



**UNESCO-IHE**  
Institute for Water Education

## **MASTER PROGRAMME WM 2016-2018**



**Water Management**

**General description UNESCO-IHE**

**Study guide part 1**

# Table of contents

- [1 UNESCO-IHE](#)
  - [1.1 Introduction](#)
  - [1.2 MSc Degree Programmes](#)
  - [1.3 Research and PhD Programmes](#)
  - [1.4 Organisation](#)
- [2 Programme framework](#)
  - [2.1 Introduction](#)
  - [2.2 Academic Regulations](#)
  - [2.3 Structure of the Programmes](#)
  - [2.4 Curriculum Information](#)
  - [2.5 Final Qualifications](#)
  - [2.6 Teaching Methods](#)
  - [2.7 Examinations](#)
  - [2.8 Study Load](#)
  - [2.9 Planning and Scheduling](#)
  - [2.10 Participation in coursework and lunch seminars](#)
  - [2.11 Evaluation of the Programme by Students](#)
- [3 Regulations](#)
  - [3.1 Education and Examination regulations](#)
  - [3.2 Library regulations](#)
  - [3.3 Code of conduct](#)
  - [3.4 Plagiarism](#)
- [4 Facilities](#)
  - [4.1 Location](#)
  - [4.2 Student Affairs \(office\)](#)
  - [4.3 Student Association Board](#)
  - [4.4 ICT services](#)
  - [4.5 General Facilities in the Building](#)
  - [4.6 UNESCO-IHE Library and Information Services](#)
  - [4.7 Laboratories](#)
  - [4.8 Study Materials](#)
  - [4.9 English support courses](#)

# 1 UNESCO-IHE

## 1.1 Introduction

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**

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

- Environmental Science
- Urban Water and Sanitation
- 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**

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**

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:

- Water Science and Engineering
- Environmental Engineering and Water Technology
- 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**

### **2.1 Introduction**

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

The Institute provides the following Master of Science degree programmes:

- the master programme in Environmental Science;
- the master programme in Urban Water and Sanitation;
- the master programme in Water Management; and
- 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**

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**

The curriculum follows a modular structure.

The Delft-based curricula of the MSc Programmes have a duration of 18 months, and consist of 106 ECTS credit points divided between a Taught Part (61 ECTS credit points) and a Thesis Research Part (45 ECTS credit points).

The Taught Part is formed by 13 modules.

A module consists of a teaching period (usually 3 weeks) and an exam period (within the exam week following each two consecutive modules). Modules may be shared between or among specializations and/or programmes.

The Thesis Research Part consists of two modules on research methodology and MSc proposal drafting and defense, followed by a period of six months of individual research and writing of the thesis. The MSc thesis is defended publically at the end.

## **2.4 Curriculum Information**

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:

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

## **2.5 Final Qualifications**

Each programme specialisation has a set of final qualifications that state the knowledge, insight and skills achieved by students who successfully complete the programme. A distinction is made between discipline-specific qualifications, which are required by the field of study, and general academic skills, which are expected from university education graduates.

Similarly, each module 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 in the modules usually aim to achieve a further detailed subset of the module learning objectives.

## 2.6 Teaching Methods

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:

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

An exercise takes one of the following forms:

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

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

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

## 2.7 Examinations

Examinations serve to test if students have achieved the learning objectives of a module, and ultimately those of the programme itself. The examination for a module 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 module will be granted the credit points for that module. 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**

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**

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 in coursework and lunch seminars**

Active participation and attendance by students is required for all curricular activities on the schedule.

Special attention is required for lunch seminars. During the academic programme lunch seminars are organised focussing on a specific topic. Participants are required to attend these seminars as well

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**

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

### 3.1 Education and Examination regulations

See for the Education and Examination regulations the separate part after the Academic Calendar

### 3.2 Library regulations

#### **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**

#### **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

### **3.4 Plagiarism**

NOTE: FAILURE TO COMPLY WITH THE TERMS OF THIS SECTION COULD JEOPARDISE YOUR DEGREE. PLEASE READ AND DIGEST CAREFULLY.

It is very important that all students understand UNESCO-IHE's rules about plagiarism. Students sometimes break these rules unintentionally because they do not realise that some of the ways in which they have incorporated other people's work into their own, before they came to UNESCO-IHE, may be against the rules here.

At the beginning of the programme, and before submitting any assessments, you will be required to agree to an 'own work declaration' (see annex). You will also be invited to give consent for the scanning of your work by plagiarism detection software. Work cannot be submitted unless these conditions are agreed to.

#### **What is plagiarism?**

Plagiarism is the practice of taking someone else's work or ideas and passing them off as one's own. [[Oxford English Dictionary](#)]

This act is considered as academic fraud. (in the sense of the word as established by Article 2.1 of the Education and Examination Regulations.) When there is a strong presumption of plagiarism, whether occurring during the course of the study or after the completion of the study, cases will be investigated by the Examination Board, (as stipulated by 17. 2 of the Education and Examination Regulations.) The Examination Board shall examine the cases of alleged plagiarism on their individual merits. After examining all the evidence, the Examination Board shall establish whether plagiarism and implicitly fraud has been committed. When fraud has been established the offender will be given the mark of 1.0 for the examination work.

#### **Plagiarism detection**

UNESCO-IHE uses a computer program called Turnitin® to assist with the detection of plagiarism. The plagiarism detection service is an online service that enables UNESCO-IHE and its staff to carry out electronic comparison of students' work against electronic sources including other students' work.

Turnitin ® works by executing searches of the World Wide Web, and extensive databases of reference material, as well as content previously submitted by other UNESCO-IHE students. Each new submission is compared with all the existing information. The software makes no decisions as to whether a student has plagiarised, it simply highlights sections of text that are duplicated in other sources. All work will continue to be reviewed by the course coordinator. Once work has been submitted to the system it becomes part of the ever growing database of material against which subsequent submissions are checked.

The software is used as a tool to highlight any instance where there is a possible case of plagiarism. Passages copied directly or very closely from existing sources will be identified by the software and both the original and the potential copy will be displayed for the examiner to view. Where any direct quotations are relevant and appropriately referenced, the examiner will be able to see this and will continue to consider the next highlighted case.

## **Citing references**

The key to avoiding plagiarism is to make sure that you give correct references for anything that you have taken from other sources to include in your academic work. This might include, for example, any ideas, theories, findings, images, diagrams or direct quotations that you have used. At UNESCO-IHE the house style for references is based on the Hydrogeology Journal output. If you take any material word for word from another source, it is essential that you make it clear to your reader that this is what you have done.

If you take material from another source, change a few words and then include the reference you may still have committed a plagiarism offence because you have not made it clear to your reader that you have essentially reproduced part of the original source. You should either express the ideas fully in your own words and give the reference or else use clearly labelled direct quotes. Bear in mind that if you include too many direct quotes in your work this may reduce your grade, as the marker will find it difficult to see evidence of your own understanding of the topic. You must also include a bibliography and references section at the end of your work that provides the full details of all of the sources cited within the text. You should be aware that, for work done in other subject areas, you might be expected to use a different referencing system.

The process of referencing may seem rather complicated and arbitrary, if it is new to you, but it should begin to make more sense as you progress through your studies. In order to assess your work and to give you useful feedback your marker needs to have a clear sense of what ideas you have developed for yourself and what comes from elsewhere. To be fair to all of the students on the course it is important that each student is given grades that accurately reflect their own efforts. As you learn to produce work at a Master standard, you are developing the skills that will allow you to participate within wider communities of scholars. In these communities new knowledge and understanding is often developed by building on the work of others. By properly acknowledging earlier work you give credit where it is due and help to maintain the integrity and credibility of academic research in this area. Clear referencing also allows readers to learn about the wider literature through your work. It is often the case that understanding the ways in which particular scholars have contributed to the development of the literature makes it much easier to make sense of the current state of play.

## **Team work, accidental and self-plagiarism plagiarism**

Students sometimes wonder where to draw the line between discussing their ideas with their peers (which can be an excellent learning experience) and unacceptable collusion. The time to be particularly careful is when you are preparing work for assessment. You need to be certain that the work you submit represents your own process of engagement with the task set. You may get into difficulty if, for example, reading another student's plan for their work influences you, or if you show them your plan. Assisting another student to plagiarise is a cheating offence.

In addition to giving references for all of the materials that you have actually included within your assignments, it is important to appropriately acknowledge other sources of guidance you have used when preparing your work.



Accidental plagiarism is sometimes a result of a student not yet having fully come to terms with how to study effectively at university. For example, the ways in which students take their notes sometimes makes it difficult for them to later distinguish between verbatim quotes, paraphrased material and their own ideas. A student may also plagiarise unintentionally because they have been feeling daunted by a piece of work and so have put it off for so long that they have had to rush to meet the deadline. If you think these kinds of wider issues may be relevant to you then you should contact your module coordinator.

### **Plagiarism guide's references**

The following sources were used in the development of the plagiarism guide:

Blum, S. D. (2009). *My word! : plagiarism and college culture*. Ithaca: Cornell University Press.

Carroll, J. and Appleton, J. (2001). *Plagiarism: A Good Practice Guide*. Oxford: Oxford Brookes University and Joint Information Systems Committee

Eisner, C., & Vicinus, M. (2008). *Originality, imitation, and plagiarism : teaching writing in the digital age*. Ann Arbor: University of Michigan Press.

Sutherland-Smith, W. (2008). *Plagiarism, the Internet and student learning : improving academic integrity*. New York: Routledge.

Harvard University Guide to Plagiarism

<http://isites.harvard.edu/icb/icb.do?keyword=k70847&pageid=icb.page355322>

Purdue University Writing Lab

<http://owl.english.purdue.edu/>

University of Princeton Academic Integrity

Site <http://www.princeton.edu/pr/pub/integrity/pages/plagiarism/>

University of Teesside Plagiarism Guidance

<http://dissc.tees.ac.uk/Plagiarism/Plag-4.htm>

## **4 Facilities**

### **4.1 Location**

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

### **4.2 Student Affairs (office)**

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.

### **4.3 Student Association Board**

The Student Association Board (SAB) is composed of representatives who are elected by the students in annual elections that take place several 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.

## **4.4 ICT services**

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 education programmes. Upon registration you will receive an UNESCO-IHE e-mail account which enables you to make use of all relevant computing facilities at the Institute. Your account will be revoked when you will have ended your study at UNESCO-IHE. 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.

## **4.5 General Facilities in the Building**

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. Two monitor screens opposite the reception desk are regularly updated with news or information on events taking place at UNESCO-IHE.

The restaurant provides a wide variety of reasonable-priced multicultural meals and beverages during lunchtime. The meals can be paid using the bank-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. Photocopy services are available to students. In the building also a meditation room is available, which is located on the third floor.

## 4.6 UNESCO-IHE Library and Information Services

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.

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

## **4.7 Laboratories**

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.

## **4.8 Study Materials**

Study materials such as textbooks, lecture notes and hand-outs are provided by the Institute. Students receive the lecture notes either on paper in their personal locker or via the electronic repository 'eCampus XL', before the start of the involved lecture series. Additional material (on paper or electronically) can be provided by the lecturers in the form of hand-outs. Also other materials, such as for example PowerPoint presentations or exercise materials used by the lecturers, can be accessed or downloaded from the electronic repository.

Reference works are available from the Institute library or the library of the Delft University of Technology (see above).

