclusions of a case study (presentation and written report)

### Topics and Learning Activities

#### Lectures Environmental Systems Analysis

Lectures with overview of module, learning goals, learning activities, and basic concepts of ESA. Lectures introducing ecosystem functions and services framework, Millennium Ecosystem Assessment, other concepts and frameworks for ecosystem functional analysis and assessment, scale aspects (temporal and spatial), examples of rivers and wetlands. Lecture introducing concept of drivers of change. Direct and indirect drivers, exogenous and endogenous drivers, impacts of drivers on decision makers and decision making at different spatial scales. Interactions between drivers. Examples of drivers of change. Case study Basse Cassemance, Senegal. Introduction to Bayesian Network models as tools for operationalizing causal network models of environmental systems. Bayes' theorem and conditional probability, components of a BN (nodes and links), conditional probability tables (CPTs), data requirements for BN models, example with case study of Nyando wetland, Kenya. Human well-being and livelihoods.

#### **Learning Activities:**

*Lectures, total 12 hours*

#### Problem analysis and conceptual models

Problem analysis and problem trees, rich pictures

#### **Learning Activities:**

*Group exercise, 4 hours*

#### Stakeholder analysis

Definitions of stakeholder and stakeholder analysis, importance and objectives of stakeholder participation in research and capacity development, primary and secondary stakeholders, identification of stakeholders and stages in stakeholder participation, strategic and participatory approach in stakeholder participation, stakeholder matrix, rich pictures, Venn diagrams, and influence and importance matrix

#### **Learning Activities:**

*Group exercise, 4 hours*

#### Guest lectures ESA

Guest lectures consist of the following topics:

1. Integrated Biodiversity Modelling, by Dr. Jan Janse and Mr. Wilfried van Rooij of the Netherlands Environmental Assessment Agency,
2. Ecosystem valuation, by Dr. Rudolf de Groot of the Environmental Systems Analysis group of Wageningen University.

#### **Learning Activities:**

*Lectures, 6 hours*



### **Exercise Environmental Systems Analysis**

During this exercise, participants apply the ESA concepts to case studies of environmental systems in different parts of the world. Participants work in group to use functional analysis, DPSIR analysis and causal networks and produce the relevant diagrams and figures. This material will be used for producing an individual report on the case studies. Part of these exercises is a writing workshop with peer review during which participants practice and improve their academic writing skills.

#### ***Learning Activities:***

*Exercise 8 hours + writing workshop 6 hours*

### **Field trip DELTARES**

During a visit to DELTARES in Delft, the DELTARES researchers present their work on modelling of ecosystems in various parts of the world. There is time for questions and discussion.

#### ***Learning Activities:***

*Field trip, 4 hours*

### **Modelling group work/case study**

Participants work in group to produce a simple dynamic simulation model of an environmental system. They use Stella as a modelling tool. They start by producing a conceptual model, then gather the data and information needed for constructing the mathematical model and for parameterization and calibration. The model is presented to the other participants during the last plenary session of the module.

#### ***Learning Activities:***

*Group work, 32 hours + final presentation, 4 hours*

### **Lecturing Material**

- Powerpoint presentations of all lectures
- Background reading materials consisting of scientific articles and other publications (list with reading materials to be provided at start of module)
- Case study descriptions and instructions for individual report and modelling group work

### **Assessment**

- **40%: Written Exam (closed book)**
- **40%: Assignment**
- **20%: Presentation**

**2012/2014-ES05TM: Environmental systems analysis**

Nr	Course/Topic	Lecture	Assignment	Workshop Case study Role play Exercise Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM:		Lecturer(s)
								contact hours	study/load hours	
1	Introduction ESA	2						2	6	van Dam
2	Ecosystem functions and services	4						4	12	Hes/van Dam
3	Drivers of change in ecosystems	2						2	6	van Dam
4	Bayesian Networks	2						2	6	van Dam
5	Human well-being and livelihoods	2						2	6	van Dam
6	Problem analysis & conceptual models		4						4	Hes
7	Stakeholder analysis		4						4	Hes
8	Integrated biodiversity modelling	4						4	12	Janse/van Rooij
9	Ecosystem valuation	2						2	6	de Groot
10	Field trip DELTARES						4	4	12	Kelderman/van Dam
11	Exercise ESA		8						8	van Dam
12	Group work (case study)	4		42				46	54	van Dam/Hes/Gettel
<b>Total</b>		<b>22</b>	<b>16</b>	<b>42</b>			<b>4</b>	<b>68</b>	<b>136</b>	
<b>MSc module - UNESCO-IHE</b>										

# ENVIRONMENTAL SCIENCE

## MASTERS PROGRAMME

Academic Year: 2012-2014  
 Specialization: Water quality management  
 Module Coordinator: P. Kelderman, PhD, MSc

### Module Sheet

Module Name Water quality assessment		Module Code ES05W	Credits 5
<b>Target Group</b> Young and mid-career professionals (scientists, consultants, decision makers) with a background in Water management or Environmental science.	<b>Prerequisites</b> Preferably a bachelor's degree in chemistry, chemical engineering, biology, environmental science, hydrology, geography or equivalent. Basic knowledge in computer operations (MS-Windows; Office). Good command of English.		

### Learning Objectives

Upon completion of the module participants will be able to..

- Describe the different water pollutant groups and their risks and fates
- Describe and apply the different criteria for successful monitoring of lakes, rivers and groundwaters
- Describe and apply a number of water quality models as a tool in Water management
- Design sustainable water quality monitoring programmes for river and lake basins

### Topics and Learning Activities

#### Water quality and monitoring

Water quality parameters. Natural water quality and pollution parameters. The monitoring cycle. Items of the monitoring programme: why, what, where, how, how often. Fieldwork and sampling. Physico-chemical and biological water quality assessment. Monitoring in the EU Water Framework Directive.

Case study: design of a sustainable water quality monitoring programme in an African river basin.

Practical field&lab work: sampling, preservation, field analyses; Quality control in the laboratory.

Groundwater monitoring: principles and case studies. Data reporting and presentation.

#### **Learning Activities:**

Lectures, exercises, groupwork, lab and fieldwork

#### Data analysis and presentation

Use of statistics in water quality monitoring. Statistical tests: t-test, confidence intervals, Q-test etc.; regression analysis.

Applications: minimum sampling frequency; significant differences between two data sets, etc.

Introduction to more advanced techniques such as ANOVA and FACTOR analysis.

Hands-on computer exercises

#### **Learning Activities:**

Lectures, exercises

#### Aquatic Ecotoxicology

Ecotoxicological tests. Environmental characteristics of pollutants. Sources, transport and fate of micropollutants.

Modelling and monitoring. Risk assessment and evaluation.

#### **Learning Activities:**

Lectures

#### Water quality modelling

Mathematical concepts; water and mass balances. Types and construction of water quality models. Simple In/Out

lake models: set up and exact solutions. Finite-difference approximations. BOD-DO modelling in a river system.

Modelling of micropollutants. Example: the Rhine and Danube alarm models. Good modelling practice.

Hands-on exercises with mass balances, and with the SOBEK model, for BOD-DO modelling.

#### **Learning Activities:**

Lectures, exercises

#### Fieldtrips

(Liable to changes, e.g. due to constraints at the side of the hosts): half-whole day visits are planned to water quality monitoring and modelling Institutions.

#### **Learning Activities:**

Excursions

## Lecturing Material

- P. Kelderman (2011) - Water quality and monitoring. UIHE lecture notes LN5/11/1.
- G.F. Kruis and P. Kelderman - Handout Fieldwork water quality monitoring and Laboratory QA/QC. Febr. 2011.
- P. Kelderman, H.A.M. de Kruijf and M. Mul (2011). Handout - Case study Water Quality Monitoring Network for the Inkomati River Basin in Mozambique. Febr. 2011.
- P. Kelderman (2010) - Handout data handling and presentation. Febr. 2010.
- H.A.M de Kruijf (2011). Handout Aquatic Ecotoxicology. Febr. 2011.
- E.M. Meyers (2011). Handout Water quality modelling. Febr 2011.
- E.M. Meyers and R.S. Penailillo Burgos (2009). Water quality modelling: Introduction SOBEK Exercise.
- Compiled powerpoint slides on Groundwater monitoring; powerpoint slides on all above topics; additional materials: relevant info, fieldtrips materials, etc.

## Assessment

- **70%: Written Exam (closed book)**
- **20%: Assignment**
- **10%: Lab Report**

2012/2014-ES05W: Water quality assessment												
Nr	Course/Topic	Lecture	Assignment	Workshop Case study	Role play Exercise	Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM: contact hours	SUM: studyload hours	Lecturer(s)
<b>1</b>	<b>Water Quality and Monitoring</b>											
1.1.	Introduction on Water quality	2								2	6	Kelderman
1.2.	Water quality monitoring and assessment	6								6	18	Kelderman, Kruis
1.3.	Case study water quality monitoring			3						3	3	De Kruijf, Kelderman
	<b>Å</b>											
<b>2</b>	<b>Data analysis and presentation</b>	<b>6</b>	<b>6</b>							<b>6</b>	<b>24</b>	Kelderman, van Dam
<b>3</b>	<b>Aquatic Ecotoxicology</b>											
3.1.	Principles of Aquatic Ecotoxicology	4								4	12	De Kruijf
3.2.	Environmental fate of micropollutants	4								4	12	De Kruijf
3.3.	Monitoring, modelling and risk assessment	4								4	12	De Kruijf
<b>4</b>	<b>Water quality modelling</b>	<b>8</b>	<b>6</b>							<b>8</b>	<b>30</b>	Meijers
<b>5</b>	<b>Lab/fieldwork water quality monitoring</b>		<b>4</b>	<b>8</b>						<b>8</b>	<b>12</b>	Kruis
6.	Fieldtrip							8		8	8	Kelderman
	<b>Exam</b>		<b>3</b>								<b>3</b>	
	<b>Total</b>	<b>34</b>	<b>19</b>		<b>11</b>			<b>8</b>		<b>53</b>	<b>140</b>	

MSc module - UNESCO-IHE

# ENVIRONMENTAL SCIENCE

## MASTERS PROGRAMME

Academic Year: 2012-2014  
 Specialization: Core Programme  
 Module Coordinator: J.J.A. van Bruggen, PhD, MSc

### Module Sheet

Module Name Stream and river ecology		Module Code ES06L	Credits 5
Target Group Programme target group	Prerequisites Programme prerequisites		

### Learning Objectives

Upon completion of the module participants will be able to..

- Overall Objective  
The aim of this module is to equip the participants with the skills and knowledge necessary in conservation and management of stream and river ecosystems for the benefit of humankind.
- Distinguish the main stream ecosystem boundaries at watershed, ecosystem and stream segment scales;
- Characterize the bio-geophysical components of watersheds;
- Relate and conceptualize the inter connectedness between riverine and other ecosystems;
- Analyse, identify and discriminate the various riparian vegetation in terms of their importance as sources of energy to streams;
- Assess water quality using physical and biological characteristics of the stream;  
Evaluate the importance of socio-economics in sustainable management of watersheds (riverine ecosystems);  
Design suitable sampling strategies for stream benthos (i.e. organic matter, biofilms, and nutrients).

### Topics and Learning Activities

#### Watershed ecology and management

Concepts of the watershed ecology and management. Watershed characteristics and geomorphology (climate, slopes, geology, geological structures, soils, geomorphology and land-use).