Students can login to the electronic repository from any location via the Internet web page located at <http://ecampusxl.unesco-ihe.org>

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

## **4.9 English support courses**

### **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.



**UNESCO-IHE**  
Institute for Water Education

## **MASTER PROGRAMME WM 2016-2018**



**Water Management**

**WM Programme description UNESCO-IHE**

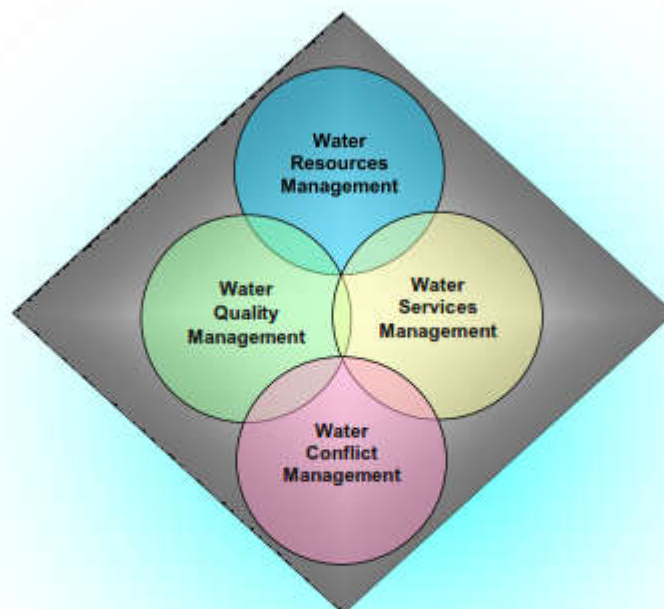
**Study guide part 1**



## **Table of contents**

- [WM Programme](#)
- [Intro to WM Programme](#)
- [Final Qualifications WM Programme](#)
- [Specializations](#)
- [Water Resources Management](#)
- [Water Services Management](#)
- [Water Quality Management](#)
- [Water Conflict Management](#)
- [Academic Staff](#)

# WM Programme Handbook 2016 - 2018



INTERNATIONAL MASTER'S PROGRAMME IN

## Water Management

Coordinator WRM Specialization - Yong Jiang  
Coordinator WSM Specialization - Klaas Schwartz  
Coordinator WCM Specialization - Zaki Shubber  
Coordinator WQM Specialization - Erik de Ruyter van Steveninck  
MSc Research Coordinator - Michelle Kooy  
Programme Coordinator - Ilyas Masih  
Programme Chair - Margreet Zwarteveen

### Disclaimer:

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 UNESCO-IHE or from partner organisations cannot be guaranteed. No rights can therefore be derived from the programme as specified in this handbook.

## **Intro to WM Programme**

The International Master's programme in Water Management provides a unique combination of knowledge, skills and competencies to help comprehensively analyse, critically reflect and effectively contribute to solve contemporary water problems. The question of how to balance objectives of social equity with those of ecological integrity and productivity are at the heart of societal efforts to deal and live with water. In answering this question, science and data are always deeply entangled with particular visions on development, moral worldviews, and economic or geopolitical interests. This is why the study programme pays explicit critical attention to the definition and workings of authority and power, and to the organisation of democracy in water.

As solutions to water problems always consist of a combination of engineering (infrastructure, technology), institutions (rules, laws, policies), and organisations, water management master programme brings together insights about water quality and quantity - and hence of key biophysical and hydrological processes - with understandings of the infrastructural, political and institutional arrangements to regulate its access, allocation, treatment, use and discharge. Courses on offer thus range from those that are rather technical or natural science oriented (focusing on physical, biological or technical processes) via more skills-oriented modules aimed at acquiring the abilities to effectively 'do' water management and governance (law, conflict resolution, mediation, modelling, environmental assessment) to more interpretive social science courses. Throughout the programme, there is a lot of attention to different ways of integrating these different disciplines and sources of knowledge.

The programme's anchor are water problems as they are experienced by relevant actors - users, operators, policymakers, politicians, experts – in their everyday dealings with water. The applicability of taught practical and analytical skills for dealing with actual water management and governance situations is therefore the most crucial measure of their value. However, by deepening their insights about how socio-natural processes shape water flows and vice-versa, the programme not just provides tools to help solve problems, but also develops students' theoretical ability to critically compare and reflect on proposed solutions, measuring their effectiveness against wider environmental and social objectives.

An important target audience for the programme are mid-career water professionals from Southern countries: those already working in the water sector (either with governments, NGOs or the private sector), who aspire to improve their knowledge and skills. However, we also welcome students from other disciplinary and professional backgrounds (lawyers, journalists, entrepreneurs, activists) or countries of origin who aim to specialize in water, and we are open to less experienced students who are interested in studying at UNESCO-IHE because it gives them a unique, broad and interdisciplinary background in contemporary water management and governance questions.

The programme's overall ambition is to train and educate reflexive water professionals and experts who have the knowledge and capacity to develop, plan, implement and evaluate water management and governance policies and strategies in support of the ecologically wise and socially equitable use of water.

In line with the overall UNESCO-IHE approach to education, the programme's contents is diverse: lectures by experts in the field are complemented by practical assignments, work in the laboratory, excursions and group-work. Innovative distance learning and electronic interactive educational tools support the programme. Throughout the educational cycle, lecturers and professors make creative use of opportunities to build on and learn from the rich

experiences of students. More in general, the programme is student-centred, which means that students have a large degree of freedom to put together the curriculum that best fits their choice, interests and needs

### **Career**

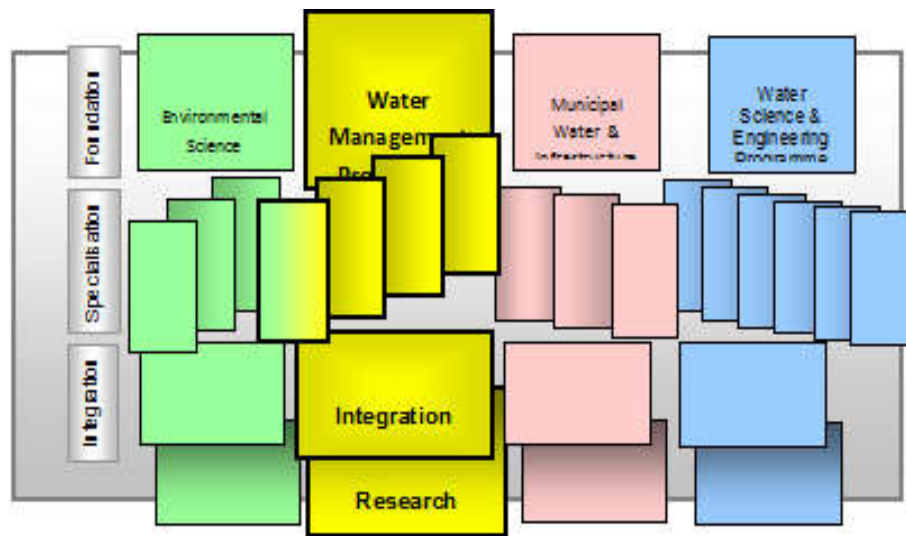
Graduates of the WM programme start or resume a career dealing with wide range of water management and governance jobs in the water sector or related sectors such as infrastructure, energy, agriculture or mining.

- In public administration: central and local governments (river basin organizations, urban water authorities, water boards, urban/rural development ministries/authorities)
- In the private sector: e.g. consulting firms, water supply companies, law firms
- In academia and research institutes
- At NGOs and international organizations (UN, Worldbank, OAS etc.)

Graduates with excellent study results are eligible to undertake a PhD.

### ***Structure of WM Programme***

Water Management is one of four UNESCO-IHE Master's programmes. It is offered as an 18-month Master's of Science (MSc) programme. The first year of the programme are taught modules and is followed by a six-month research period resulting in a thesis. The first year starts with five general modules followed by three modules in four specialisations and another three common modules.



*Figure 1 Sharing Specialisations between UNESCO-IHE Master's Programmes*

The programme follows a modular structure – each module having duration of three weeks – and consists of three distinct phases:

**1. Foundation :** a common basis at the start of the programme, where candidates of the WRM, WQM, WCM, WSM specialisations and WM tailor made profile follow five common modules.

**2. Thematic Profile/Specialisation :** Five (elective) modules, three selected from different themes/specialisations and two from institute wide electives, allow the participants to broaden, but especially deepen their understanding of specific management issues and learn to apply the necessary tools with regard to water resources, conflict, quality and services management.

**3. Integration :** participants of the WM program come together to test the knowledge, insight and skills acquired in the preceding modules in a multi-disciplinary, problem-solving environment, consisting of a two-week international field trip, facing contemporary water management issues in Europe and a four-week group work seeking management solutions for a river basin in a development context. The **WM** programme culminates in a research proposal development & summer courses period followed by a 6-month research period, dedicated to integrating and applying individual knowledge and skills through applied research in a field directly pertaining to the participant's professional experience, interest and context, integrated with the existing UNESCO-IHE research lines.

The modular structure of the programme allows for sharing of selected modules between specialisations. To a limited extent participants will be allowed to take a module offered under another specialisation or even another programme. However, if a module has not been designated as an elective subject, this will be possible only after prior consultation with and approval of the programme coordinator.

**4. Research :** The students undertake their MSc research after the taught part. The research topics can be selected and developed from the suggested topics by the staff members or proposed by the students or their employers. The student play a leading role in conducting the research but do receive guidance from a team of supervisor and mentor(s).

The student receive degree in Master of Science in Water Management, with mention of specific thematic profile or specialisation, when they successfully complete the required credits.

## **Final Qualifications WM Programme**

### **Knowledge & understanding**

1. Knowledge of current theory and contemporary developments in Water Management.
2. The ability to describe the rationale for an integrated and interdisciplinary approach for managing water systems.
3. Knowledge of biological, physical and chemical principles of water systems.
4. Knowledge of economic, institutional and legal principles, approaches and instruments in water management.
5. Understanding the broader scientific, engineering and socio-economic context and the role of other disciplines required for Water Management.

### **Applying knowledge and understanding**

6. The ability to apply the knowledge and academic capabilities acquired, in management and engineering contexts.
7. The ability to contribute to managing water systems and organisations and to the development of institutional arrangements.
8. The ability to collect, analyse and organise relevant information and to draw sound conclusions.
9. The ability to prepare and implement a scientific research plan.
10. The ability to contribute to theoretical, methodological or applied developments within the field of study.

### **Making judgements**

11. The ability to decide between different ideas and approaches independently, based on available information, and assess the potential for application, integration and further development.
12. The ability to select and apply a variety of techniques, tools and procedures in order to evaluate the consequences of different development and intervention scenarios.
13. The ability to reflect critically on how different activities impact on the sustainable use of water.

### **Communication**

14. The ability to report and communicate results clearly, and to explain and defend the reasoning, knowledge and assumptions to a variety of audiences.
15. The ability to function effectively in a multi-disciplinary team.
16. The capability to assess interests among different stakeholders and to facilitate decision-making processes.

### **Learning skills**

17. The ability to extend and enhance one's own knowledge, insight and skills in a largely autonomous manner.

## Specializations

### Thematic Profiles/Specialisations

The Water Management Programme has five thematic profiles/specializations.

- Water Management-Tailor Made Study Profile (Delft based)
- Water Conflict Management (Delft based)
- Water Resources Management (Delft based)
- Water Services Management (Delft based)
- Water Quality Management (Delft based)
- Water Cooperation and Peace ([Joint programme with Oregon State University, USA and UPEACE, Costa Rica](#))

Participants who chose not to select a particular specialization within the WM programme and registered for the general Water Management programme (WM-WM) instead, will develop - with their mentors - their own study profile. Such a profile includes the foundation and integration modules and can contain modules from different specializations.

## **Water Resources Management**

Under water resources management thematic profile/specialisation, the students study the biophysical (hydrological in particular) characteristics of water resource systems and its interaction with human water use and development activities. It focuses particularly on the resource aspect of water at different scales, including its spatial temporal distribution and dynamics, process simulation and modeling, use assessment and planning, and institutional and regulation arrangement for promoting integrated water resource management and sustainable water use.