##### **Learning Activities:**

lectures, laboratory and fieldwork, case studies

#### Stream Characterization

structure and function of streams, basic concepts (river continuum, disturbance/stability, habitat template, connectivity, matter & energy flow and decomposition processes, drift, biozoenotic zonation, substrate characterization. Hydrological exchange processes in the hyporheic zone, floodplain ecology, Ecological integrity

##### **Learning Activities:**

lectures, laboratory and fieldwork, case studies

#### Stream hydrology

hydrologic flow paths and hydrodynamic exchange processes; aquatic-terrestrial connectivity; water current measurements; discharge calculations.

##### **Learning Activities:**

lectures, laboratory and fieldwork, case studies

#### River/stream riparian vegetation interactions/connectivity

vegetation types and distribution. Species composition, social biology, mapping, sampling and identification techniques

##### **Learning Activities:**

lectures, laboratory and fieldwork, case studies

#### Organic matter, biofilm and nutrient dynamics in streams and rivers

sampling techniques, sample processing and data analysis on organic matter, biofilm, and nutrient, POM & DOM, food-webs in streams and rivers

##### **Learning Activities:**

lectures, laboratory and fieldwork, case studies

#### Stream macroinvertebrate communities

Benthic invertebrates, taxonomic groups, bio-indicators, the role of macroinvertebrates in water quality monitoring

##### **Learning Activities:**

lectures, laboratory and fieldwork, case studies

#### Socio-economics of riverine ecosystem

Interaction of water & gender, water supply (quantity and quality), Water resource utilization conflicts, case studies

of socio-economics.

**Learning Activities:**

lectures, laboratory and fieldwork, case studies

**Lecturing Material**

- Lecture notes, laboratory guidelines & method descriptions, reference materials

**Assessment**

- 60%: Written Exam (closed book)
- 20%: Presentation
- 20%: Lab Report

2012/2014-ES06L: Stream and river ecology										
Nr	Course/Topic	Lecture	Assignment	Workshop Case study Role play Exercise Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM: contact hours	SUM: study/load hours	Lecturer(s)
	Introduction			1				1	1	M Erimba
	Watershed ecology	1				3		4	6	Gichaba
	Geomorphology and landuse	2						2	6	Gichaba
	Stream characterization, morphometry, ecosystems theories and concepts	3				3		6	12	M Erimba, Kitaka, Mathooko
	Riparian vegetation	3				3		6	12	Kariuki
	Organic matter, biofilms and nutrient dynamics	4				1		5	13	Kihia, Kitaka
	Stream hydrology & Physico-chemical parameters			2		3		5	5	Kitaka
	Invertebrate ecology	3		3		6		12	18	M Erimba
	Stream integrity	3						3	9	Raburu
	Floodplain, regulated rivers in tropics	2						2	6	Mathooko
	Socioeconomics, water and gender	2						2	6	Muhia
	Group work/lab		1	6		6		12	13	
	Excursion (Naromoru River)			7				7	7	
	Sample processing, Data analysis, presentations, and discussion			23				23	23	
	Exam			2				2	2	
	<b>Total</b>	<b>23</b>	<b>1</b>	<b>44</b>		<b>25</b>		<b>92</b>	<b>139</b>	
<b>MSc module - UNESCO-IHE</b>										

# ENVIRONMENTAL SCIENCE

## MASTERS PROGRAMME

Academic Year: 2012-2014  
 Specialization: Core Programme  
 Module Coordinator: Prof. J. Leentvaar, PhD, MSc

### Module Sheet

Module Name		Module Code	Credits
Water and environmental policy making		ES06M	5
<b>Target Group</b> The specialization is intended for professionals with an interest in environmental policy making in the water management (or related) context.	<b>Prerequisites</b> Programme prerequisites		

### Learning Objectives

*Upon completion of the module participants will be able to..*

- understand the nature of policy making as a continuous negotiation process
- identify the drivers of policy agendas and policy making decisions and explain them in terms of conflicting stakeholder interests
- apply basic tools and techniques to the planning and design of water and environmental policies
- interrelate water policies to other policy areas as well as to international environmental governance
- draw on the basic philosophy of team role management in negotiation processes

### Topics and Learning Activities

#### Water Policy and the Policy Cycle

Introduction principles governance, the relationship governance and policy, policy as continuous negotiation driven by interests and agendas of stakeholders, areas of environmental policy, and overview over socio-economically and naturally driven water issues and policy areas

#### **Learning Activities:**

*lectures, assignments and group discussions*

#### Policy Planning and Design - Tools and Methods

Principles of planning, policy analysis and environmental assessment methods, overview over policy instruments, basics of policy enforcement, and approaches to public participation in policy design and decision-making, application of policy analysis tools to assess a water conflict case

#### **Learning Activities:**

*lectures, classroom exercises, assignment (report) and group discussion/presentations*

#### International Processes, Network Management, and Negotiation

Global Environmental Change as driver for policy changes and international, integrated approaches to water management, network management, and basic of negotiation based on teamrole analysis

#### Round Table Discussion and Fieldtrip

Roundtable discussion with high-level Dutch government and NGO representatives on participatory policy making, fieldtrip to the Dutch Delta Works

#### **Learning Activities:**

*Groupwork and Fieldtrip*

### Lecturing Material

- Lectures
- Reader
- Handouts

### Assessment

- 70%: Written Exam (closed book)
- 20%: Assignment
- 10%: Homework

**2012/2014-ES06M: Water and environmental policy making**

Nr	Course/Topic	Lecture	Assignment	Workshop Case study Role play Exercise Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM: contact hours	SUM: study/load hours	Lecturer(s)
<b>1</b>	<b>Water Policy and the Policy Cycle</b>									
1.1	Introduction EPM	2						2	6	Prof. J. Leentvaar, PhD, MSc
1.2	Environmental Policy and Water Governance	3	1					3	10	Prof. J. Leentvaar, PhD, MSc
1.3	Water Agendas: Societal Demands and Policy Making	2	1					2	7	Prof. J. Leentvaar, PhD, MSc
1.4	Water as Environmental Issue	2						2	6	Prof. J. Leentvaar, PhD, MSc
<b>2</b>	<b>Policy Planning and Design - Tools and Methods</b>									
2.1	Principles of Planning	2						2	6	H. Clouting, PhD
2.2	Policy Analysis: Process and Methods	2	1					2	7	Prof. J. Leentvaar, PhD, MSc
2.3	Environmental Assessments: Introduction to EIA/SEA	2						2	6	H. Clouting, PhD
2.4	Policy Design and Decision Making Process	4	1					4	13	Prof. J. Leentvaar, PhD, MSc
2.5	Cases on Water Conflicts (Assignment)		4						4	
<b>3</b>	<b>International Processes, Network Management, and Negotiation</b>									
3.1	Water Governance in the Anthropocene	2						2	6	Prof. J. Leentvaar, PhD, MSc
3.2	Network Management	6	4					6	22	Ir M. Bijlsma, MBA
3.3	A Teamrole Approach to Negotiation	4	4					4	16	Prof. J. Leentvaar, PhD, MSc
<b>5</b>	<b>Round Table Discussion</b>			2				2	2	
<b>6</b>	<b>Fieldtrip</b>						8	8	24	
	<b>Exam</b>		3						3	
	<b>Total</b>	<b>31</b>	<b>19</b>	<b>2</b>			<b>8</b>	<b>41</b>	<b>138</b>	

**MSc module - UNESCO-IHE**



# ENVIRONMENTAL SCIENCE

## MASTERS PROGRAMME

Academic Year: 2012-2014  
Specialization: Core Programme  
Module Coordinator: H.J. Lubberding, PhD, MSc

### Module Sheet

Module Name Environmental engineering		Module Code ES06T	Credits 5
Target Group Programme target group	Prerequisites Programme prerequisites		

### Learning Objectives

Upon completion of the module participants will be able to..

- Describe the basic chemical and biological processes and their engineering in water and wastewater treatment;
- Evaluate different approaches to wastewater treatment and select the best option for local conditions.

### Topics and Learning Activities

#### Water treatment

Water is playing an essential role in relation with the environment and in this module it is shown, how man can actively intervene in its pollution. Man is using several simple and advanced techniques to produce reliable drinking water from groundwater and surface water

#### **Learning Activities:**

*Lectures, workshop, fieldtrip*

#### Wastewater treatment

To limit environmental pollution wastewater has to be treated; an overview of basic processes available for the treatment of domestic and industrial wastewater, with special emphasis on natural processes and systems that can be applied, is given in wastewater treatment

#### **Learning Activities:**

*Lectures, laboratory.*

#### Environmental Process Technology

For a better understanding of water and wastewater treatment the principles of mass balances, reaction kinetics and reactor design are discussed in environmental process technology

#### **Learning Activities:**

*Lectures, workshop*

#### Lecturing Material

- Lecture notes Water treatment
- Lecture notes + laboratory notes wastewater treatment
- Lecture notes EPT

#### Assessment

- 50%: Written Exam (closed book)
- 25%: Assignment
- 25%: Assignment

**2012/2014-ES06T: Environmental engineering**

Nr	Course/Topic	Lecture	Assignment	Workshop Case study Role play Exercise Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM: contact hours	SUM: study/load hours	Lecturer(s)
	<b>Water treatment</b>		<b>20</b>	<b>8</b>				<b>8</b>	<b>28</b>	Buiteman
	<b>Wastewater treatment, natural processes</b>	<b>16</b>		<b>16</b>				<b>32</b>	<b>64</b>	van Bruggen, van der Steen, Lubberding, Kelderman
	<b>Environmental process technology</b>		<b>20</b>	<b>16</b>				<b>16</b>	<b>36</b>	Bijlsma
	<b>Fieldtrip</b>						<b>4</b>	<b>4</b>	<b>12</b>	Å
	<b>Exam</b>		<b>2</b>						<b>2</b>	
	<b>Total</b>	<b>16</b>	<b>42</b>	<b>40</b>			<b>4</b>	<b>60</b>	<b>142</b>	
<b>MSc module - UNESCO-IHE</b>										

# ENVIRONMENTAL SCIENCE

## MASTERS PROGRAMME

Academic Year: 2012-2014  
Specialization: Core Programme  
Module Coordinator: J.J.A. van Bruggen, PhD, MSc

### Module Sheet

Module Name Wetlands for water quality		Module Code ES06W	Credits 5
Target Group Programme target group	Prerequisites Programme prerequisites		

### Learning Objectives

*Upon completion of the module participants will be able to..*

- assess the value of wetlands and explain the use of natural and constructed wetlands for the treatment of wastewater;
- describe the concept of wastewater treatment by wetlands;
- design and operate a wetland treatment system.

### Topics and Learning Activities

#### Introduction on natural wetlands

what are wetlands, where are wetlands, wetland ecology, biodiversity, economics. The role of wetlands in the catchment: general aspects, hydrological aspects, wetlands as buffers and the role in relation to climate.

#### **Learning Activities:**

*lectures, and video presentations.*

#### Natural wetlands for wastewater treatment

the basic principles, the advantages and disadvantages, the risks. Examples in a temperate climate and examples in the tropics.

#### **Learning Activities:**

*lectures, and video presentations.*

#### Constructed wetlands for wastewater treatment

the different types, the design and criteria for design. Advantages and disadvantages. Constructed wetlands in The Netherlands, the tropics and the rest of the world.

#### **Learning Activities:**

*lectures, and video presentations, field trip*

#### Integrated wetland production systems

theory, examples, advantages, disadvantages, economics, nutrient flows. Modelling of integrated production systems.

Field visits.

#### **Learning Activities:**

*lectures, and video presentations, assignment*

### Lecturing Material

- Lecture notes and case studies

### Assessment

- 60%: Written Exam (closed book)
- 40%: Assignment

**2012/2014-ES06W: Wetlands for water quality**

Nr	Course/Topic	Lecture	Assignment	Workshop Case study Role play Exercise Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM:		Lecturer(s)
								contact hours	study/load hours	
1	Introduction into the module	1						1	3	
2	Wetlands	8	2					8	26	
3	Wastewater treatment aspects	6						6	18	
4	Natural wetlands for water treatment	4						4	12	
5	Constructed wetlands	14						14	42	
6	Integrated production systems	6						6	18	
7	Fieldtrip					16		16	16	
8	Exam		3						3	
	<b>Total</b>	<b>39</b>	<b>5</b>			<b>16</b>		<b>55</b>	<b>138</b>	

**MSc module - UNESCO-IHE**

# ENVIRONMENTAL SCIENCE

## MASTERS PROGRAMME

Academic Year: 2012-2014  
Specialization: Core Programme  
Module Coordinator: J.J.A. van Bruggen, PhD, MSc

### Module Sheet

Module Name Tropical wetlands for water quality		Module Code ES07L	Credits 5
Target Group Programme target group	Prerequisites Programme prerequisites		

### Learning Objectives

Upon completion of the module participants will be able to..

- Identify types of wetlands and explain processes in natural wetlands, assess their functions and values
- Evaluate the water quality function and explain the process of wastewater purification by natural and constructed wetlands
- Design and operate constructed wetland for wastewater treatment

### Topics and Learning Activities

#### Introduction to natural wetlands

Definition and characteristics of wetlands, classification, wetland biota, vegetation zonation and dynamics, wetland assessment and monitoring, functions and values, sustainable use and community based wetland management, wetlands and climate.

#### **Learning Activities:**

lectures, fieldwork, laboratory work, structured exercises, assignment, group and individual presentations and discussions. Field work will include natural and constructed wetlands.

The ability to make a proper design for the treatment of wastewater by a constructed wetland will be tested by group and or individual assignment.

#### Wastewater sources & characteristics

challenges and options for wastewater management-conventional wastewater treatment, use of wetlands and Eco-sanitation.

#### **Learning Activities:**

lectures, fieldwork, laboratory work, structured exercises, assignment, group and individual presentations and discussions. Field work will include natural and constructed wetlands.

The ability to make a proper design for the treatment of wastewater by a constructed wetland will be tested by group and or individual assignment.

#### Use of natural wetlands for wastewater treatment

basic principles, the role of the different wetland components (biota, soil and water), contaminant removal mechanisms, Natural wetlands for water treatment-Case studies on wetlands for water quality.

#### **Learning Activities:**

lectures, fieldwork, laboratory work, structured exercises, assignment, group and individual presentations and discussions. Field work will include natural and constructed wetlands.

The ability to make a proper design for the treatment of wastewater by a constructed wetland will be tested by group and or individual assignment.

#### Constructed wetlands for wastewater treatment

Why constructed wetlands? Types of constructed wetlands, factors influencing performance, design, construction and set up (features, criteria, wetland sizing, planting), operation and maintenance, case studies-industrial and domestic constructed wetlands for wastewater treatment and modelling. Economics of constructed wetlands and re-use of treated wastewater.

#### **Learning Activities:**

lectures, fieldwork, laboratory work, structured exercises, assignment, group and individual presentations and discussions. Field work will include natural and constructed wetlands.

The ability to make a proper design for the treatment of wastewater by a constructed wetland will be tested by group and or individual assignment.

### Lecturing Material

- Lecture notes, Laboratory manuals, case studies, reference materials (books, scientific publications).

### Assessment

- 60%: Written Exam (closed book)
- 10%: Assignment
- 20%: Presentation
- 10%: Integrated in modules

2012/2014-ES07L: Tropical wetlands for water quality										
Nr	Course/Topic	Lecture	Assignment	Workshop Case study Role play Exercise Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM: contact hours	SUM: study/load hours	Lecturer(s)
1	Introduction			1				1	1	
2	Natural wetlands	8	3	9		6		23	42	Kipkemboi
3	Wastewater and treatment options	3		1		8		12	18	Kipkemboi
4	Natural wetlands for WWT	5		2				7	17	Muchiri/Abira
5	Constructed wetlands for WWT	8	13	14		8		30	59	Kansiime/Ngiringacha
	Examination									Kimwaga/Abira
	<b>Total</b>	<b>24</b>	<b>16</b>	<b>27</b>		<b>22</b>		<b>73</b>	<b>137</b>	

MSc module - UNESCO-IHE

# ENVIRONMENTAL SCIENCE

## MASTERS PROGRAMME

Academic Year: 2012-2014  
Specialization: Core Programme  
Module Coordinator: H. Clouting, PhD

### Module Sheet

Module Name		Module Code	Credits
Environmental planning and implementation		ES07MW	5
<b>Target Group</b> Young and mid-career professionals (scientists, decision-makers) with a background in environmental management, water management and / or watershed management.	<b>Prerequisites</b> Affinity with environment policy and enforcement, development economics, and preferably experience in water management arena. Good command of English.		

### Learning Objectives

*Upon completion of the module participants will be able to..*

- Explain the concept and importance of sustainable development into environmental planning and management
- Apply and discuss economic valuation methods and policy instruments for environmental policy
- Explain principles, processes and methods of environmental assessment (EIA-SEA) and be able to apply them in water related plans, programmes and projects
- Apply basic theories behind policy enforcement, monitoring and evaluation to master effective environmental policies
- Use environmental information systems to support planning and management

### Topics and Learning Activities

**Sustainable Development**

**Environmental Planning Process**

**Environmental Assessments (EIA/SEA)**

**Environmental Economics**

**Environmental Policy Enforcement**

### Lecturing Material

- Lecture Notes
- Additional Reading Materials
- Lecture powerpoint slides

### Assessment

- **70%: Written Exam (closed book)**
- **30%: Assignment**

**2012/2014-ES07MW: Environmental planning and implementation**

Nr	Course/Topic	Lecture	Assignment	Workshop Case study Role play Exercise Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM: contact hours	SUM: study/load hours	Lecturer(s)
1	Sustainable Development	6	8					6	26	Hoekstra
2	Environmental Planning	2						2	6	Hamdard
3	Environmental Economics	14						14	42	Bijlsma
4	Environmental Assessment (EIA/SEA)	10	8					10	38	Vis, Clouting, Hamdard
5	Environmental Policy Enforcement	5	6					5	21	Douven, Guest lecture
6	Fieldtrip					8		8	8	Hamdard
7	Exam		3						3	
<b>Total</b>		<b>37</b>	<b>25</b>			<b>8</b>		<b>45</b>	<b>144</b>	

**MSc module - UNESCO-IHE**



# ENVIRONMENTAL SCIENCE

## MASTERS PROGRAMME

Academic Year: 2012-2014  
 Specialization: Environmental Science and Technology  
 Module Coordinator: P. Kelderman, PhD, MSc

### Module Sheet

Module Name Environmental monitoring and modelling		Module Code ES07T	Credits 5
<b>Target Group</b> Young and mid-career professionals (scientists, consultants, decision makers) with a background in Water management or Environmental science	<b>Prerequisites</b> Preferably a bachelor's degree in Chemistry, Biology, Environmental science, Hydrology, or related/equivalent. Basic knowledge in computer operations (MS Windows; Office). Good command of English		

### Learning Objectives

*Upon completion of the module participants will be able to..*

- Describe and apply main monitoring requirements and programmes for surface water, groundwater and air, and some common analytical techniques used therein.
- Describe and apply the different criteria for successful monitoring of lakes and rivers.
- Describe and apply basic Environmental Impact Assessment techniques.
- Describe and apply a number of water quality models as a tool in Environmental management.

### Topics and Learning Activities

#### Water quality and monitoring

Introduction on Environmental monitoring. Water quality parameters. Natural water quality and pollution parameters. The monitoring cycle. Items of the monitoring programme: why, what, where, how, how often. Fieldwork and sampling. Physico-chemical and biological water quality assessment. Monitoring in the EU Water Framework Directive. Practical field&lab work: sampling, preservation, field analyses; Quality control in the laboratory.

#### **Learning Activities:**

*Lectures, exercises, lab and fieldwork*

#### Groundwater monitoring and modelling

Basics of Hydrogeology. Main groundwater pollutants. Groundwater monitoring: objectives, surveys, design and installation; monitoring in the EU-WFD. Groundwater modelling: concepts and mathematical background; MODFLOW and PMWIN.

#### **Learning Activities:**

*Lectures, exercises*

#### Air quality monitoring and modelling

Impacts of main air quality pollutants. Emission and dispersion under different meteorological conditions. Air quality monitoring: background; networks (EMEP, GEMS, etc.); automated instrumentation. Examples of air quality models: CAR, LOTOS, etc. Case studies and exercises: Emission data base; setting up a monitoring network; hands-on computer exercises with air quality models.

#### **Learning Activities:**

*Lectures, exercises*

#### Water quality modelling

Some mathematical concepts; water and mass balances. Types and construction of water quality models. Finite-difference approximations. BOD-DO modelling in a river system. Modelling of micropollutants. Example: the Rhine and Danube alarm models. Good modelling practice. Hands-on exercises with mass balances, and with the SOBEK model, for BOD-DO modelling.

#### **Learning Activities:**

*Lectures, exercises*

#### Environmental Impact assessment

Objectives of EIA; participants and approaches. Screening tables. Scoping and mitigation. Identification of impacts; Impact matrix: scaling and weighing. Factors of success; cost of EIA. Practical examples such as Impacts of dams and reservoirs. Hands-on exercises EIA.

#### **Learning Activities:**

*Lectures, exercises*

#### Laboratory Environmental monitoring

Introduction to the different techniques and instruments. Analysis of heavy metals with AAS: sample destruction, use of conventional and graphite oven AAS. Analysis of organic micropollutants with GC; standards; detectors. Quality Control in AAS and GC.

**Learning Activities:**

Laboratory work

**Fieldtrip**

(Liable to changes, e.g. due to constraints at the side of the hosts): A whole-day visit is planned to water and air quality monitoring/modelling Institutions.

**Learning Activities:**

Excursions

**Lecturing Material**

- P. Kelderman (2011) - Water quality and monitoring. UIHE lecture notes LN5/11/1.
- G.F. Kruis and P. Kelderman (2011) - Handout Fieldwork water quality monitoring and Laboratory QA/QC. Febr. 2011.
- M.P. Keuken (2010). Air quality monitoring and modelling. UIHE lecture notes LN63/10/1
- E.M. Meyers (2011). Handout Water quality modelling. Febr 2011.
- E.M. Meyers and R.S. Penailillo Burgos (2009). Water quality modelling: Introduction SOBEK Exercise. UIHE lecture notes LN415/9/1
- Compiled powerpoint slides on Groundwater monitoring; EIA; powerpoint slides on all above topics; additional materials: relevant info, fieldtrips materials, etc.