The thematic profile/specialisation starts with the module *Water Resources Assessment* which focuses on quantification of the different components of the water resources spectrum (rainfall, river flow, groundwater), and assessment of water availability and demand at different scales. The module *Water Systems Modelling* provides a broad introduction to the basics of hydrological, hydraulic and water allocation modelling. By acquiring an understanding of the basic modelling concepts and developing modelling skills, the participant develops an intuitive ability to interact with more advanced modelling approaches useful for system understanding, assessments and decision making processes. Water Resources planning module provides a learning environment for the tested and innovative approaches for effective water resources planning, strategy formulation, economic theory and impact assessment and multi-criteria evaluation of management options at the range of spatial and temporal scales, e.g. river basin, national and international levels, short, medium and long time horizons.

The participants then choose Institutional analysis or a module from the other MSc programmes. The institutional analysis module focuses on understanding how arrangements over access to water are formed.

Concluding the Thematic profile/specialisation, the participant selects an elective module from several courses available institute wide. For instance, Climate Change and Water Management. The study of climate change scenarios and their impact on water resources allows them to effectively contribute in the formulation of alternative water management strategies for climate change adaptation.

The learning objectives of the WRM specialization are as follows:

See:

### **Education and Examination Regulations for cohort 2016– 2018**

#### **Appendix A Qualifications of Graduates**



## **Water Services Management**

The Water Services Management thematic profile/specialisation studies the provision of water and sanitation services and the management of related infrastructure, and designs new institutional and financial instruments and business models for different socio-economic contexts.

The module *Managing Water Organisations* provides WSM participants profound understanding into what makes and keeps an organisation and its managers effective in addressing changing demands on its services.

The module *Environmental Management and Water Services* studies urban water cycle and urban water systems, technical/ecological and institutional principles of integrated urban water management, and potential impacts of climate change and anthropogenic impacts on the urban water cycle.

The module *Finance in the Water Sector* the participant to understand financial management at the level of the utility and suggests different ways of financing water companies and cost-recovery for sanitation and wastewater treatment.

Concluding the specialisation, the participant selects two elective modules in line with her or his professional interests from *Institutional Analysis* or *Partnerships in the Water Sector and Urban Water Governance*.

*The learning objectives of the WSM specialization are as follows:*

**See:**

### **Education and Examination Regulations for cohort 2016– 2018**

#### **Appendix A Qualifications of Graduates**

## **Water Quality Management**

The Water Quality Management thematic profile/specialisation studies the water quality impacts of human activities on aquatic ecosystems, as well as alternative remedial actions, under different levels of environmental stress and in different socio-economic contexts. The specialisation starts with the module *Water Quality Assessment*, in which the participant re-acquaints her-/himself with common and critical water pollution parameters, their indicators, sources, causes and effects. Appropriate monitoring, modelling and risk assessment techniques are demonstrated, discussed, applied in case study and simulated settings.

As the second module the participants choose between *Wetlands for Water Quality* and *Environmental Engineering*.

The third Water Quality Management specialisation module is *Environmental Planning and Management*, where the participant will learn to apply sustainable development concepts to policy analysis techniques, as environmental impact assessment and natural resource valuation.

In the module *Aquatic Ecosystems* the participant is encouraged to grapple with environmental issues related to the use of and impacts on freshwater ecosystems. This module immerses the participant in practical field measurements of a small catchment, combined with laboratory experiments based on samples taken, GIS and computer modelling. Concluding the specialisation, the participant selects either the module *Watershed and River Basin Management* or another module offered by WM or other master programs at UNESCO-IHE.

*The learning objectives of the WQM specialization are as follows:*

**See:**

### **Education and Examination Regulations for cohort 2016– 2018**

#### **Appendix A Qualifications of Graduates**

## **Water Conflict Management**

Water Conflict Management thematic profile/specialisation studies the management of conflicts over water resources. It focuses on negotiation, mediation and decision-making processes, in order to prevent, manage and resolve conflicts concerning water.

The specialisation starts with the module Mediation for Water Conflict Management which addresses the issues potential for conflict and for cooperation when sharing water resources. During the second module, Advanced Mediation for Water Conflict Management, the participant will be able to design and facilitate inclusive consultation, negotiation, mediation and decision-making processes between various water users, water managers, politicians and other decision makers.

After the modules on Mediation for Water Conflict Management the participants choose between the Water Resources Planning module (see WRM specialisation) and the Financial Management of Water Organizations module (see WSM specialisation) depending upon her or his professional interests.

Concluding the specialisation, the participant selects two elective modules in line with her or his professional interests from *Institutional Analysis* or *Partnerships in the Water Sector and Urban Water Governance*.

*The learning objectives of the WCM specialisation are as follows:*

**See:**

### **Education and Examination Regulations for cohort 2016– 2018**

#### **Appendix A Qualifications of Graduates**

## **Academic Staff**

### **Programme committee**

Prof. M. Zwarteveen, Chair

I. Masih, PhD; Secretary, Programme Coordinator

M. Kooy, PhD; Member, MSc Research coordinator

Prof. P. van der Zaag, PhD; Member, Head WRM Specialization

Prof. J. Gupta, PhD; Member, Head WCM Specialization

Prof. K. Irvine, PhD; Member, Head WQM Specialization

Y. Jiang, PhD; Member, Coordinator WRM

K. Schwartz, PhD; Member, Coordinator WSM

Z. Shubber, LL.M.; Member, Coordinator WCM

J.H. Koster, MSc; Senior Education Advisor

### **Module coordinators**

**WM1** J. Evers

**WM2** J. Susnik

**WM3** J. Kemerink & T. Acevedo

**WM4** Y. Jiang

**WM5** F. Jaspers

**WRM6** Y. Mohamed

**WCM6** Z. Shubber

**WQM6** To be confirmed (for information contact Erik de Ruyter)

**WSM6** K. Schwartz

**WRM7** S. Graas

**WSM7** F. Bichai

**WQM7** H. van Bruggen

**WCM7** Z. Shubber

**WRM8** N. Van Cauwenbeerg

**WQM8** J. Evers

**WSM8** K. Schwartz & M. Tutusaus

**WM9** M. Tutusaus & T. Acevedo

**WQM10** G.M. Gettel

**WSM10** K. Schwartz

**WRM10** H. Smit & J. Kemerink

**WQM11** Y. Jiang

**WSM11** T. Acevedo & M. Kooy

**WM 12** Summercourses

**WM13** J. Susnik

**WM14** M. Kooy

**WM15** M. Kooy

### **Academic Staff in Water Management Programme**

G. Alaerts, Professor of Capacity Building

W.G.M. Bastiaanssen, Professor in Water Accounting

L.P. Darvis, Librarian

W.J.A.M. Douven, Associate Professor of Integrated River Basin Management

J. Evers, Lecturer in Environmental planning and management

A.C. Flamini, Junior Lecturer in Water Services Management

S. Graas, Senior Lecturer in Water Systems Modelling

J. Gupta, Professor of Policy Law of Water Resources and Environment

G. Gettel, Lecturer in Aquatic Biogeochemistry

E.M.A. Hes, Lecturer in Environmental Science

M. Hofstra, Senior Advisor Policy Analysis and Water Governance

K. Irvine, Professor of Aquatic Ecosystems

F.G.W. Jaspers, Associate Professor of Water Resources Management

Y. Jiang, Senior Lecturer in Water Economics

P. Kelderman, Senior Lecturer in Environmental Chemistry

J.S. Kemerink, Lecturer in Water Governance

M. Kooy, Senior Lecturer in Water Governance

F. Kruis, Head of Environmental Laboratory

I. Masih, Senior Lecturer in Water Resources Planning

Y. Mohamed, Associate Professor of Water Resources Management

I.P. Popescu, Associate Professor of Hydroinformatics

M. Ronteltap, Senior Lecturer in Sanitary Engineering

E. de Ruyter, Senior Lecturer Aquatic and Marine Ecology

L. Salame, Lecturer in Water Conflict Management

K.H. Schwartz, Associate Professor of Urban Water Governance

Z. Shubber, Lecturer in Law and Water Diplomacy

H. Smit, Lecturer in River Basin Governance

W.J. Sturrock, Senior Lecturer in Language and Academic Skills

J. Susnik, Lecturer/Researcher in Water Resources

M. Tutusaus, Lecturer/Researcher in Water Services Management

J.J.A. van Bruggen, Senior Lecturer in Microbiology

A.A. van Dam, Senior Lecturer in Ecological & Environmental Modelling

H. van der Kwast, Senior Lecturer in Ecohydrological Modeling

N. van Cauwenbergh, Lecturer in Water Resources Planning

P. van der Zaag, Professor of Integrated Water Resources Management

J. Wenninger, Senior Lecturer in Hydrology

U. Wehn, Associate Professor of Water Innovation Studies



# Water Management Programme Overview 2016-2018

		WM WM Water Management C1362	WQM Water Quality Management C1383	WRM Water Resources Management C1396	WCM Water Conflict Management C1370	WSM Water Services Management C1409
1	.....-23/10 24/10-30/10	Week one introduction (ALL)				
2	31/10-06/11 07/11-13/11	Principles of integrated water resources management (WM01) M3084		The Water resources system (WM02) M3042		
2	14/11-20/11 21/11-27/11 28/11-04/12					
..	05/12-11/12	Examination week				
3	12/12-18/12 19/12-25/12	Water governance (WM03) M3032				
..	26/12-01/01 02/01-08/01	Free period				
3	09/01-15/01	<i>(WM03) continue...</i>				
4	16/01-22/01 23/01-29/01 30/01-05/02	Water economics (WM04) M3028				
..	06/02-12/02	Examination week				
5	13/02-19/02 20/02-26/02 27/02-05/03	Water and environmental law (WM05) M1003				
6	06/03-12/03 13/03-19/03 20/03-26/03	Elective >>>>	Water quality assessment (=> ES06W) M2835	Water resources assessment (WRM06) M1617	Water Conflict Management I (WCM06) M3069	Managing water organisations (WSM06) M3103
..	27/03-02/04	Examination week				
7	03/04-09/04 10/04-16/04 17/04-23/04	Elective >>>>	Tropical wetlands for water quality (=> ES07W) M2492 or Environmental engineering (=> ES07T) M3081	Water systems modelling (WRM07) M2054	Water Conflict Management II (WCM07) M3070	Environmental Management and Water Services (WSM07) M3041
8	24/04-30/04 01/05-07/05	Elective >>>>	Environmental planning and implementation	Water resources planning (WRM08)		Finance in the Water Sector (WSM08)
..	24/07-30/07	Examination week				
12	31/07-06/08	Summer course (WM12)				
13	07/08-13/08 14/08-20/08 21/08-27/08	IWRM Groupwork (WM13) M2252				
..	28/08-03/09	Examination week				
..	04/09-10/09	free				
14	11/09-17/09 18/09-24/09 25/09-01/10 02/10-08/10 09/10-15/10	MSc Preparatory Course and Thesis Research Proposal for WM (WM14) M2169				
..	16/10-22/10	Examination week				
15	23/10/15 .. ..... ..... ..... ..... 15/04/16	MSc research, thesis and defence (6 months) (WM15) M2927				
..	16/04-22/04 23/04-29/04	Final examination week - Diploma awarding 24/04/2017				





**UNESCO-IHE**  
Institute for Water Education

## **MASTER PROGRAMME WM 2016-2018**



**Water Management**

**Exam regulations UNESCO-IHE**

**Study guide part 1**



**UNESCO-IHE**  
Institute for Water Education



**Education and  
Examination  
Regulations  
for cohort  
2016– 2018**

For:

- the Master Programmes in
  - a. Urban Water and Sanitation
  - b. Environmental Science
  - c. Water Management
  - d. Water Science and Engineering
- short and online courses which are part of these programmes (starting Sep 2016, and ending Sep 2017)
- Graduate professional diploma programmes

Approved by the Rectorate of UNESCO-IHE, [19-07-2016]



## Table of Contents

1	Definition of terms.....	2
2	General Information .....	4
3	Content of the Programme.....	7
4	Assessments .....	8
5	Results of Assessments.....	12
6	Thesis Examination .....	14
7	Criteria, degrees and certificates .....	16
8	Appeals.....	20
9	Final Articles .....	20
	Appendix A Qualifications of Graduates .....	23
	1. Urban Water and Sanitation Programme .....	23
	2. Environmental Science Programme.....	27
	3. Water Management Programme.....	31
	4. Water Science and Engineering Programme .....	36
	Appendix B Examination Procedures .....	45
	Appendix C Grading Systems used by partner institutes .....	47
	Appendix D MSc modules: names, credits & assessment methods.....	50
	Appendix E MSc thesis marking guidelines .....	77
	Appendix F Appeal procedure .....	78

## 1 Definition of terms

The following terms are defined in the context of these regulations:

<b>Act:</b>	the Higher Education and Scientific Research Act ( <i>Wet op Hoger Onderwijs en Wetenschappelijk Onderzoek</i> );
<b>Assessment:</b>	is the evaluation of a student's achievement on a course or topic. Assessments can have different formats, such as (written and oral) examinations, assignments, presentations etc.
<b>Blind marking:</b>	the student information is hidden from the examiner while they are marking the examination;
<b>Consent agreement:</b>	a negotiated agreement of examining committee members to an examination which resolves the disputed issues;
<b>Co- mentor:</b>	a staff member from an external institute or different chair group within UNESCO-IHE involved in the daily direction of a student during the MSc thesis research phase;
<b>Degree:</b>	a degree as stipulated in article 7.10a. of the Act;
<b>Double (multiple) degree programme:</b>	a master programme offered by multiple institutes of higher education leading to multiple degrees;
<b>Diploma:</b>	a written proof of evidence as stipulated in art 7.11 of the Act that a student has passed all programme requirements;
<b>Diploma supplement:</b>	a written document as stipulated in art 7.11/4 giving information about nature and content of the programme and the results obtained by the student for each component of the programme;
<b>ECTS:</b>	the European Credit Transfer and Accumulation System: a standard for comparing the study attainment and performance of students of higher education across the European Union and other collaborating European countries;
<b>ECTS transfer:</b>	the procedure of granting credits to a student for studies completed at another institute;
<b>Examination:</b>	an assessment for a part of the module as stipulated in art 7.10/1 of the Act;
<b>Examination Board:</b>	the committee as stipulated in article 7.12 of the Act;
<b>Academic Appeals Board:</b>	the committee as stipulated in article 7.60 of the Act;
<b>(External) Examiner:</b>	a person who sets and marks examinations to test student's knowledge or proficiency
<b>Fraud:</b>	a deception deliberately practiced in order to secure unfair or unlawful gain;
<b>Joint programme:</b>	a master programme offered by two or more institutes of higher education leading to a joint or multiple degree(s);
<b>Mentor:</b>	staff member involved in the daily direction of a student during the MSc thesis research phase;
<b>Module:</b>	a self-contained programme unit with specified learning objectives, as stipulated in article 7.3 of the Act;
<b>Module plan:</b>	a document describing a.o. the learning objectives, content, didactic methods and assessments. Modules plans are part of the study guide;
<b>Observer:</b>	a person who is present at an oral examination in order to monitor and listen to what happens;
<b>Online short course:</b>	a module offered as an online certificate course;

<b>Peer review:</b>	is the evaluation of work by one or more people of similar competence to the producers of the work (peers);
<b>Plagiarism:</b>	the practice of taking someone else's work or ideas and passing them off as one's own;
<b>Practical:</b>	a practical educational activity as stipulated in article 7.13, paragraph 2, clause d of the Act, taking one of the following forms: <ul style="list-style-type: none"> <li>• the writing of a report or thesis;</li> <li>• producing a report, study assignment or design;</li> <li>• conducting a test or experiment;</li> <li>• performing an oral presentation;</li> <li>• participating in groupwork, fieldwork or a fieldtrip;</li> <li>• conducting a research assignment; or</li> <li>• participation in other educational activities that aim to develop specific skills;</li> </ul>
<b>Programme evaluation:</b>	the formal evaluation of the student performance before graduation (in the Act: <i>examen</i> );
<b>Study Guide:</b>	a reference document for a specific programme containing generic and programme specific information, which students need to know throughout their programme;
<b>Short course:</b>	a module offered as a face-to face certificate course;
<b>Student:</b>	a person who is registered in a study programme and sits for assessments;
<b>Supervisor:</b>	professor responsible for the work of student during the MSc thesis research phase.
<b>Taught part:</b>	part of the study programme consisting of taught modules and courses;
<b>Research part:</b>	part of the study programme consisting of an individual research work by the student leading to a MSc thesis, based on an approved research proposal.

## 2 General Information

### Article 1 Scope of the regulations

- 1.1 The present regulations apply to the education offerings and examinations within:  
the Master programmes in:
- Urban Water and Sanitation
  - Environmental Science
  - Water Management
  - Water Science and Engineering

Short and online courses which are part of these master programmes  
Graduate Professional Diploma Programmes (GPDP)

referred to hereafter as ‘the programmes’.

The programmes are executed by the UNESCO-IHE Institute for Water Education, Delft, the Netherlands, referred to hereafter as ‘the Institute’ and several partner institutes in various countries.

- 1.2 For the following 4 joint degree specialisations separate examination regulations apply:
- Urban Water Engineering and Management (UWEM);
  - Limnology and Wetland Management (LWM);
  - International Master of Science in Environmental Technology and Engineering (IMETE);
  - Environmental Technology for Sustainable Development (ETSuD).
- 1.3 In case a joint specialisation (see art. 1.4) leads to a double or multiple degrees, the rules and regulations of the partner institute will be applicable for those parts of the programme organised and implemented by the partner.
- 1.4 The following Master of Science programmes and specialisations are offered:

#### 1. Urban Water and Sanitation programme:

Specialisation	Offered by	Type of degree
1. Water Supply Engineering	UNESCO-IHE	UNESCO-IHE degree
	• UNESCO-IHE • Kwame Nkrumah University of Science and Technology, Ghana	Double degree
	• UNESCO-IHE • Universidad de Valle, Cali, Colombia	Double degree
2. Sanitary Engineering	UNESCO-IHE	UNESCO-IHE degree
	• UNESCO-IHE • Kwame Nkrumah University of Science and Technology, Ghana	Double degree
	• UNESCO-IHE • Universidad de Valle, Cali, Colombia	Double degree
3. Urban Water Engineering and Management	• UNESCO-IHE • Asian Institute of Technology, Thailand	Joint degree

## 2. Environmental Science programme:

Specialisation	Offered by	Type of degree
1. Environmental Science and Technology	UNESCO-IHE	UNESCO-IHE degree
	<ul style="list-style-type: none"> <li>• UNESCO-IHE</li> <li>• Universidad de Valle, Cali, Colombia</li> </ul>	Double degree
2. Environmental Planning and Management	UNESCO-IHE	UNESCO-IHE degree
3. Water Quality Management	UNESCO-IHE	UNESCO-IHE degree
4. Limnology and Wetland Management	<ul style="list-style-type: none"> <li>• UNESCO-IHE</li> <li>• BOKU - University of Natural Resources and Life Sciences, Vienna, Austria</li> <li>• Egerton University, Egerton, Kenya</li> </ul>	Joint degree
5. Environmental Technology for Sustainable Development	<ul style="list-style-type: none"> <li>• UNESCO-IHE</li> <li>• Asian Institute of Technology, Thailand</li> </ul>	Joint degree
6. Environmental Technology and Engineering (Erasmus Mundus programme)	<ul style="list-style-type: none"> <li>• UNESCO-IHE</li> <li>• Ghent University, Belgium,</li> <li>• ICTP, Prague, Czech Republic</li> </ul>	Joint degree

## 3. Water Management programme:

Specialisation	Offered by	Type of degree
1. Water Management	UNESCO-IHE	UNESCO-IHE degree
2. Water Resources Management	UNESCO-IHE	UNESCO-IHE degree
3. Water Services Management	UNESCO-IHE	UNESCO-IHE degree
4. Water Quality Management	UNESCO-IHE	UNESCO-IHE degree
5. Water Conflict Management	UNESCO-IHE	UNESCO-IHE degree

## 4. Water Science and Engineering programme:

Specialisation	Offered by	Type of degree
1. Hydrology and Water Resources	UNESCO-IHE	UNESCO-IHE degree
	<ul style="list-style-type: none"> <li>• UNESCO-IHE</li> <li>• Hohai University, China P.R.</li> </ul>	UNESCO-IHE degree
2. Hydraulic Engineering - River Basin Development	UNESCO-IHE	UNESCO-IHE degree
	<ul style="list-style-type: none"> <li>• UNESCO-IHE</li> <li>• University of Kuala Lumpur</li> </ul>	Double degree
3. Coastal Engineering and Port Development	UNESCO-IHE	UNESCO-IHE degree
	<ul style="list-style-type: none"> <li>• UNESCO-IHE</li> <li>• Hohai University, China P.R.</li> </ul>	UNESCO-IHE degree
4. Land and Water development	UNESCO-IHE	UNESCO-IHE degree
	<ul style="list-style-type: none"> <li>• UNESCO-IHE</li> <li>• Asian Institute of Technology Thailand</li> </ul>	Double degree
	<ul style="list-style-type: none"> <li>• UNESCO-IHE</li> <li>• University of Nebraska -Lincoln, USA</li> </ul>	Double degree
5. Hydroinformatics- Modelling and information systems for water management	UNESCO-IHE	UNESCO-IHE degree
	<ul style="list-style-type: none"> <li>• UNESCO-IHE</li> <li>• Hohai University, China P.R.;</li> </ul>	UNESCO-IHE degree
	<ul style="list-style-type: none"> <li>• UNESCO-IHE</li> <li>• Universidad del Valle, Colombia</li> </ul>	UNESCO-IHE degree
	<ul style="list-style-type: none"> <li>• UNESCO-IHE</li> <li>• Universidad del Valle, Colombia</li> </ul>	UNESCO-IHE degree



6. Flood Risk Management (Erasmus Mundus programme).	<ul style="list-style-type: none"> <li>• UNESCO-IHE</li> <li>• Technische Universität Dresden, Germany</li> <li>• Universitat Politècnica de Catalunya, Spain</li> <li>• University of Ljubljana, Slovenia</li> </ul>	Multiple degree
7. Groundwater and Global Change - Impacts and Adaptation (Erasmus Mundus programme).	<ul style="list-style-type: none"> <li>• UNESCO-IHE</li> <li>• TU Dresden, Germany</li> <li>• University of Lisbon, Portugal</li> </ul>	Multiple degree

**5. Graduate professional diploma programmes:**

Name	Offered by	
Sanitation and Sanitary Engineering	• UNESCO-IHE	Diploma

## **Article 2 Aim of the programmes and courses**

- 2.1 The aim of the master programmes is for students to acquire knowledge, insight and skills that are required for them to function as independent professionals within their field of study and to be appropriate candidates for further study towards a research career.
- 2.2 The qualifications of the master programme graduates are listed in Appendix A.
- 2.3 The aim of a short course or an online course is for students to acquire knowledge, insight and skills of a particular field of study.
- 2.4 The aim of the GPDP is to convey to the students the knowledge, insight and skills of a particular field of study and consists of a number of online modules, regular master modules or a combination of both.