**Assessment**

- 70%: Written Exam (closed book)
- 20%: Assignment
- 10%: Lab Report

2012/2014-ES07T: Environmental monitoring and modelling										
Nr	Course/Topic	Lecture	Assignment	Workshop Case study Role play Exercise Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM: contact hours	SUM: studyload hours	Lecturer(s)
<b>1</b>	<b>Water quality and monitoring</b>									
1.1	Introduction on Environmental monitoring			2				2	2	McClain
1.2	Water quality monitoring	4	4	4	8	8		24	44	Kelderman, Kruis
<b>2</b>	<b>Groundwater monitoring and modelling</b>	<b>6</b>						<b>6</b>	<b>18</b>	Foppen
<b>3</b>	<b>Air quality monitoring and modelling</b>	<b>6</b>		<b>6</b>				<b>12</b>	<b>24</b>	Keuken
<b>4</b>	<b>Water quality modelling</b>	<b>6</b>		<b>4</b>				<b>10</b>	<b>22</b>	Meijers
<b>5</b>	<b>Environmental Impact assessment</b>	<b>4</b>		<b>8</b>				<b>12</b>	<b>20</b>	Vis, Clouting
<b>6</b>	<b>Laboratory Environmental monitoring</b>			<b>8</b>				<b>8</b>	<b>8</b>	Kruis
	<b>Exam</b>		<b>3</b>						<b>3</b>	
	<b>Å</b>									
	<b>Total</b>	<b>26</b>	<b>7</b>	<b>32</b>	<b>8</b>	<b>8</b>		<b>74</b>	<b>141</b>	
<b>MSc module - UNESCO-IHE</b>										

# ENVIRONMENTAL SCIENCE

## MASTERS PROGRAMME

Academic Year: 2012-2014  
 Specialization: Core Programme  
 Module Coordinator: J.J.A. van Bruggen, PhD, MSc

### Module Sheet

Module Name Fisheries and aquaculture		Module Code ES08L	Credits 5
Target Group Programme target group		Prerequisites Programme prerequisites	

### Learning Objectives

Upon completion of the module participants will be able to..

- Evaluate global/national production trends and emerging issues in fisheries
- Appraise and apply the ecology of fish to fisheries management and aquaculture exploitation
- Evaluate the interaction of fish and the environment (water quality, environmental impacts, etc.)
- Appraisal of aquaculture systems and their productivity potential
- Assess interactions and emerging issues on fish and people
- Evaluate techniques for fish post-harvest handling (preservation, processing, packaging & Marketing)

Appraise measures to reduce fish diseases and fish parasites in aquaculture

### Topics and Learning Activities

#### Capture fisheries and management

global and regional production trends; economic contribution of capture fisheries; status and dynamics of inland fisheries; marine fisheries; fisheries management (fishermen, fishing gears, destructive fishing methods and efforts, environmental impacts of fisheries); emerging fisheries issues (e.g. transboundary conflicts, alien species).

#### Learning Activities:

lectures, laboratory work, field-work, excursions, sampling, sample processing, data analysis and group discussion on case studies. Field-work is done at Lake Victoria and experimental fish-ponds at Egerton University. Excursions are organized to cage culture sites, a fish hatchery and a marine fish culture farm.

#### Fish ecology

Temporal and spatial distribution (abiotic and biotic factors); life history and reproduction strategies; habitats and resources partitioning; food habits; trophic relationships; sampling techniques and methods of fish stock assessment; wild fish diseases and parasites

#### Learning Activities:

lectures, laboratory work, field-work, excursions, sampling, sample processing, data analysis and group discussion on case studies. Field-work is done at Lake Victoria and experimental fish-ponds at Egerton University. Excursions are organized to cage culture sites, a fish hatchery and a marine fish culture farm.

#### Socio-economics

People and fish;- socio-economic challenges in fisheries development (sectorial conflicts, trade, poverty alleviation); policies and emerging issues; economic valuation in fisheries and aquaculture

#### Learning Activities:

lectures, laboratory work, field-work, excursions, sampling, sample processing, data analysis and group discussion on case studies. Field-work is done at Lake Victoria and experimental fish-ponds at Egerton University. Excursions are organized to cage culture sites, a fish hatchery and a marine fish culture farm.

#### Aquaculture

Introduction to aquaculture. Definition & principles, species & site selection, types of ponds. production trends, potential, limitations and risks; water quality and pond management (liming, fertilization, environmental carrying capacity, stocking densities, predation control); main culture systems; key factors affecting fish growth; fish breeding; fingerling production enhancement; manipulation of production systems (feeding rates/frequencies, integrated systems, etc.); fish breeding & genetics, selective breeding, Fish nutrition fish feed formulation, processing and handling; environmental impacts of aquaculture practices, introduction to mariculture

**Learning Activities:**

lectures, laboratory work, field-work, excursions, sampling, sample processing, data analysis and group discussion on case studies. Field-work is done at Lake Victoria and experimental fish-ponds at Egerton University. Excursions are organized to cage culture sites, a fish hatchery and a marine fish culture farm.

**Post- harvest and fish handling**

harvesting techniques; processing and preservation techniques

**Learning Activities:**

lectures, laboratory work, field-work, excursions, sampling, sample processing, data analysis and group discussion on case studies. Field-work is done at Lake Victoria and experimental fish-ponds at Egerton University. Excursions are organized to cage culture sites, a fish hatchery and a marine fish culture farm.

**Fish pathology and parasitology**

parasites and diseases, zoonotic fish diseases and economic importance

**Learning Activities:**

lectures, laboratory work, field-work, excursions, sampling, sample processing, data analysis and group discussion on case studies. Field-work is done at Lake Victoria and experimental fish-ponds at Egerton University. Excursions are organized to cage culture sites, a fish hatchery and a marine fish culture farm.

**Lecturing Material**

• Lecture notes, laboratory & fieldwork, Excursion, manuals, videos, reference materials (text books, scientific publications)

**Assessment**

- 60%: Written Exam (closed book)
- 10%: Integrated in modules
- 20%: Presentation
- 10%: Integrated in modules

**2012/2014-ES08L: Fisheries and aquaculture**

Nr	Course/Topic	Lecture	Assignment	Workshop Case study Role play Exercise Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM: contact hours	SUM: studyload hours	Lecturer(s)
1.0	Fisheries and management	4		8				12	20	Njiru, Manyala, Jembe
1.1	Socio-economics: fish & people	2		2				4	8	Muhia
2.1	Fish ecology	4		8				12	20	Njiru , Manyala
2.2	Fish diseases and parasites	2		10				12	16	Mbuthia, Wathuta
2.3	Aquaculture & ecology of fishponds	12		15				27	51	Liti, Munguti, Lokoruka, Charo
2.4	Data analysis			12				12	12	All resource persons
3.0	Excursion					13		13	13	Munguti, Kitaka
4.0	Exam			3				3	3	
<b>Total</b>		<b>24</b>		<b>58</b>		<b>13</b>		<b>95</b>	<b>143</b>	

**MSc module - UNESCO-IHE**

# WATER MANAGEMENT

## MASTERS PROGRAMME

Academic Year: 2012-2014

Specialization: Core Programme

Module Coordinator: Prof. P. van der Zaag, PhD, MSc /J.Kemerink, MSc

### Module Sheet

Module Name Water and environmental law		Module Code ES08MW	Credits 5
<b>Target Group</b> Young and mid-career professionals and middle level decision-makers dealing with water management.	<b>Prerequisites</b> Preferably a relevant water science and engineering related bachelor's degree or equivalent; affinity with water management; good command of English.		

### Learning Objectives

*Upon completion of the module participants will be able to..*

- to describe and understand the fundamentals of national and international water and environmental law and legislation.
- to perceive and apply accepted and desired legal and institutional arrangements for applying principles of Integrated Water Resources and Environmental Management.
- to describe and apply legal instruments for the application of IWRM with the emphasis on functional decentralization, river basin organizations, planning and decision-making through water allocation criteria, systems of water rights, water (effluent) permit systems etc.
- to perceive and appraise concepts of customary water rights.
- to get insight in to processes of international water allocation.
- to explain the concept of multi-level governance and the relationship between national and international legal and policy systems.

to be able to persuasively argue a case for international water conflict resolution.

### Topics and Learning Activities

#### Introduction to national and international water law and institutions

Comparative environmental law and water law principles. Innovative legal and policy instruments; changing patterns of global governance. Introduction to the UN system. Introduction to the Law of Treaties. Key international environmental and water treaties. Principles of dispute resolution.

#### Processes of water policy development

Water sector reform, functional decentralization and development and benchmarking of river basin organizations.

#### Systems of (transboundary) water allocation and (customary) water rights

Shared vision and strategy development, water and benefit sharing from international rivers.

#### Regulations for international and trans-boundary water quality management

EU Framework Directive, Dutch water policy and organizations, application of environmental standards and others.

### Lecturing Material

- F.G.W. Jaspers- Legal Arrangements for Water Governance, UNESCO-IHE Lecture Notes.
- F.G.W. Jaspers- Role Play International Rivers, UNESCO-IHE Lecture Note.
- F.G.W. Jaspers- Introduction in Contract Management, UNESCO-IHE Lecture Note.
- J. Gupta- International Water Law and Institutions, UNESCO-IHE Lecture Note.
- P. van der Zaag e.a- Legislation of International Waters, UNESCO-IHE Lecture Note.
- Various inputs from guest lecturers.

### Assessment

- **100%: Written Exam (closed book)**

**2012/2014-ES08MW: Water and environmental law**

Nr	Course/Topic	Lecture	Assignment	Workshop Case study Role play Exercise Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM: contact hours	SUM: study/load hours	Lecturer(s)
<b>1</b>	<b>Water Law</b>									
1.1	Introduction to Water Law	2						2	6	Jaspers
1.2	Conflict Resolution			4				4	4	Gupta
1.3	International Environmental Law	12						12	36	Gupta
1.4	Contract Management	4		2				6	14	Jaspers
1.5	Regulations Water Quality Management	4						4	12	Hendry
1.6	EU Water Framework Directive			4				4	4	Hendry
<b>2</b>	<b>Legal Arrangements</b>									
2.1	River Basin Organization (Intro)	4		4				8	16	Jaspers
2.2	Legal Instruments	4						4	12	Jaspers
2.3	Water Rights and Allocation	4						4	12	Jaspers
2.4	International Water Sharing	4						4	12	van der Zaag
2.5	Customary Water Rights	4		6				10	18	van der Zaag
<b>3</b>	<b>Role Play International Rivers</b>									Jaspers
<b>4</b>	<b>Electives* (may not be offered every year)</b>									
4.1	Workshop Sector Reform			6				6	6	Jaspers
4.2	Case Studies			4				4	4	To be announced
<b>5</b>	<b>Fieldtrip</b>									Jaspers
	<b>Exam</b>									
	<b>Total</b>	<b>42</b>		<b>30</b>				<b>72</b>	<b>156</b>	
<b>MSc module - UNESCO-IHE</b>										

# ENVIRONMENTAL SCIENCE

## MASTERS PROGRAMME

Academic Year: 2012-2014  
 Specialization: Core Programme  
 Module Coordinator: M.A. Siebel, PhD, MSc, PE

### Module Sheet

Module Name Cleaner production & the water cycle		Module Code ES08T	Credits 5
<b>Target Group</b> The module is directed at engineers and scientists working in the urban or industrial water field and wanting to have a better grasp at the efficient dealing with water. As such the module is of interest to engineers and scientists in the fields of urban, municipal and industrial sanitation, water-related chemistry and biology, water resources, process design and implementation.	<b>Prerequisites</b> Participants should possess a BSc degree in an area relate environmental engineering and science, microbiology, chemical engineering, chemistry, public health, etc. Professional experience in the water field helps to fully grasp the significance of the back-ground thinking relayed in the module and of the practical benefits of some of the concepts presented. A good command of the English language is required.		

### Learning Objectives

Upon completion of the module participants will be able to..

- suggest options for preventing pollution within urban and industrial water management settings;
- assess the environmental impact of products and processes;
- suggest treatment/disposal methods for industrial wastewater from which the value has been taken out;
- understand the importance of environmental management systems in the industrial context;
- suggest methods for the management of wastewater nutrients using a three steps approach;
- make basic calculations related to life cycle analysis.

### Topics and Learning Activities

#### Introduction to the field of Cleaner Production

What is Cleaner Production (CP)? How did it develop, in what context? How can Cleaner Production be applied to industrial, domestic, institutional management? How does Cleaner Productin relate to Water Management

##### **Learning Activities:**

*Introductory lectures, group discussions, application in own (home) conditions*

#### Life Cycle Analysis, Eco Design and Material Flow Analysis

What is Life Cycle Analysis (LCA)? What does it aim at? How does it work in practice and what is the practical significance of LCA?

##### **Learning Activities:**

*Lectures, examples, calculational exercises*

#### Environmental Management Systems

What is Environmental Management, what are Environmental Management Systems (EMS)? What are the major components? How does ESM relate to environmental issues? What is the industrial perspective of ESM? Does is EMS applied to industrial systems?

##### **Learning Activities:**

*Lectures, group studie, group exercises, calculation examples*

#### Urban Water Management

What is Urban Water Management (UWM)? What is the role of CP in UWS? What practical benefit can be achieved when CP is applied to UWM?

##### **Learning Activities:**

*Lectures, movie, discussion, learning by practice, designing your own urban water saving system*

#### Industrial Water Management

What is Industrial Water Management (IWM)? What does industry management water? WHat are pitfalls, what are options? What is the role of CP in UWM?

##### **Learning Activities:**

*Lectures, group exercises, calculations, discussion*

#### Nutrient Management

What is nutrient management? How does it relate to water management? What are the benefits of managing nutrients in the water phase? What are consequences?

**Learning Activities:**

Lectures, movie, calculation exercises, group discussion, application exercises to own conditions

**Lecturing Material**

- Lecture notes in electronic form
- Reading materials published by others
- Case studies
- Movies
- Group work, group discussions, role play

**Assessment**

- **60%: Written Exam (open book)**
- **35%: Assignment**
- **5%: Presentation**

2012/2014-ES08T: Cleaner production & the water cycle										
Nr	Course/Topic	Lecture	Assignment	Workshop Case study Role play Exercise Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM: contact hours	SUM: studyload hours	Lecturer(s)
	Introduction to the field of Cleaner Production			4				4	4	Siebel
	Tools in cleaner production	2						2	6	Siebel
	À Life cycle analysis	4						4	12	Dijk
	Environmental management systems	2	4	2				4	12	Stans
	Urban water management		2	4				4	6	Siebel
	Industrial water management	4						4	12	Hill
	Recovery and re-use of wastewater	4						4	12	van der Steen
	À Simulation game			6				6	6	Siebel
	Group exercise	2	8	38				40	52	Siebel
	Field trip		4			8		8	12	Siebel
	Exam		3						3	
	<b>Total</b>	<b>18</b>	<b>21</b>	<b>54</b>		<b>8</b>		<b>80</b>	<b>137</b>	
<b>MSc module - UNESCO-IHE</b>										



# ENVIRONMENTAL SCIENCE

## MASTERS PROGRAMME

Academic Year: 2012-2014  
Specialization: Limnology and Wetland Management  
Module Coordinator: Edwin M.A. Hes

### Module Sheet

Module Name		Module Code	Credits
Wetlands for livelihoods and conservation		ES09L	5
Target Group	Prerequisites		
Programme target group	Programme prerequisites		

### Learning Objectives

Upon completion of the module participants will be able to..

- understand the concept of ecosystem functions and services, and means of assessing it;
- develop adaptive management for wetlands in response to climate change;
- analyse problems and formulate objectives according to the Objective Oriented Planning (OOP) method;
- analyse systematically the role that stakeholders have in wetland planning and management;
- develop and carry out stakeholder interviews and surveys;
- construct a wetland management plan based on the guidelines of the Ramsar Convention.

### Topics and Learning Activities

#### Ecosystem functions and services

**Learning Activities:**

*lectures, field-work and data analysis*

#### Climate change as a driver of change in wetland management planning

**Learning Activities:**

*lectures and exercises*

#### Objective Oriented Planning

Developing a wetland management plan according to the guidelines of the Ramsar Convention

**Learning Activities:**

*lectures, field-work and case study*

#### Stakeholder analysis and participatory approaches

**Learning Activities:**

*lectures, field-work, case study and role play*

### Lecturing Material

- Case study descriptions
- PowerPoint presentations
- Selected scientific and other publications

### Assessment

- 40%: Written Exam (closed book)
- 40%: Assignment
- 20%: Presentation

**2012/2014-ES09L: Wetlands for livelihoods and conservation**

Nr	Course/Topic	Lecture	Assignment	Workshop Case study Role play Exercise Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM: contact hours	SUM: study/load hours	Lecturer(s)
	Ecosystem functions and services	8		4		16		28	44	
	Climate change as a driver of change in wetland management planning	8		4				12	28	
	Objective Oriented Planning	2		16		16		34	38	
	Stakeholder analysis and participatory approaches	2		14		8		24	28	
	Examination		2						2	
	<b>Total</b>	<b>20</b>	<b>2</b>	<b>38</b>		<b>40</b>		<b>98</b>	<b>140</b>	
<b>MSc module - UNESCO-IHE</b>										

# ENVIRONMENTAL SCIENCE

## MASTERS PROGRAMME

Academic Year: 2012-2014  
Specialization: Core Programme  
Module Coordinator: J.J.A. van Bruggen, PhD, MSc

### Module Sheet

Module Name Foreign fieldtrip and fieldwork ES		Module Code ES09TMW	Credits 5
<b>Target Group</b> Programme target group	<b>Prerequisites</b> Programme prerequisites		

### Learning Objectives

*Upon completion of the module participants will be able to..*

- The international fieldtrip is an exposure tour to interesting sites in Europe and is aimed to become familiar with environment-related organisations and companies in Western Europe.
- After completion of the fieldwork participants will be able to conduct experimental fieldwork.

### Topics and Learning Activities

#### International Fieldtrip

Excursions to environment-related organisations and companies in Western Europe.

#### **Learning Activities:**

*Excursions*

#### Fieldwork

In the integrated fieldwork, hydrological, chemical and biological measurements will be integrated into an overall evaluation of the water quality in a river basin in relation to land use.

#### **Learning Activities:**

*Fieldwork in a river system*

### Lecturing Material

- Practical and field guides

### Assessment

- **100%: Integrated in modules**

**2012/2014-ES09TMW: Foreign fieldtrip and fieldwork ES**

Nr	Course/Topic	Lecture	Assignment	Workshop Case study Role play Exercise Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM: contact hours	SUM: study/load hours	Lecturer(s)
1.0	International fieldtrip					88		88	88	van Bruggen
<b>2</b>	<b>Fieldwork</b>									
2.1	Introduction	1					4	5	15	deRuyter, Venneker
2.2	Land use and soil quality		4	6		4		10	14	Hartemink
2.3	Chemical & biological water quality					4		4	4	deRuyter, Kruis
2.4	GIS					4		4	4	vandeVeer
2.5	Biomonitoring	1						1	3	Rousseau
3.0	Data analysis		8						8	deRuyter, vandeVeer
	<b>Total</b>	<b>2</b>	<b>12</b>	<b>6</b>		<b>100</b>	<b>4</b>	<b>112</b>	<b>136</b>	
<b>MSc module - UNESCO-IHE</b>										

# ENVIRONMENTAL SCIENCE

## MASTERS PROGRAMME

Academic Year: 2012-2014  
Specialization: Core Programme  
Module Coordinator: J.J.A. van Bruggen, PhD, MSc

### Module Sheet

Module Name Conservation and restoration ecology		Module Code ES10L	Credits 5
Target Group Programme target group	Prerequisites Programme prerequisites		

### Learning Objectives

*Upon completion of the module participants will be able to..*

- assess the ecological integrity and biodiversity of freshwater ecosystems
- integrate conservation aspects into management programmes for freshwater ecosystems
- apply knowledge to evaluate, monitor and provide advice for the design of ecological restoration programmes of freshwater ecosystems

### Topics and Learning Activities

#### Assessing biodiversity of freshwater ecosystems

evolutionary biology; methods for assessing biodiversity; genetic diversity; species/population dispersal, migration, demographics and effective population size; endangered and alien species.

#### **Learning Activities:**

*lectures, field-work, laboratory/computer sessions and excursions. Case-studies are visited, evaluated by small student groups and conclusions/recommendations are discussed in a workshop set-up.*

#### Conservation ecology

field surveys; sampling design and statistics; GIS; remote sensing; landscape ecology approach.

#### **Learning Activities:**

*lectures, field-work, laboratory/computer sessions and excursions. Case-studies are visited, evaluated by small student groups and conclusions/recommendations are discussed in a workshop set-up.*

#### Ecological survey methods

ecological integrity of rivers and floodplains; biodiversity and conservation genetics; principles in conservation ecology; habitat, species and population management; case examples of conservation programmes.

#### **Learning Activities:**

*lectures, field-work, laboratory/computer sessions and excursions. Case-studies are visited, evaluated by small student groups and conclusions/recommendations are discussed in a workshop set-up.*

#### Restoration ecology

fundamentals in restoration ecology; restoring ecological functioning of freshwater ecosystems; human dimension in restoration programmes; bio-indicators; monitoring concepts; adaptive management approach (participatory collaboration to integrate research, policy and practice) and multicriteria approach; workshop on evaluation, design and monitoring of restoration programmes.