## **Article 3 Full-time/part-time**

- 3.1 The master programmes and short courses are offered on a full-time basis.
- 3.2 Online courses are offered on a part-time basis.
- 3.3 The GPDP is executed on a part-time basis.

## **3 Content of the Programme**

### **Article 4 Constitution of the specializations and joint specializations**

- 4.1 The constitution of each programme specialization and diploma programme is described in the study guides of UNESCO-IHE and the partner institutes (in case of joint or double / multiple degree programmes)
- 4.2 The learning objectives of all modules (face to face and online), the content and assessment methods are described in the module plans of the study guides.

### **Article 5 Participation**

- 5.1 The attendance and active participation of students is required for all scheduled curricular activities, examinations and the practicals of the programme in which they are registered.

## 4 Assessments

### Article 6 Timing, formats and duration of assessments

- 6.1 Assessments tests whether a student has met the learning objectives.
- 6.2 A module is assessed through (a combination of) written and/or oral examinations, assignments and presentations as described in the module plans of the study guide.
- 6.3 The sequence of the modules and its assessments will take place according to the order described in the study guide.
- 6.4 Students cannot sit for a module assessment more than twice per academic year.
- 6.5 Students of a short and online course can sit for the assessment only once.
- 6.6 In case a student fails the examination of a GPDP module twice, the student can either redo the whole module again, or choose another module. In both cases agreement of the programme coordinator is needed.
- 6.7 The date and time of the written and oral examinations are announced in the programme schedules. Written and oral examinations take place during the examination periods indicated in the academic calendar.
- 6.8 Written and oral examinations for short and online course participants are held within two weeks after the end of the module.
- 6.9 The format for the assessment of a short course can deviate from the assessment format for the corresponding module.
- 6.10 Students of short courses or online courses are eligible to sit for the assessment of the course they are registered for provided that the fee to sit for these assessments has been paid.
- 6.11 The duration of a written examination may not exceed three hours and is scheduled to take place in a morning or afternoon session. In case examination work consists of two or more different parts, a break of 15 minutes is allowed, provided that all examination work of the first part(s) is collected by the invigilators before the break.
- 6.12 In the case of a combination of an oral and written examination of a module during the examination week, the maximum total duration of the combined examination shall not exceed three hours.

### Article 7 Re- assessments

- 7.1 Re-assessment consists of re-taking one or more failed assessments as described in the assessment part of the module plan, as is required to achieve a successful module result.
- 7.2 Written and oral re-examinations take place during the following examination period as indicated in the academic calendar. Dates and times of written re-examinations are announced in the programme schedules. Not reading or misreading the schedules is

not accepted as legitimate reason for failure to participate in a re-examination. All students will take the re-sit of a written examination at the same time.

- 7.3 The dates and times of written and oral (re-)examinations during the thesis period are set by the module coordinator in collaboration with the programme coordinator and the education bureau.
- 7.4 Students will only be allowed to re-sit an assessment for which a fail (i.e. mark lower than 6.0) has been obtained. The highest mark obtained (first assessment or re-sit) for the assessment will be used to compute the final module mark.
- 7.5 Students are not allowed to sit for further assessments during the programme period they are registered for, if they failed three separate modules (after re-assessments) during the taught part of the programme ('modules' does not include the MSc proposal defence).
- 7.6 The format of a re-examination may deviate from that of the first examination for the same module.
- 7.7 The latest moment to sit for a re-examination is one month before the submission date of the MSc thesis.

#### **Article 8 The organisation of the examinations**

- 8.1 Examinations are carried out according to the Examination Procedures as described in annex B of these regulations.
- 8.2 In the case of an oral or written examination for an online course, the student has to provide proof of identity (e.g. passport) to the examiner.
- 8.3 Students are expected to be in the examination room 10 minutes before the scheduled start of the exam. They will not be allowed to enter the examination room after the scheduled start of the examination.
- 8.4 Misreading the date, time or room allocation are not accepted as legitimate reasons for absence from an examination or for arriving too late.
- 8.5 Students who suffer from a physical or sensory impairment are offered the opportunity to take examinations such that, as much as possible, account is taken of their disability. If required, an expert will be consulted for advice.

#### **Article 9 Oral examinations**

- 9.1 Oral examinations are taken individually (only one student at a time). During oral examinations, a second staff member is present as an observer.
- 9.2 During oral examinations for online courses a second staff member as observer is not required. The oral examination has to be digitally recorded and kept on file for 12 weeks.
- 9.3 Oral examinations are non-public, unless stated otherwise in the module plan or current regulations.

### **Article 10 MSc proposal defence**

- 10.1 The MSc thesis proposal examination is an oral examination during the examination period indicated in the academic calendar. The examination consists of a presentation of the proposal, and a discussion with the examining committee. The examining committee consists of the supervisor and the mentor of the student. The examination is open to public attendance and discussion.
- 10.2 To be allowed to sit for the MSc proposal defence, students must have successfully completed all but maximum 2 modules.
- 10.3 The MSc thesis proposal defence is assessed as a pass or a fail. In the case of a fail, the student may present their defence one more time within one month after the first attempt before the same examining committee as stipulated in article 10.1. In the case of an unsuccessful second attempt the student is not allowed to embark on their MSc thesis work.

### **Article 11 Exemptions and transfer of credit points**

- 11.1 Exemptions for assessments are generally not granted. In exceptional cases, the Examination Board may evaluate a request and conclude to grant a transfer of credit points, after receiving a favourable recommendation from the programme committee.
- 11.2 For joint specializations credits obtained at the partner institute are accepted on the basis of the credit transfer agreements made in the cooperation documents.

### **Article 12 Absence from examinations and late submission of assignments**

- 12.1 Absence from an examination or late submission of an assignment must be reported by the student to the programme coordinator as early as possible. Absence is only allowed if the student missed a substantial part of the education relevant for the examination and/or the examination itself due to:
- a. medical reasons, to be confirmed by student counsellor or a statement by a doctor;
  - b. serious personal circumstances beyond control of the student which should be supported by written evidence as far as possible.
- 12.2 For cases in which the programme coordinator, in agreement with the module coordinator, decides that the absence from an examination or the late submission of the assignment is justified, the student shall sit the examination or submit the assignments as soon as is reasonably possible.
- 12.3 For cases in which the programme coordinator, in agreement with the module coordinator, decides that the absence from an examination or the late submission of the assignment is not justified, a mark of 1.0 will be recorded.
- 12.4 For all cases mentioned under art 12.2 and 12.3 the programme coordinator will inform the Examination Board and the planning office.

### **Article 13 Fraud**

- 13.1 If a student is caught in an attempt to take unfair advantage during an examination, the invigilators or examiners will inform the Academic Registrar who will submit a written report to the Examination Board after investigation of the incident, and after having had a discussion with the student.
- 13.2 Plagiarism is an act of fraud.
- 13.3 An examiner who observes or suspects fraud during the marking of examination work is required to submit a substantiating report to the Examination Board via the module coordinator.
- 13.4 If the Examination Board, after investigation of the incident as described in articles 13.1-13.3, concludes that there has been a case of fraud, the offender will be given a mark of 1.0 for the examination work.
- 13.5 If a student commits severe or repeated fraud, the Examination Board may decide to exclude the student concerned the right to sit for one or more examinations for a determined period with a maximum period of one year.
- 13.6 In case of severe or repeated fraud the rectorate, upon advice of the Examination Board, may also decide to permanently terminate the registration of the student concerned.

## 5 Results of Assessments

### Article 14 Assessment and notice of assessment results

- 14.1 Assessment results (including the thesis examination) are represented on a scale of 1.0 to 10.0, with one decimal of accuracy. Marks 6.0 and higher indicate a pass. The following grading scale is used:
- |               |            |
|---------------|------------|
| 9.0 - 10.0    | Excellent  |
| 8.0 - 8.9     | Very good  |
| 7.0 - 7.9     | Good       |
| 6.0 - 6.9     | Sufficient |
| 5.9 and below | Fail       |
- 14.2 Assessment results (including the thesis examination) obtained at partner institutes are represented according to the descriptions in annex C of these regulations.
- 14.3 The mark for a module is determined by the weighted average of the results of the various assessments. The weights for each assessment are stated in the module plan. The minimum mark that should be obtained for each assessment is 5.0. Marks between 5.0 and 5.9 can be compensated by higher marks of other assessments in the same module.
- 14.4 All written examination work of the students will, where feasible, be blind marked by the examiners involved.
- 14.5 Students will be informed on the outcome of their examination work as soon as possible, but at least three weeks before the planned re-examination.
- 14.6 The examination committee for the thesis examination shall determine the result immediately after the defence. The mark shall be formally communicated to the student before the diploma awarding by the Education Bureau.
- 14.7 After the assessment of a module has been completed, the student receives a written statement from the Education Bureau mentioning the overall module mark, the marks given for the different assessments, and if successful also the credit points granted for the module.
- 14.8 After a successful re-sit of an assessment, the mark for the module is recalculated according to the weighted average of the assessment results. However, the maximum module mark which can be awarded when there has been a re-assessment is 7.0.

### Article 15 Period of validity

- 15.1 The result of a module, if successful, is valid for an unlimited period of time.
- 15.2 Notwithstanding paragraph 1 of this article, the period of validity for which the Examination Board takes module results into account for the programme evaluation is four years.

**Article 16 Right to inspection of assessments**

- 16.1 Students may, upon their own request, peruse their assessment work within ten working days after they were notified of the result.
- 16.2 Where a practical is part of a module, the work for that part may be returned to the students when all assessments of the module are fully completed.
- 16.3 Written examination work is archived for a minimum of 7 years.

**Article 17 Study progress and study advice**

- 17.1 All study results that are required for evaluating the performance of the students, are recorded by the Education Bureau on behalf of the Examination Board.
- 17.2 Upon request, students will be provided with a written summary of the study results obtained in the programme to date.



## 6 Thesis Examination

### Article 18 The organisation of the thesis examination

18.1 The thesis will be assessed by a thesis examination committee, normally consisting of three members: a professor as the chairperson, the mentor and maximum one external independent examiner.

In special circumstances the committee may consist of more than three members:

- a) If the UNESCO-IHE mentor is a PhD fellow, mentoring the MSc student in the context of his/her own research, is a member of the committee, an additional staff member is compulsory.
- b) If the research work is carried out outside UNESCO-IHE a second co-mentor from that external institute may be appointed.
- c) If the research work is co-mentored by a staff member from another chair group at UNESCO-IHE;
- d) In the case of a double degree or joint degree programme, where the MSc research work is carried out under co-supervision of staff members of the partnering institutes.

External examiners:

- are not involved in the thesis work (independent)
- are from outside the institute or are in exceptional cases from a chair group within the institute, but not involved in the supervision of the research work.
- have to possess at least a Master degree.

18.2 The opportunity to sit the thesis examination is offered once every calendar month.

18.3 All students have to submit the examination version of the thesis report on the same date, and defend their thesis in the designated period, as annually announced by the Examination Board.

18.4 Students can sit the thesis examination only if all other modules required to obtain the degree have been successfully completed.

18.5 If the outcome of the thesis examination, including the defence, is negative, the examination can be repeated once. The examination committee will detail the reasons for the failure in writing and clarify what is required to pass the exam. The student has to finalize the work without further supervision nor financial support. The re-sit shall be taken within three months after the first attempt and will, in principle, be assessed by the same committee as for the first attempt. In special circumstances the examination can take place via videoconference.