#### **Learning Activities:**

*lectures, field-work, laboratory/computer sessions and excursions. Case-studies are visited, evaluated by small student groups and conclusions/recommendations are discussed in a workshop set-up.*

### Lecturing Material

- Lecture notes, laboratory manuals, reference materials (text books, scientific publications)

### Assessment

- 60%: Written Exam (closed book)
- 30%: Presentation
- 10%: Lab Report

2012/2014-ES10L: Conservation and restoration ecology														
Nr	Course/Topic	Lecture	Assignment	Workshop	Case study	Role play	Exercise	Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM: contact hours	SUM: studyload hours	Lecturer(s)
1.1	River and wetland management: the ecological perspective	1										1	3	Hein
1.2	Biodiversity & conservation genetics	2										2	6	Weisse, Weiss
1.3	Methods for assessing biodiversity of freshwater ecosystems	2										2	6	Schmutz, Schinegger, Pinter, Pokorny
2.1	Conservation ecology and ecological functioning of freshwater ecosystems	2										2	6	Hein, Muhar, Schmutz, Welti
2.2	Habitat, species and population management	1										1	3	Schmutz, Muhar
3.1	Remote sensing	3										3	9	Hesslerova
3.2	Landscape ecology	2										2	6	Pokorny
3.3	Ecological field surveys (excursions & field visits)		12								40	40	132	Hein, Reckendorfer, Zitek, Schinegger, Pinter, Winkler
4.1	Restoration ecology	2										2	6	Hein, Schmutz
4.2	Human dimension in restoration programmes	2										2	6	Sendzimir, Pokorny
4.3	Adaptive management approach (participatory collaboration to integrate research, poli	2										2	6	Sendzimir
4.4	Group work on case studies		20										20	Hein, Welti, Sendzimir, Pokorny, Hesslerova
4.5	Workshop on case studies and evaluation, design and monitoring of restoration progra		7										7	Hein, Welti, Pokorny, Winkler
5	<b>Written exam</b>													
	<b>Total</b>	<b>19</b>	<b>39</b>							<b>40</b>	<b>59</b>	<b>216</b>		

MSc module - UNESCO-IHE

# ENVIRONMENTAL SCIENCE

## MASTERS PROGRAMME

Academic Year: 2012-2014  
Specialization: Core Programme  
Module Coordinator: G.M. Gettel, PhD, MSc

### Module Sheet

Module Name		Module Code	Credits
Aquatic ecosystems: processes and applications		ES10TWL	5
<b>Target Group</b> Programme target group (Participants in the programmes at IHE) and qualified short course participants	<b>Prerequisites</b> Programme prerequisites (BSc in a topic appropriate to UNESCO-IHE programme) and basic knowledge of aquatic ecology.		

### Learning Objectives

*Upon completion of the module participants will be able to..*

- Conduct laboratory techniques used for basic limnological studies. Specifically, you will be able to measure physical-chemical properties, chlorophyll a concentration in seston and periphyton; measure and calculate primary production and community respiration, measure nutrient concentration and turbidity, calculate and measure ash free dry mass, and perform zooplankton counts.
- Develop a research question based on the experimental design.
- Analyze data using either statistical or modeling techniques to answer your research question.
- Produce a report in the format of a scientific article that presents your research question, the data supporting it, and a discussion of your results, including a review of relevant literature.
- Critically analyze your colleagues' work in the form of a professional peer review.

### Topics and Learning Activities

#### Eutrophication in shallow-lake ecosystems

A mesocosm experiment will be used to analyse the effects of eutrophication in shallow lakes and to familiarise participants with techniques that are common in ecological research. Ample attention will be paid to the development of a critical scientific approach, including study design, statistical analysis and data presentation. Lectures on ecological processes and human impacts on aquatic ecosystems will provide the necessary theoretical background.

#### **Learning Activities:**

*Students will conduct laboratory experiments to generate a data set, which they will analyze using appropriate tools. Students will then write a scientific report and perform a peer review.*

### Lecturing Material

#### Assessment

- 80%: Assignment
- 10%: Assignment
- 10%: Presentation

**2012/2014-ES10TWL: Aquatic ecosystems: processes and applications**

Nr	Course/Topic	Lecture	Assignment	Workshop Case study Role play Exercise Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM: contact hours	SUM: study/load hours	Lecturer(s)
	<b>Lecture</b>	14						14	42	Gettel, Irvine
	<b>Laboratory Work</b>				16			16	32	Gettel, Irvine
	<b>In-class activity (data analysis, group work)</b>			44				44	44	Gettel, Irvine
	<b>Paper Writing and Review</b>		20						20	Gettel, Irvine
	<b>Total</b>	14	20	44	16			74	138	
<b>MSc module - UNESCO-IHE</b>										



# WATER MANAGEMENT

## MASTERS PROGRAMME

Academic Year: 2012-2014  
Specialization: Core Programme  
Module Coordinator: M.W. Blokland, MSc

### Module Sheet

Module Name Managing water organisations		Module Code WSM06	Credits 5
<b>Target Group</b> Young and mid-career professionals with an interest in strategic and operational management of water organisations.	<b>Prerequisites</b> Preferably experience in the water sector. A bachelor's degree or equivalent. Basic PC-computer knowledge. Good command of English language.		

### Learning Objectives

*Upon completion of the module participants will be able to..*

- Explain the position and strategy of a water organisation in relation to its institutional environment.
- Summarize the scope, scale, structure and key work processes of organisations
- Analyze the management and decision-making processes in water organisations, including the management of change.
- Plan the use of performance analysis and benchmarking in the regulation and management of water organisations.
- Assess the processes of human resources, health and safety, management for integrity and sustainability, asset management and customer management.

### Topics and Learning Activities

#### Water Organizations in Context

Mandate and structure, scale and scope of operations, ethics, integrity, sustainability, climate change, and reform.

#### Water Organisations at Work

Environment and strategy, performance and benchmarking, human resources management, health and safety, asset management, customer management.

### Lecturing Material

- Reading materials.
- Discussions.
- Exercises.
- Case studies.
- Power-point presentations.
- Two field trips; one to a water supply company and one to a river basin organisation.

### Assessment

- **100%: Assignment**

**2012/2014-WSM06: Managing water organisations**

Nr	Course/Topic	Lecture	Assignment	Workshop Case study Role play Exercise Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM: contact hours	SUM: study/load hours	Lecturer(s)
<b>1</b>	<b>Introduction</b>									
1.1	Course and Fieldtrip Introductions			2				2	2	Blokland
1.2	Managing a Water Utility			8				8	8	To be announced
<b>2</b>	<b>Water Organisations in Context</b>									
2.1	Organisations Undergoing Reform			6				6	6	Schwartz
2.2	Mandate and Structure of RBO's			6				6	6	Mostert
2.3	Environment and Strategy			6				6	6	Schouten
2.4	Scale and Scope of Operations			8				8	8	Douven
<b>3</b>	<b>Water Organisations at Work</b>									
3.1	Effective Organisations			6				6	6	Schuurmans
3.2	Performance and Benchmarking			10				10	10	Blokland
3.3	Integrity, Sustainability			6				6	6	Mairesse, Fahsi
3.4	Health and Safety			6				6	6	Harle
3.5	Asset Management			8				8	8	van Dijk
3.6	Customer Management			6				6	6	Beltman
3.7	Human Resources Management			6				6	6	van Heijzen
<b>4</b>	<b>Fieldtrip</b>					<b>16</b>		<b>16</b>	<b>16</b>	Waternet Amsterdam & Drinking water utility WMD
<b>5</b>	<b>Assignment</b>		<b>43</b>						<b>43</b>	
	<b>Total</b>		<b>43</b>	<b>84</b>		<b>16</b>		<b>100</b>	<b>143</b>	

**MSc module - UNESCO-IHE**

# ENVIRONMENTAL SCIENCE

## MASTERS PROGRAMME

Academic Year: 2012-2014  
Specialization: LWM specialisation  
Module Coordinator: A.A. van Dam

### Module Sheet

Module Name		Module Code	Credits
Data analysis and modelling for aquatic ecosystems		ES11L	5
<b>Target Group</b> Participants in the Limnology and Wetland Management specialisation of the UNESCO-IHE Environmental Science MSc-programme; Other UNESCO-IHE participants who select this module as an elective; Participants who take this module as a short course.	<b>Prerequisites</b> Programme prerequisites; Basic course in statistics.		

### Learning Objectives

*Upon completion of the module participants will be able to..*

- Store and manipulate experimental data efficiently in a simple database and perform exploratory data analysis using time series plots, scatter plots and descriptive statistics in MS Excel and R;
- Perform basic statistical procedures and analyses using R (distribution tests and transformations, t-tests, ANOVAs, non-parametric tests, simple and multiple regression, etc.)
- Do multivariate statistical analyses, such as multiple regression analysis and factor analysis, using R; and understand the principles of some other advanced modelling applications for ecological data;
- Construct a simple dynamic simulation model of an aquatic ecosystem using Stella;
- Discuss critically the strengths, weaknesses, missing information, advantages and disadvantages of the analyses;
- Communicate effectively the methods, results and conclusions of a case study (presentation and written report).

### Topics and Learning Activities

**DAMAE Module introduction**

**Ecological modelling**

**Multivariate statistics**

**Advanced topics**

**Exercises**

**Case study group work**

**Lecturing Material**

**Assessment**

- 40%: Written Exam (closed book)
- 40%: Assignment
- 20%: Presentation

**2012/2014-ES11L: Data analysis and modelling for aquatic ecosystems**

Nr	Course/Topic	Lecture	Assignment	Workshop Case study Role play Exercise Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM:		Lecturer(s)
								contact hours	study/load hours	
	<b>Intro DAMAE module</b>	1						1	3	van Dam
	<b>Ecological modelling</b>	10						10	30	van Dam / Hes
	<b>Multivariate statistics</b>	4						4	12	van Dam / Tran Duy
	<b>Advanced topics</b>	4						4	12	van Dam / guest lecturer
	<b>Exercises data handling</b>				2			2	4	van Dam / Tran Duy
	<b>Exercises basic statistics</b>				2			2	4	van Dam / Tran Duy
	<b>Exercises multivariate statistics</b>				8			8	16	van Dam / Tran Duy
	<b>Exercises ecological modelling</b>				8			8	16	van Dam / Hes
	<b>Intro Case study</b>	1						1	3	van Dam
	<b>Case study conceptual model</b>			1				1	1	van Dam / Hes
	<b>Case study group work</b>			32				32	32	van Dam / Hes
	<b>Case study presentation</b>			3				3	3	Irvine / Gettel / Hes / van Dam
	<b>Test</b>			2				2	2	
	<b>Total</b>	20		38	20			78	138	

**MSc module - UNESCO-IHE**

# WATER MANAGEMENT

## MASTERS PROGRAMME

Academic Year: 2012-2014

Specialization: Water Resources Management & Water Quality Management

Module Coordinator: Y. Jiang

### Module Sheet

Module Name Watershed and river basin management		Module Code ES11MW	Credits 5
<b>Target Group</b> Young and mid-career professionals (scientists, decision-makers) with a background in water management, environmental management, and / or watershed management.	<b>Prerequisites</b> Affinity with hydrology, development economics, agronomy or geography (preferably a relevant water science or engineering related bachelor's degree or equivalent) and preferably experience in watershed and / or river basin management. Good command of English.		

### Learning Objectives

Upon completion of the module participants will be able to..

- describe the main natural and anthropogenic interactions at a watershed scale; and how they can be aggregated to river basin scale
- describe the role of water in sustaining different land uses, including ecosystems
- understand the watershed planning and management approaches, specifically in terms of soil and water management
- explain temporal and spatial scales issues in hydrology
- characterize the fundamental economic issues in watersheds and river basins and the role of economic valuation of aquatic ecosystem services in watershed and river basin management

### Topics and Learning Activities

#### Introduction

This section introduces watershed and river basin management

#### **Learning Activities:**

Lecture, group exercise/workshop

#### Biophysical processes and anthropogenic interactions

This section overviews biophysical processes and interactions with human activities in watersheds and river basins, covering soil & water management, watershed hydrology and human interventions, environmental flow, and groundwater management

#### **Learning Activities:**

Lecture, group exercise/workshop

#### Watershed and river basin planning

This section describes the planning process of watershed and river basin management, including technical and participatory tools to support planning processes

#### **Learning Activities:**

Lecture, group exercise/workshop

#### Watershed economics

This section introduces and characterises the fundamental economic issues in watersheds and river basins, explain the relevance and role of economics and economic valuation in watershed and river basin management

#### **Learning Activities:**

Lecture, group exercise/workshop

#### Watershed and river basin management

This section synthesizes the institutional aspects in watershed and river basin management, explains transboundary interdependencies and cooperation, and presents a case study of watershed and river basin management in the real world

#### **Learning Activities:**

Lecture, group exercise/workshop

#### Role play- ShaRiva

This group exercise uses hydrological simulation as a decision support tool to help understand the interdependency of different stakeholders and the importance of communication and cooperation to effective watershed and river basin management

#### **Learning Activities:**

group exercise

**Field trip**

**Lecturing Material**

- Lecture Notes
- Role play reading materials
- Lecture powerpoint slides
- Additional reading materials

**Assessment**

- **70%: Written Exam (closed book)**
- **30%: Assignment**

2012/2014-ES11MW: Watershed and river basin management										
Nr	Course/Topic	Lecture	Assignment	Workshop Case study Role play Exercise Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM: contact hours	SUM: study/load hours	Lecturer(s)
1	<b>Introduction</b>			2				2	2	Jiang/Hamdard
2	<b>Biophysical processes and anthropogenic interactions</b>									
2.1	Soil & Water Management	6						6	18	Van der Zaag
2.2	Watershed hydrology and human interventions	4						4	12	Mul
2.3	Environmental flow allocation	4						4	12	McClain
2.4	Groundwater Management	4						4	12	Guest Lecturer
3	<b>Watershed and river basin planning</b>									
3.1	Planning processes	2						2	6	Douven
3.2	Technical tools to support planning processes	2						2	6	Mohamed
3.3	Participatory tools to support planning processes	2						2	6	Kemerink
4	<b>Watershed economics</b>									
4.1	Fundamental economic issues in watersheds and river basins	3						3	9	Jiang
4.2	Economic valuation of aquatic ecosystem services	3						3	9	Jiang
5	<b>Watershed and river basin management</b>									
5.1	Institutional aspects in watershed and river basin management	2						2	6	Douven
5.2	Transboundary Interdependencies and cooperation	2						2	6	Douven
5.3	Case Study	2						2	6	Guest Lecturer
6	<b>Role-Play SHA-RIVA</b>		20						20	Mul/Jiang/Hamdard
7	<b>Field trip</b>					4		4	4	Jiang
	<b>Exam</b>		3						3	
	<b>Total</b>	<b>36</b>	<b>23</b>	<b>2</b>	<b>4</b>	<b>42</b>	<b>137</b>			

MSc module - UNESCO-IHE

# ENVIRONMENTAL SCIENCE

## MASTERS PROGRAMME

Academic Year: 2012-2014  
 Specialization: Core Programme  
 Module Coordinator: M.A. Siebel, PhD, MSc, PE

### Module Sheet

Module Name Solid waste management		Module Code ES11T	Credits 5
<b>Target Group</b> Engineers, academicians, staff from Non-Government Organizations, Community-based Organizations, politicians, health officials, students, scientists, local, regional or national government officials, etc., involved or interested in the management of solid waste.		<b>Prerequisites</b> 1) Involved in or familiar with one or more of the key elements of solid waste management, or 2) having studied the topic in a formal educational setting, or 3) having a university engineering degree.	

### Learning Objectives

Upon completion of the module participants will be able to..

- suggest options for waste reduction at source so as to reduce quantities of waste generated;
- choose from an array of options to turn waste into economic goods;
- suggest treatment/disposal methods for waste from which the value has been taken out and to make basic calculations related to the conceptual design thereof;
- assess the impact of waste and waste management on other environmental compartments;
- roughly assess financial consequences of proposed management aspects in SWM;
- conceptually develop a solid waste management scheme for an urban area.

### Topics and Learning Activities

#### 1) Introduction & Stakeholders

what is solid waste? what are the key problems (social, financial, environmental)? who are involved?

##### **Learning Activities:**

lecture, group activity/learning from each other, role play

#### 2) Generation, collection & separation

How/why is SW generated? how can generation be reduced? what are collection schemes & means, what means waste separation? at what point in the process? what are advantages? how can separation/reuse be stimulated?

##### **Learning Activities:**

lecture, group activity/learning from each other, exercise, role play,

#### 3) Biological processes, composting, digestion

Aerobic and anaerobic conversion of waste organics, process characteristics, fields of application, impacts on waste reduction

##### **Learning Activities:**

lecture, calculation exercise, laboratory experiment

#### 4) Landfill technology, CDM, MBT and Incineration

What are main waste management technologies? in more or in less developed countries? design elements, application areas? GHG issues

##### **Learning Activities:**

lecture, group activity/learning from each other, calculation exercise

#### 5) Transboundary issues in SWM

What is Basel Convention? what is transboundary waste transport, processing and storage? What are environmental, social, economic aspects thereof?

##### **Learning Activities:**

lecture, group activity/learning from each other, role play,

#### 6) Prevention & Recycling

How can waste generation be reduced? what are policy, economic tools? How can generated waste quickest be brought into the economic cycle?

##### **Learning Activities:**

lecture, group activity/learning from each other, calculation exercise

#### 7) SWM planning and financing

How can all possible SWM pieces be put together to design a waste management system for a build-up area that is financially, socially and environmentally sustainable?

##### **Learning Activities:**

group activity/learning from each other, exercise, role play

### Lecturing Material

- 1) PPT's; reviewed paper; BOOK: Waste Technology and Management; BOOK: Vital waste statistics
- 2) PPT's; reviewed paper; BOOK: From waste to resource; BOOK: Solid Waste Management in World Cities
- 3) PPT's; reviewed paper; BOOK: Waste Technology and Management; Video: Anaerobic degradation processes
- 4) PPT's; reviewed paper; BOOK: Waste Technology and Management; Video Bioreactor Landfill; UNEP SWM Landfill chapter
- 5) PPT's; reviewed paper; BOOK: Waste Technology and Management
- 6) PPT's; reviewed paper; BOOK: Waste Technology and Management
- 7) papers on planning practice

### Assessment

- **60%: Written Exam (open book)**
- **35%: Assignment**
- **5%: Presentation**

2012/2014-ES11T: Solid waste management											
Nr	Course/Topic	Lecture	Assignment	Workshop Case study Role play Exercise Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM: contact hours	SUM: studyload hours	Lecturer(s)	
											1
2	Waste prevention	4						4	12	Dijk	
3	Exercise household waste generation			9				9	9	Siebel	
4	Waste collection/ source separation	3						3	9	Å	
5	Composting and biogas	6						6	18	Valencia	
6	Excursion					4		4	4	Siebel	
7	Informal sector	4						4	12	Rotter	
8	Material cycles			4				4	4	Rotter	
9	Landfill processes	3						3	9	Valencia	
10	Landfill technology	3						3	9	Valencia	
11	Mechanical biological treatment	4						4	12	Rotter	
12	Lab landfill			3				3	3	Rotter	
13	Integrated planning			8				8	8	Siebel	
14	Presentations			2				2	2	Siebel	
15	Assignments		13						13		
16	Exam		2						2		
<b>Total</b>		<b>33</b>	<b>15</b>	<b>26</b>		<b>4</b>		<b>63</b>	<b>144</b>		

MSc module - UNESCO-IHE



# ENVIRONMENTAL SCIENCE

## MASTERS PROGRAMME

Academic Year: 2012-2014  
 Specialization: Core Programme  
 Module Coordinator: Dr E. de Ruyter van Steveninck

### Module Sheet

Module Name		Module Code	Credits
IWRM as a tool for adaptation to climate change		ES11X	5
<b>Target Group</b> Programme target group (Participants in the programmes at IHE) and qualified short course participants.	<b>Prerequisites</b> Programme prerequisites (BSc in a topic appropriate to UNESCO-IHE programme) and basic knowledge of water management.		

### Learning Objectives

Upon completion of the module participants will be able to..

- describe the expected impacts of climate change on water resources and water use sectors in relation to (other) human activities
- identify the consequences of the predicted impacts of climate change and climate variability for integrated water resources management
- integrate climatic change conditions at different time and spatial scales into (risk) management in the water sector
- justify decisions on adaption to the impacts of climate change under uncertainty

### Topics and Learning Activities

#### Principles of Integrated Water Resources Management

Introduction into the concept of IWRM

##### **Learning Activities:**

*Lecture and discussion*

#### Climate change and impacts

The climate system and the causes of climate change and variability. Impacts of climate change on the hydrological cycle, the environment and on water use sectors

##### **Learning Activities:**

*Lectures and exercises*

#### Vulnerability and adaptation under uncertainty

What determines vulnerability to CC. Adaptation measures and strategies how to adapt under a high level of uncertainty

##### **Learning Activities:**

*Lecture, exercise and fieldtrip*

#### Institutional aspects and stakeholder participation

The importance of involving stakeholders in water management and CC adaptation and strategies on involving stakeholders

##### **Learning Activities:**

*Lecture, exercise and role play*

#### Multi sector/multicriteria decision making

Modelling effects of CC on water resources using Climateland as a case study

##### **Learning Activities:**

*Lecture and computer/modelling exercise*

### Lecturing Material

- Lecture notes, power point presentations, background materials

### Assessment

- 30%: Presentation
- 70%: Written exam (closed book)

**2012/2014-ES11X: IWRM as a tool for adaptation to climate change**

Nr	Course/Topic	Lecture	Assignment	Workshop Case study Role play Exercise Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM:		Lecturer(s)
								contact hours	study/load hours	
1	IWRM, climate change and the hydrological cycle	8						8	24	de Ruyter, van Dorland, Uhlenbrook
2	Climate change: impacts and adaptation	14		6				20	48	de Ruyter, Pathirana, de Fraiture, Kukuric
3	Vulnerability and adaptation under uncertainty	9		7				16	34	Bresser, vdSluis, vdMeulen/Balica, deRuyter
4	Institutional aspects and stakeholder participation			6				6	6	Kemerink
5	Multi sector/multicriteria decision making			20				20	20	Venneker/Wenninger
6	Oral presentations			2				2	2	
7	Field trip					6		6	6	van der Meulen
8	Examination			3				3	3	
<b>Total</b>		31		44		6		81	143	
<b>MSc module - UNESCO-IHE</b>										

# ENVIRONMENTAL SCIENCE

## MASTERS PROGRAMME

Academic Year: 2012-2014  
 Specialization: Core Programme  
 Module Coordinator: J.J.A. van Bruggen, PhD, MSc

### Module Sheet

Module Name		Module Code	Credits
Water quality monitoring and bio-indicators		ES12L	5
Target Group		Prerequisites	
Programme target group		Programme prerequisites	

### Learning Objectives

Upon completion of the module participants will be able to..

- identify potential sources of water pollution and their effects on ecosystems and humans;
- appraise the ecological status of rivers and to assess health risks for humans;
- evaluate water quality criteria concerning the suitability for different water use;
- develop water-quality monitoring programmes based on international guidelines (drinking water, irrigation, bathing, EU-WFD, WHO etc.)