18.6 The maximum recorded mark for a re-sit of the thesis examination is 6.0.

18.7 The MSc thesis work shall be assessed according to the MSc thesis assessment criteria as outlined in appendix E.

- 18.8 The mark for the thesis examination is based on the following components: written MSc thesis report, oral presentation, and examination. The latter includes the ability of the student to satisfactorily answer questions from the examination committee. The oral presentation of the thesis research has a maximum duration of 30 minutes and is followed by a maximum 30 minutes examination discussion with the examining committee. The oral presentation is open to public attendance and discussion.
- 18.9 The decision on a final mark for the thesis examination in principle will be based on a consensus of the examining committee. In the case of insurmountable disagreements the chair of the examining committee takes a decision.
- 18.10 The maximum duration of the MSc research phase is six months for full-time study. In the case of a *force majeure*, as supported by substantiating documents, extension of this period may be granted by the Examination Board on request by the student through their mentor.

## 7 Criteria, degrees and certificates

### Article 19 Evaluation of the programme

19.1 The student has fulfilled the requirements for the programme evaluation if s/he has:

#### SINGLE DEGREES:

- For the single UNESCO-IHE degree programmes:
  - Successfully completed all modules of the programme; and
  - Obtained a minimum of 106 ECTS.
  
- For the single UNESCO-IHE GPDP diploma:
  - Successfully obtained a minimum of 20 ECTS for the programme.

#### JOINT DEGREES:

- For the joint degree Limnology and Wetland Management programme (LWM):
  - Successfully completed all modules of the programme, according to the grading rules of BOKU, Egerton University and UNESCO-IHE; and
  - Obtained a minimum of 120 ECTS.
  
- For the joint degree International Master of Science in Environmental Technology and Engineering programme (IMETE) (Erasmus Mundus programme):
  - Successfully completed all modules of the programme, according to the grading rules of Ghent University, Institute of Chemical Technology in Prague and UNESCO-IHE; and
  - Obtained a minimum of 120 ECTS.
  
- For the joint degree Environmental Technology for Sustainable Development (ETSuD) conducted with the Asian Institute of Technology (AIT):
  - Obtained a minimum of 48 AIT credits / 125 ECTS credits, and
  - Obtained a minimum cumulative GPA of 2,75 for courses taken at AIT, and
  - Passed all modules taken at UNESCO-IHE, and
  - Has obtained a grade 'fair' or higher for their Master's thesis at AIT.
  
- For the joint degree Urban Water Engineering and Management (UWEM) conducted with the Asian Institute of Technology (AIT):
  - Obtained a minimum of 48 AIT credits / 120 ECTS credits, and
  - Obtained a minimum cumulative GPA of 2,75 for courses taken at AIT, and
  - Passed all modules taken at UNESCO-IHE, and
  - Has obtained a grade 'fair' or higher for their Master's thesis at AIT.

#### DOUBLE / MULTIPLE DEGREES:

- For the double degree programme Land and Water development conducted with the Asian Institute of Technology (AIT):
  - Obtained a minimum of 48 AIT credits / 120 ECTS credits, and
  - Obtained a minimum cumulative GPA of 2,75 for courses taken at AIT, and
  - Passed all modules taken at UNESCO-IHE, and
  - Has obtained a grade 'fair' or higher for their Master's thesis at AIT.
  
- For the double degree programmes in Water Supply Engineering, Sanitary Engineering, and Environmental Science and Technology conducted with Universidad del Valle:
  - Obtained a GPA of 3.5 or higher for the course work done at Univalle; and

- Successfully completed all modules at UNESCO-IHE; and
  - Achieved a mark '6' or higher for the thesis examination; and
  - Obtained a minimum of 113,36 ECTS.
- For the double degree programmes in Water Supply Engineering, and Sanitary Engineering conducted with KNUST:
    - Obtained a CWA of 55% or higher for the course work done at KNUST; and
    - Successfully completed all modules at UNESCO-IHE; and
    - Achieved a pass for the thesis examination at KNUST; and
    - Obtained a minimum of 118 ECTS.
- For the double degree programme Land and Water development conducted with the University of Nebraska-Lincoln:
    - Successfully completed all modules of the programme; and
    - Obtained a minimum of 112 ECTS.
- For the double degree programme River basin development conducted with the University of Kuala Lumpur:
    - Successfully completed all modules of the programme; and
    - Obtained a minimum of 108.7 ECTS.

**DOUBLE / MULTIPLE DEGREES (Erasmus Mundus programmes):**

- For the multiple degree programme on Flood Risk Management:
    - Successfully completed all modules of the programme, according to the grading rules of TU-Dresden, University of Ljublijana, TU-Catalonia and UNESCO-IHE; and
    - Obtained a minimum of 120 ECTS.
  - For the double degree programme Water Co-operation and Peace conducted with the University of Peace and University of Oregon:
    - Successfully completed all modules of the programme, according to the grading rules of UPEACE, University of Oregon, and UNESCO-IHE; and
    - Obtained a minimum of 120 ECTS.
  - For the multiple degree programme in Groundwatch:
    - Successfully completed all modules of the programme, according to the grading rules of the University of Lisbon, Technical University Dresden, and UNESCO-IHE; and
    - Obtained a minimum of 120 ECTS.
- 19.2 The student has fulfilled the requirements for the short or online course if s/he successfully completed all assessments of the course.
- 19.3 The student has successfully completed the programme evaluation or short / online course evaluation if the Examination Board takes a decision to that effect.

**Article 20 Awarding of degrees and certificates**

20.1 Master of Science degree.

- Students who have successfully completed the programme evaluation requirements will be awarded the Master of Science degree at the next scheduled degree awarding ceremony. The degree is signed by the Chairman of the Examination Board, the Rector of the Institute and the Academic Registrar. In addition to the degree certificate, the graduate receives a degree supplement stating the results achieved and credit points for each component of the programme.
- 20.2 **Certificate of Graduate Study.**  
Students who fail to meet the master programme evaluation requirements and have accumulated a minimum of 45 credits will be awarded a certificate of graduate study in the programme for which they are registered. Registration as student will be terminated.
- 20.3 **Certificate of attendance.**  
Students who fail to meet the master programme evaluation requirements, or who suspend or terminate their registration, will be issued a certificate stating the result achieved and credit points for each successfully completed component of the programme, and the period of registration. The Certificate of Attendance is signed by the Course coordinator and the Academic Registrar.
- 20.4 **If a student re-registers within 4 years after termination and meets (after assessment(s)) the requirements of an MSc degree, s/he is obliged to return the certificate as mentioned under art 20.2 and art 20.3.**
- 20.5 **With reference to art 20.4, if a student re-registers within 4 years with the aim to obtain an MSc degree, s/he has to re-take in full all failed and missed modules. Re-registration is only possible for a subsequent academic period.**
- 20.6 **Certificate for short or online course.**  
Students who have successfully completed a credited short or online course including all its assessments, will be awarded a certificate. The certificate is signed by the Course coordinator and the Academic Registrar. In addition to this certificate, the graduate receives an academic transcript stating the result achieved and credit points awarded.
- 20.7 **Certificate of Attendance.**  
Students who have successfully completed the short or online course without assessments, and who have demonstrated an active participation in the course throughout the whole study period, will be awarded a Certificate of Attendance. The Certificate of Attendance is signed by the Course coordinator and the Academic Registrar.
- 20.8 **GPDP diploma**  
Students who have successfully collected a minimum of 20 ECTS for the programme will be awarded a Postgraduate Professional Diploma in Sanitation and Sanitary Engineering.  
The diploma is signed by the Rector of the Institute, the Chair of the Examination Board and the Academic Registrar. In addition to this diploma the graduate receives a diploma supplement stating the learning objectives, the composition of the programme, the results achieved and the associated credit points.
- 20.9 **Students who fail to meet the requirements for the awarding of the GPDP diploma will receive a Certificate (art 20.4) for those courses which were successfully completed.**

## **Article 21 Criteria for MSc degree with distinction**

21.1 The Master of Science degree can be awarded with distinction by the Examination Board if:

For single degree programmes:

- the candidate obtained a mark of 8.5 or higher for the thesis examination, and an arithmetic average mark at UNESCO-IHE of 8.0 or higher for all modules that are assessed on a numerical scale, conform article 14.1,
- there were no re-assessments during the taught part, and
- a recommendation is made by the chair of the examination committee.

For double / multiple degree programmes where student sits for the thesis examination at UNESCO-IHE:

- the candidate obtained a mark of 8.5 or higher for the thesis examination, and
- an arithmetic average mark at UNESCO-IHE of 8.0 or higher for all modules that are assessed on a numerical scale, conform article 14.1.
- a recommendation is made by the chair of the examination committee.

The recommendation should also be based on the results for the courses obtained at the partner institute(s).

For double / multiple degree programmes where student sits for the thesis examination at a partner institute:

- the candidate obtained an arithmetic average mark at UNESCO-IHE of 8.0 or higher for all modules that are assessed on a numerical scale, conform article 14.1.
- a recommendation is made by the professor responsible for the specialization concerned.

The recommendation should also be based on the results for the courses and thesis obtained at the partner institute(s).

## 8 Appeals

### Article 22 Grounds for appeal

- 22.1 Students have the right to appeal against an assessment result, if
- the performance of the student suffered through illness or other factors;
  - a material administrative error in the conduct of an assessment occurred;
  - the assessment or evaluation was not conducted in accordance with the regulations;
  - some other material irregularity occurred;
  - there is a serious unsolved conflict with the supervisor or the mentor.

### Article 23 Procedure for appeal

- 23.1 A student shall first attempt to resolve the problem with the body or person that has taken the disputed decision.
- 23.2 If the appeal concerns a decision taken by an Examiner or an MSc Examination Committee, the appeal shall be submitted to the Examination Board within 3 weeks following the date on which the decision was made known. It should be submitted by the student in writing, stating the grounds for appeal and enclosing appropriate documentation, including an account of the attempt to resolve the case amicably.
- 23.3 If the appeal concerns a decision taken by the Examination Board - not being an appeal as referred to in Article 23.2 - or a decision taken by the Academic Registrar, the appeal shall be submitted to the Academic Appeals Board within 3 weeks following the date on which the decision was made known. It should be submitted by the student in writing, stating the grounds for appeal and enclosing appropriate documentation, including an account of the attempt to resolve the case amicably.
- 23.4 Pending the outcome of the appeal procedure, the initial (contested as per appeal) decision will remain in force and will be implemented
- 23.5 Reference is made to Appendix F for a detailed description of the appeal procedure.

## 9 Final Articles

### Article 24 Amendments

- 24.1 Amendments to these regulations are made by separate decision of the Rectorate.
- 24.2 No amendments shall be made in relation to the ongoing academic year, unless there is reasonable expectation that the amendment will not disadvantage the students.

### Article 25 Unforeseen situations

- 25.1 Situations which are not foreseen by the present regulations will be decided on by the Examination Board, where necessary after consultation with the programme committee concerned.

### Article 26 Publication

- 26.1 The Rectorate is responsible for the timely publication of these Examination Regulations, and any amendments thereof.