### Topics and Learning Activities

#### Sources and effects of water pollution

overview about sources of water pollution and the effect on both humans and the structure and functioning of freshwater ecosystems.

#### Learning Activities:

lecture

#### Applying methods and techniques for assessing water quality

physico-chemical (O<sub>2</sub>, T, pH, Cond, Alkalinity, Hardness and nutrients; NH<sub>4</sub>-N, NO<sub>2</sub>-N, NO<sub>3</sub>-N, N<sub>tot</sub>, P<sub>tot</sub>, PO<sub>4</sub>-P, SS, Anions, SO<sub>4</sub><sup>-</sup> and Cl<sup>-</sup>, DOC, SAC-254 and BOD-5),  
 microbiological (HPC, TC, FC, Enterococci, E. coli, pour plate and membrane filtration technique dilution series, demonstration of colilert detection system, preparation of pure cultures MPN-technique, Clostridium perfringens, API, PCR and gel-electrophoresis, microbial saprobity, HPC, Bacteria abundance & bacteria production, 3H leucine incorporation, epifluorescence microscopy),  
 biological methods (macrozoobenthos: sampling design, relative purity/pollution index, saprobity index, abundance, species richness/diversity/evenness, similarity index, presence/absence data).

#### Learning Activities:

lectures, laboratory/field-work, excursions and sample processing.

#### International water-quality guidelines and design/implementation of water quality monitoring programmes

European Water Framework Directive (EU-WFD); WHO standards/recommendations; Austrian water law; drinking water; bathing water; water for irrigation; standards in laboratory safety & quality assurance; water quality assessment and monitoring in the tropics.

#### Learning Activities:

lectures

### Lecturing Material

- Lecture notes, laboratory manuals, reference materials (text books, scientific publications)

### Assessment

- 60%: Written Exam (closed book)
- 10%: Skills assessment
- 30%: Presentation

**2012/2014-ES12L: Water quality monitoring and bio-indicators**

Nr	Course/Topic	Lecture	Assignment	Workshop Case study Role play Exercise Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM: contact hours	SUM: study/load hours	Lecturer(s)
1.1	Catchment of River Schwechat	1	2					1	5	Ruzicka, Kreuzinger
1.2	Pollution microbiology and risk assessment	1						1	3	Farnleitner
2.1	Ecological integrity and bio-indicators	2						2	6	Moog
2.2	Sampling River Schwechat	1				8		9	11	Moog et al.
2.3	Chemical parameters/methods	2	20					2	26	Kreuzinger, Ruzicka, Yillia
2.4	Macroinvertebrates as indicators of water quality	2						2	6	Moog, Graf, Stubauer
2.5	Methods for assessing ecological integrity and water quality	2	20					2	26	Moog et al
2.6	Methods in pollution microbiology	2	20					2	26	Farnleitner et al
2.7	Microbial indicators in the tropics	2						2	6	Mushi
3.1	Water quality standards, guidelines	3						3	9	Farnleitner, Kavka, Kreuzinger
3.2	European Water Framework Directive	3						3	9	Graf, Ruzicka, Farnleitner
4.1	Data analysis, interpretation and development of water quality monitoring programme		18						18	Moog et al
4.2	Final presentations/ discussion		5						5	
<b>5</b>	<b>Exam</b>									
	<b>Total</b>	<b>21</b>	<b>85</b>			<b>8</b>		<b>29</b>	<b>156</b>	

**MSc module - UNESCO-IHE**

# ENVIRONMENTAL SCIENCE

## MASTERS PROGRAMME

Academic Year: 2012-2014  
 Specialization: Core Programme  
 Module Coordinator: H.J. Lubberding, PhD, MSc

### Module Sheet

<b>Module Name</b> Groupwork ES		<b>Module Code</b> ES12TMW	<b>Credits</b> 5
<b>Target Group</b> Programme target group		<b>Prerequisites</b> Programme prerequisites	

### Learning Objectives

Upon completion of the module participants will be able to..

- Solve complex environmental problems by integrating the content of the preceding modules;
- 
- Make decisions on the basis of a limited amount of information;
- Work in a team to solve complex environmental problems

### Topics and Learning Activities

#### Ecoland

The group work consists of a case study in which the techniques and knowledge obtained in the preceding modules are integrated. The group work is located in the fictitious country Ecoland. Ecoland faces enormous environmental problems, which have to be addressed by the participants in their role as consultant or EPA member. During the group work participants have discussion meetings, give presentations and write a report.

#### Learning Activities:

The group work is carried out as a role-play, in which participants are either belonging to a consultancy or to a local EPA. The participants have group discussions and individual tasks, give progress and final presentations and write a final report.

### Lecturing Material

- Handout Ecoland

### Assessment

- 100%: Assignment

2012/2014-ES12TMW: Groupwork ES										
Nr	Course/Topic	Lecture	Assignment	Workshop Case study Role play Exercise Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM: contact hours	SUM: studyload hours	Lecturer(s)
Discussions										
Presentations			16						16	
Selfstudy, report writing			142						142	
	Total		160						160	
MSc module - UNESCO-IHE										

# MUNICIPAL WATER AND INFRASTRUCTURE

## MASTERS PROGRAMME

Academic Year: 2012-2014

Specialization: Core Programme

Module Coordinator: H.J. Lubberding, PhD, MSc / E.A. de Jong, MA..

### Module Sheet

Module Name Summer courses / research methodology for ES		Module Code ES13	Credits 3
<b>Target Group</b> All participants of the programme		<b>Prerequisites</b> The successful completion of at least 8 of the first 11 modules of the programme	

### Learning Objectives

*Upon completion of the module participants will be able to..*

- Discuss the latest insights, context and concepts of a contemporary issue of choice
- Able to justify his or her research in the context of UNESCO-IHE research lines, personal professional interests and preferably in local, national and regional contemporary issues.

### Topics and Learning Activities

#### Research methodology

Selected attention to one or several aspects of epistemology, literature review, scientific research methods, statistics, writing for publication, etc.

#### **Learning Activities:**

*Presentations by and debate between staff, guest lecturers and participants on issues of research methods, epistemology, contemporary issues, etc*

#### Summer courses

Participant will need to select 1 course out of the available Summer Courses on offer during this period (each Masters programme will offer one or more Summer Course open to all participants, as long as prerequisites are met). Topics will be presented as seminars by UNESCO-IHE staff and guest lecturers on specific contemporary themes and issues. Some examples of previous Summer Courses are:

- Water and Climate
- Environmental Flows
- Conflict Resolution
- Flood resilient planning and building

#### **Learning Activities:**

*Lectures, workshops, assignments*

### Lecturing Material

- To be announced

### Assessment

- 100%: Assignment

**2012/2014-ES13: Summer courses / research methodology for ES**

Nr	Course/Topic	Lecture	Assignment	Workshop	Case study	Role play	Exercise	Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM: contact hours	SUM: study/load hours	Lecturer(s)
	Research Methodology													Various
	Summer Course													Various
	<b>Total</b>													
<b>MSc module - UNESCO-IHE</b>														

# ENVIRONMENTAL SCIENCE

## MASTERS PROGRAMME

Academic Year: 2012-2014

Specialization: Core Programme

Module Coordinator: H.J. Lubberding, PhD, MSc / E.A. de Jong, MA

### Module Sheet

Module Name		Module Code	Credits
MSc research proposal development for ES		ES14	7
<b>Target Group</b> All students of the Environmental Science programme		<b>Prerequisites</b> The successful completion of at least 8 of the first 11 modules	

### Learning Objectives

*Upon completion of the module participants will be able to..*

- concisely define the intended research topic, state precise aims and objectives, describe the research methodology, argue expected relevance and justification, and identify boundary conditions and self- or externally imposed limitations;
  - list available literature and replicate main arguments expounded in the literature on the specified research topic;
  - demonstrate analytical problem-analysis skills and the ability to distil the strategic issues to be addressed in the research phase;
  - plan the research process in weekly time-steps and indicate essential milestones, targets and indicators, required human, financial and other resources, deliverables and perceived threats and constraints at each stage of the research project;
  - develop and formulate the research proposal in a clearly written, well argued and convincing report, submitted within a set deadline;
  - develop and formulate the research proposal in a clearly written, well argued and convincing report, submitted within a set deadline;
- successfully present and defend individual work, cross-reference it to and critically evaluate it in light of contemporary thinking in a specific field of study.

### Topics and Learning Activities

#### Selection of research topic

The initial research topic of study will be selected in a consultative process with a mentor, the MSc coordinator and a professor.

#### **Learning Activities:**

*Discussion with academic staff members.*

#### Proposal drafting

Research is likely to be based primarily on a review of selected literature, to a limited extent other methods of data gathering and analysis may also be applied (e.g. interviews, laboratory and field work, computer modelling, expert consultations, etc). One hour weekly meetings with the tutor form the main stay of the proposal development process. It is however expected that the MSc candidate will be self-motivated and pro-active, taking all necessary initiatives to reach the set target in a timely fashion.

#### **Learning Activities:**

*Writing of the proposal*

#### Proposal presentation

The resulting proposal will be presented in written form and orally defended before an audience of critical peers and a panel of staff members.

#### **Learning Activities:**

*Presentation of the proposal*

### Lecturing Material

- MSc thesis Protocol
- How to write an MSc thesis – Wendy Sturrock

### Assessment

- **100%: Presentation**



**2012/2014-ES14: MSc research proposal development for ES**

Nr	Course/Topic	Lecture	Assignment	Workshop Case study Role play Exercise Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM: contact hours	SUM: study/load hours	Lecturer(s)
	MSc research proposal drafting		188						188	
	MSc research proposal presentation				4			4	8	Mentor and professor
	<b>Total</b>		188		4			4	196	
<b>MSc module - UNESCO-IHE</b>										

# ENVIRONMENTAL SCIENCE

## MASTERS PROGRAMME

Academic Year: 2012-2014  
 Specialization: Core Programme  
 Module Coordinator: H.J. Lubberding, PhD, MSc

### Module Sheet

<b>Module Name</b> MSc research		<b>Module Code</b> ES15	<b>Credits</b> 36
<b>Target Group</b> Programme target group		<b>Prerequisites</b> Programme prerequisites	

### Learning Objectives

Upon completion of the module participants will be able to..

- Conduct research, independently or in a multidisciplinary team, including the formulation of research questions and hypotheses, the selection and application of research methodologies and techniques and the formulation of well-founded conclusions and recommendations;
- Communicate, debate and defend, clearly and systematically, findings and generated insights, and provide rational underpinning of these in oral and written presentations to a variety of audiences;
- Demonstrate academic attitude and learning skills (including thinking in multidisciplinary dimensions and distinguishing main issues from minor ones), to enhance and keep up-to-date the acquired knowledge and application skills in a largely independent manner.

### Topics and Learning Activities

#### Lecturing Material

#### Assessment

- 100%: Assignment

2012/2014-ES15: MSc research												
Nr	Course/Topic	Lecture	Assignment	Workshop Case study	Role play Exercise	Lab session	Laboratory work	Fieldtrip - Fieldwork	Design exercise	SUM: contact hours	SUM: study/load hours	Lecturer(s)
	Å MSc Research		1008							1008		
	<b>Total</b>		<b>1008</b>							<b>1008</b>		
MSc module - UNESCO-IHE												