**Article 27 Period of application**

27.1 These regulations take effect for the cohort 2016 – 2018. Approved by the Rectorate of UNESCO-IHE on 19-07-2016





## Appendix A Qualifications of Graduates

### 1. Urban Water and Sanitation Programme

#### 1.1 Sanitary Engineering

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

Knowledge and understanding	<ol style="list-style-type: none"><li>1. understand and explain the role of sanitation in urban water cycle and its relation to public health and environment;</li><li>2. develop rational approaches towards sustainable waste(water) management via pollution prevention, appropriate treatment, resources recovery and re-use on both centralized and decentralized level;</li><li>3. understand in-depth relevant physical, chemical and biological processes, and their mutual relationships within various sanitation components;</li></ol>
Applying knowledge and understanding	<ol style="list-style-type: none"><li>1. apply gained knowledge and skills in practice;</li><li>2. prepare conceptual engineering and process design of sanitation components;</li><li>3. apply modern tools for technology selection and carry out modelling of sanitation components;</li><li>4. identify, develop and conduct independent research including formulation of hypotheses selection and application of research methodologies, and the formulation of conclusions and recommendations;</li><li>5. carry out desk studies, field work, and laboratory based research;</li><li>6. contribute to the development of innovative approaches to the provision of adequate and sustainable sanitation services in developing countries and countries in transition;</li></ol>
Making judgements	<ol style="list-style-type: none"><li>1. define and critically analyse, assess and evaluate various urban drainage and sewerage schemes, and wastewater, sludge and solid waste treatment process technologies;</li><li>2. analyse, synthesise, integrate, interpret, and discuss both scientific and practical information in the context of various research and engineering projects including preparation of Master plans, feasibility studies and preliminary designs;</li></ol>
Communication	<ol style="list-style-type: none"><li>1. clearly communicate concerning both oral and written skills;</li></ol>
Lifelong learning skills	<ol style="list-style-type: none"><li>1. continuously acquire knowledge and assimilate and implement innovative learning methods and skills in an independent manner;</li><li>2. operate both autonomously and in a multidisciplinary and multinational environment.</li></ol>

## 1.2 Water Supply Engineering

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

Knowledge and understanding	<ol style="list-style-type: none"><li>1. understand the structure of drinking water supply systems, including water transport, treatment and distribution;</li><li>2. understand water quality criteria and standards, and their relation to public health, environment and urban water cycle;</li><li>3. understand in-depth occurring physical, chemical and biological phenomena and their mutual relationships, within water supply systems;</li><li>4. understand water quality concepts and their effect on treatment process selection;</li><li>5. understand the interaction of water quality and materials applied;</li><li>6. understand hydraulic concepts and their relationship to water transport in treatment plants, pipelines and distribution networks;</li><li>7. understand the importance and methods for operation and maintenance of water supply systems;</li><li>8. understand options for centralised and urban systems versus decentralized and rural systems;</li><li>9. understand water supply engineering within a watershed context;</li></ol>
Applying knowledge and understanding	<ol style="list-style-type: none"><li>1. design and to rehabilitate raw water abstraction, transport, treatment and distribution processes and systems;</li><li>2. use statistical and modelling tools for simulating, prediction of performance and operation of water supply system components;</li><li>3. conduct independent research, including formulation of hypotheses, selection and application of research methodologies, and the formulation of conclusions and recommendations;</li></ol>
Making judgements	<ol style="list-style-type: none"><li>1. define and evaluate project alternatives on basis of chosen selection criteria;</li></ol>
Communication	<ol style="list-style-type: none"><li>1. communicate effectively in oral and written presentations to technical and non-technical audiences.</li></ol>
Lifelong learning skills	<ol style="list-style-type: none"><li>2. posses the learning skills to acquire continual knowledge in an independent manner;</li></ol>

### 1.3 Urban Water Engineering and Management

After successful completion of the programme graduates will be able to:

Knowledge and understanding	<ol style="list-style-type: none"> <li>1. understand the urban water cycle and its water system components, their characteristics and functioning within greater urban infrastructure systems;</li> <li>2. understand urban water management problems including ability to: identify water systems' demand; deal with climatic and hydrologic uncertainties and/or extremes; institutional limitations; and work within a data-constrained environment;</li> <li>3. understand water infrastructure/asset planning, financing and management, and utility management;</li> <li>4. familiarise with the concept of integrated water resources management (IWRM) and its application to a variety of water management problems at the urban catchment scale;</li> </ol>
Applying knowledge and understanding	<ol style="list-style-type: none"> <li>1. make appropriate and critical use of methods, techniques and tools necessary to monitor, analyze and design urban water systems including: water supply infrastructure; drinking water treatment and distribution; wastewater collection, treatment, transport and disposal systems; drainage systems;</li> <li>2. identify, articulate, analyse and solve problems of the urban water cycle and systems, integrating theory and applications;</li> <li>3. collect, summarise, analyse and interpret technical data/materials in a structured form to gain knowledge on urban water system design and operation and maintenance;</li> <li>4. work with a range of information technology tools available for solving urban water management problems and for effectively communicating with fellow water managers, researchers, scientists, planners, and policy-makers;</li> </ol>
Making judgements	<ol style="list-style-type: none"> <li>1. critically recognize and assess the need for continued-education and research on planning, design, maintenance and management of urban water systems;</li> </ol>
Communication	<ol style="list-style-type: none"> <li>2. reporting and give presentation;</li> </ol>
Lifelong learning skills	<ol style="list-style-type: none"> <li>1. learn independently;</li> <li>2. demonstrate having improved IT skills;</li> <li>3. work independently and / or as part of a team;</li> <li>4. manage time effectively.</li> </ol>

#### 1.4 Graduate professional diploma programme

Upon completion of the programme participants will be qualified to:

- perform as a competent professional in the field of sanitation and/or sanitary engineering
- to contribute to the development of innovative approaches to the provision of sustainable sanitation services especially under challenging conditions usually prevailing in developing and countries in transition.

Knowledge and understanding	<ol style="list-style-type: none"><li>1. Understand and explain the role of sanitation in the urban water cycle and its relation to public health and environment;</li><li>2. Understand the relevant physical, chemical and biological processes and their mutual relationships within various sanitation components;</li></ol>
Applying knowledge and understanding	<ol style="list-style-type: none"><li>1. Develop rational approaches towards sustainable wastewater management via pollution prevention, appropriate treatment, and resource recovery and re-use at both centralized and decentralized setting;</li><li>2. Apply modern tools for technology selection and to model sanitation components.</li></ol>
Making judgements	<ol style="list-style-type: none"><li>1. Define and critically analyze, assess and evaluate various urban drainage and sewerage schemes, and wastewater, sludge (including faecal sludge) and solid waste treatment process technologies;</li><li>2. Analyze, synthesize, integrate, interpret, and discuss scientific and practical information in the context of preparing research and engineering projects including preparation of master plans, feasibility studies and preliminary designs;</li></ol>
Communication	
Lifelong learning skills	

## 2. Environmental Science Programme

### 2.1 Environmental Science & Technology

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

<p>Knowledge and understanding</p>	<ol style="list-style-type: none"> <li>1. demonstrate understanding of natural environmental processes, the socio-economic concepts underlying functioning and exploitation of environmental systems, and of the complex inter-relationship between the protection and wise use of environmental resources;</li> <li>2. describe the rationale for an integrated and interdisciplinary approach for the sustainable management of water and environmental resources;</li> <li>3. identify the impacts of human activities on the environment, under different levels of environmental stress and in different socio-economic contexts;</li> <li>4. name and explain concepts, instruments and technologies for pollution prevention and remedial actions in a national and international context;</li> </ol>
<p>Applying knowledge and understanding</p>	<ol style="list-style-type: none"> <li>1. 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;</li> <li>2. apply general methods (including statistics and modelling) in scientific and technological approaches, concepts and interventions;</li> <li>3. 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;</li> </ol>
<p>Making judgements</p>	<ol style="list-style-type: none"> <li>1. 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;</li> <li>2. 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;</li> </ol>
<p>Communication</p>	<ol style="list-style-type: none"> <li>1. 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;</li> </ol>
<p>Lifelong learning skills</p>	<ol style="list-style-type: none"> <li>1. 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.</li> </ol>

## 2.2 Environmental Planning & Management

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

<p>Knowledge and understanding</p>	<ol style="list-style-type: none"> <li>1. demonstrate understanding of natural environmental processes, the socio-economic concepts underlying functioning and exploitation of environmental systems, and of the complex inter-relationship between the protection and wise use of environmental resources;</li> <li>2. describe the rationale for an integrated and interdisciplinary approach for the sustainable management of water and environmental resources;</li> <li>3. 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;</li> <li>4. name and explain principles, concepts and instruments of major national and international water and environmental legislation and common and desired institutional and management arrangements;</li> </ol>
<p>Applying knowledge and understanding</p>	<ol style="list-style-type: none"> <li>1. 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;</li> <li>2. 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;</li> <li>3. 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;</li> <li>4. design and facilitate consultation- and decision-making processes between stakeholders, users and their representatives, water managers, politicians and other decision-makers;</li> </ol>
<p>Making judgements</p>	<ol style="list-style-type: none"> <li>1. 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;</li> <li>2. 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;</li> <li>3. 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;</li> <li>4. 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.</li> </ol>

Communication	5. 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;
Lifelong learning skills	6. 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;



## 2.3 Water Quality Management

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

<p>Knowledge and understanding</p>	<ol style="list-style-type: none"> <li>1. demonstrate understanding of natural environmental processes, the socio-economic concepts underlying functioning and exploitation of environmental systems, and of the complex inter-relationship between the protection and wise use of environmental resources;</li> <li>2. describe the rationale for an integrated and interdisciplinary approach for the sustainable management of water and environmental resources;</li> <li>3. identify the impacts of human activities on aquatic ecosystems;</li> <li>4. name and explain principles, concepts and instruments of main national and international water and environmental legislation and common and desired institutional and management arrangements;</li> </ol>
<p>Applying knowledge and understanding</p>	<ol style="list-style-type: none"> <li>1. 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;</li> <li>2. interpret, design and optimise water quality monitoring and assessment schemes in the watershed;</li> <li>3. apply experimental, statistical and modelling tools for interpreting and designing water quality management programmes;</li> <li>4. 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;</li> </ol>
<p>Making judgements</p>	<ol style="list-style-type: none"> <li>1. 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;</li> <li>2. 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;</li> <li>3. critically analyse and evaluate alternative water quality management programmes in the watershed under different socio-economic and legal contexts, often in data-poor conditions;</li> </ol>
<p>Communication</p>	<ol style="list-style-type: none"> <li>1. 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;</li> </ol>
<p>Lifelong learning skills</p>	<ol style="list-style-type: none"> <li>1. 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.</li> </ol>

### 3. Water Management Programme

#### 3.1 Water Management

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

<p>Knowledge and understanding</p>	<ol style="list-style-type: none"> <li>1. describe and predict for a given water resources system the main hydrological, hydraulic, chemical and ecological processes and how these processes are dynamically linked with human activities, including land and water use.</li> <li>2. describe and explain the main concepts and instruments for analysing and influencing formal and informal arrangements over water, including policies, laws and institutions, and by adopting a historical perspective.</li> <li>3. explain the key concepts for integrated, multi-disciplinary and interdisciplinary analyses of water systems and describe the challenges of such approaches.</li> <li>4. comprehend the broader scientific, engineering, socio-economic and environmental context in which water management and governance issues are manifested and addressed.</li> </ol>
<p>Applying knowledge and understanding</p>	<ol style="list-style-type: none"> <li>1. formulate and apply water management and governance frameworks / tools / methods to water related issues in a given context in a social inclusive and environmental sustainable manner.</li> <li>2. apply different concepts and methods in a coherent way and through a process of triangulation synthesize results and draw well reason conclusions and recommendations.</li> <li>3. conduct, independently or in a multidisciplinary team, research including the formulation of research questions and hypotheses, the selection and application of adequate research methodologies and techniques and the formulation of well-founded conclusions.</li> </ol>
<p>Making judgements</p>	<ol style="list-style-type: none"> <li>1. compare and contrast different ideas and approaches to make sound judgement based on available information, and assess the potential for application, integration and further development.</li> <li>2. apply suitable techniques, tools and procedures for a given context in order to evaluate the consequences of different development and intervention scenarios.</li> <li>3. reflect critically on ho how different activities impact on the sustainable use of water in a given context.</li> <li>4. reflect on own professional and educational background relate to this knowledge and skills needed to build a solid career in the water sector, and on this basis identify a coherent personal learning trajectory.</li> </ol>
<p>Communication</p>	<ol style="list-style-type: none"> <li>1. clearly and systematically communicate, argue and defend findings in oral and written presentations to a variety of audiences.</li> </ol>
<p>Lifelong learning skills</p>	<ol style="list-style-type: none"> <li>1. think in multidisciplinary and integrated dimensions and be able to distinguish main issues from side issues.</li> <li>2. have the academic attitude and learning skills to enhance and keep up-to-date the acquired knowledge and application skills in a largely independent manner.</li> <li>3. Have the ability to reflect on own performance and advance own career within the water sector.</li> </ol>

### 3.2 Water Resources Management

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

Knowledge and understanding	<ol style="list-style-type: none"> <li>1. describe and predict for a given water resources system the main hydrological, hydraulic, chemical and ecological processes and how these processes are dynamically linked with human activities, including land and water use.</li> <li>2. describe and explain the main concepts and instruments for analysing and influencing formal and informal arrangements over water, including policies, laws and institutions, and by adopting a historical perspective.</li> <li>3. explain the key concepts for integrated, multi-disciplinary and interdisciplinary analyses of water systems and describe the challenges of such approaches.</li> <li>4. characterize and explain water resource issues using economic concepts and theory for addressing water issues and describe how economic concepts and tools including valuation support integrated water resources management.</li> </ol>
Applying knowledge and understanding	<ol style="list-style-type: none"> <li>1. model processes of the water system (rainfall-runoff, flooding, water allocation, water accounting), validate models, critically interpret model outcomes in order to derive insight in trends, causes and effects, and define and explain model limitations.</li> <li>2. formulate and critically evaluate governance frameworks related to water resources management and apply tools for policy analysis with the emphasis on social inclusion and sustainability.</li> <li>3. Apply and develop integrated tools / methods to support water resources assessment / planning / management at different scales and accounting for aspects relating to quality and quantity and upstream / downstream linkages.</li> <li>4. conduct, independently or in a multidisciplinary team, research including the formulation of research questions and hypotheses, the selection and application of adequate research methodologies and techniques and the formulation of well-founded conclusions.</li> </ol>
Making judgements	<ol style="list-style-type: none"> <li>1. analyse a given water resources system in order to quantify the water flows over space and time, accounting for and describing the interdependencies between many (competing) water users.</li> <li>2. critically evaluate technical and/or institutional water resources interventions (policy actions / agreements) through analysis of implications for the water resources system, its users and their interrelations at various spatial and temporal scales.</li> </ol>
Communication	<ol style="list-style-type: none"> <li>1. clearly and systematically communicate, argue and defend findings in oral and written presentations to a variety of audiences</li> </ol>
Lifelong learning skills	<ol style="list-style-type: none"> <li>1. think in multidisciplinary and integrated dimensions and be able to distinguish main issues from side issues.</li> <li>2. have the academic attitude and learning skills to enhance and keep up-to-date the acquired knowledge and application skills in a largely independent manner.</li> </ol>

### 3.3 Water Conflict Management

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

Knowledge and understanding	<ol style="list-style-type: none"> <li>1. describe for a given water resources system the interplay between the main biophysical processes and social dynamics, in analyzing, anticipating, preventing and managing conflicts.</li> <li>2. describe and explain the main concepts and instruments for analysing and influencing formal and informal arrangements over water for collaboration, including policies, laws and institutions, and by adopting a historical perspective.</li> <li>3. explain the key concepts for integrated, multi-disciplinary and interdisciplinary analyses of water systems and describe the challenges of such approaches at sector, intersectoral and transboundary levels.</li> <li>4. name and critically discuss theories, concepts and tools of conflict management and cooperation building techniques in the context of natural resources and water in particular.</li> </ol>
Applying knowledge and understanding	<ol style="list-style-type: none"> <li>1. design and facilitate inclusive consultation and conflict management processes, such as consensus building, public participation, negotiation and mediation between actors at different levels.</li> <li>2. formulate and critically evaluate governance frameworks related to water conflict management and apply tools for policy analysis with the emphasis on social inclusion and sustainability.</li> <li>3. combine different types of method and through a process of triangulation synthesize outcomes in a coherent manner.</li> <li>4. conduct, independently or in a multidisciplinary team, research including the formulation of research questions and hypotheses, the selection and application of adequate research methodologies and techniques and the formulation of well-founded conclusions, recommendations and limitations.</li> </ol>
Making judgements	<ol style="list-style-type: none"> <li>1. appraise the different functions of the water resources system, and the associated competing interests of water using sectors and actors, describe the inter-dependencies between these, and finally assess the possibilities and limitations of cooperation.</li> <li>2. critically evaluate technical and/or institutional interventions focused on conflict management (projects/ programmes/ policies/ agreements) through analysis of implications for the water resources system, its users and their interrelations at various spatial and temporal scales.</li> </ol>
Communication	<ol style="list-style-type: none"> <li>1. clearly and systematically communicate, argue and defend findings in oral and written presentations to a variety of audiences.</li> </ol>
Lifelong learning skills	<ol style="list-style-type: none"> <li>1. think in multidisciplinary and integrated dimensions and be able to distinguish main issues from side issues.</li> <li>2. have the academic attitude and learning skills to enhance and keep up-to-date the acquired knowledge and application skills in a largely independent manner.</li> </ol>

### 3.4 Water Quality Management

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

Knowledge and understanding	<ol style="list-style-type: none"> <li>1. describe and predict for a given water resources system the main hydrological, hydraulic, chemical and biological processes and how these processes are dynamically linked with aquatic ecosystems as well as with human activities such as land and water use and pollution.</li> <li>2. describe and explain the main concepts and instruments for analysing and influencing formal and informal arrangements for water quality management, including policies, laws and institutions, and by adopting a historical perspective.</li> <li>3. explain the key concepts for integrated, multi-disciplinary and interdisciplinary analyses of aquatic ecosystems and describe the challenges of such approaches.</li> <li>4. describe concepts to determine the value of water for various uses and users in (amongst others) economic and ecological terms and explain how these concepts can be used in water resources planning at various spatial and temporal scales.</li> </ol>
Applying knowledge and understanding	<ol style="list-style-type: none"> <li>1. interpret, design and optimize water quality assessment and monitoring programmes by applying experimental, statistical and modelling tools.</li> <li>2. formulate and critically evaluate governance frameworks related to water quality management and apply tools for policy analysis with the emphasis on social inclusion and sustainability.</li> <li>3. combine different types of method and through a process of triangulation synthesize outcomes in a coherent manner.</li> <li>4. conduct, independently or in a multidisciplinary team, research including the formulation of research questions and hypotheses, the selection and application of adequate research methodologies and techniques and the formulation of well-founded conclusions.</li> </ol>
Making judgements	<ol style="list-style-type: none"> <li>1. define a given water resources system, and compose the water and pollution flows across time and space, including the various water uses, and describe the interdependencies these create between the various water users.</li> <li>2. critically evaluate technical and/or institutional interventions focused on water quality (projects/ programmes/ policies/ agreements) through analysis of implications for the water resources system, its users and their interrelations at various spatial and temporal scales.</li> </ol>
Communication	<ol style="list-style-type: none"> <li>1. clearly and systematically communicate, argue and defend findings in oral and written presentations to a variety of audiences.</li> </ol>
Lifelong learning skills	<ol style="list-style-type: none"> <li>1. think in multidisciplinary and integrated dimensions and be able to distinguish main issues from side issues.</li> <li>2. have the academic attitude and learning skills to enhance and keep up-to-date the acquired knowledge and application skills in a largely independent manner</li> </ol>

### 3.5 Water Services Management

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

Knowledge and understanding	<ol style="list-style-type: none"> <li>1. describe for a given water resources system the interplay between the main biophysical processes and social dynamics, in analyzing service delivery modalities.</li> <li>2. describe and explain the main concepts and instruments for analysing and influencing formal and informal arrangements concerning water supply and sanitation services, including policies, laws and institutions, and by adopting a historical perspective.</li> <li>3. explain the key concepts for integrated, multi-disciplinary and interdisciplinary analyses of water services management and describe challenges of providing water supply and sanitation services at different levels (from global to local).</li> <li>4. summarize the current debates relevant for water supply and sanitation services, using institutional and management theories from different academic disciplines (e.g. economics, public administration, sociology, political science, law).</li> </ol>
Applying knowledge and understanding	<ol style="list-style-type: none"> <li>1. design and apply analytical tools to research issues of water services management and describe, modify and apply management tools (e.g. with the benchmarking, cost benefit analysis, management information systems) with the aim of improving water supply and sanitation provision.</li> <li>2. formulate and critically evaluate governance frameworks related to water services management and apply tools for policy analysis with the emphasis on social inclusion and sustainability.</li> <li>3. combine different types of method and through a process of triangulation synthesize outcomes in a coherent manner.</li> <li>4. conduct, independently or in a multidisciplinary team, research including the formulation of research questions and hypotheses, the selection and application of adequate research methodologies and techniques and the formulation of well-founded conclusions.</li> </ol>
Making judgements	<ol style="list-style-type: none"> <li>1. analyze and evaluate governance processes and utility management arrangements in the water services sector, integrating technical, legal administrative, social and financial components.</li> <li>2. critically evaluate technical and/or institutional interventions (e.g. policies actions, agreements) through analysis of implications for water supply and sanitation services, its users and their interrelations at various spatial and temporal scales.</li> </ol>
Communication	<ol style="list-style-type: none"> <li>1. clearly and systematically communicate, argue and defend findings in oral and written presentations to a variety of audiences.</li> </ol>
Lifelong learning skills	<ol style="list-style-type: none"> <li>1. think in multidisciplinary and integrated dimensions and be able to distinguish main issues from side issues.</li> <li>2. have the academic attitude and learning skills to enhance and keep up-to-date the acquired knowledge and application skills in a largely independent manner.</li> </ol>

## 4. Water Science and Engineering Programme

### 4.1 Hydraulic Engineering and River Basin Development

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

Knowledge and understanding	<ol style="list-style-type: none"><li>1. have in-depth understanding of physical processes and natural phenomena in river basin systems, development of river basins by human interference, such as designing river structures and training works, and the management of floods and droughts;</li><li>2. master the major hydraulic methodologies and applications for river structures and river modelling techniques with regard to techniques for data collection, processing and analysis;</li><li>3. have knowledge of contemporary research (questions) and relevant literature in the field of hydraulic engineering and river basin development;</li><li>4. have acquired sufficient skills in using information and communication technology for conducting studies and analyses, in addition to presentation and communication;</li></ol>
Applying knowledge and understanding	<ol style="list-style-type: none"><li>1. evaluate and analyse river basin systems and processes at a wide range of scales for the purpose of water resources, including morphological assessments, impact analysis of hydraulic structures and natural hazards assessment and mitigation taking into account relevant aspects of environmental, economical and social planning and management;</li><li>2. design and conduct hydraulic research, experiments and tests for both practical and scientific purposes, either independently or within a team-based framework; by intelligent use of engineering and scientific principles, develop and undertake critical evaluations of strategies for the implementation of river engineering works;</li><li>3. have the skills to apply and integrate relevant concepts and methodologies in the area of hydraulic, hydrological and geotechnical engineering and research as well as applying computational principles within the context of hydraulic engineering</li></ol>
Making judgements	<ol style="list-style-type: none"><li>1. critically judge and evaluate their own work and results, as well as the information of prior research or investigations;</li></ol>
Communication	<ol style="list-style-type: none"><li>1. adequately communicate methodologies, results, evaluations, conclusions and recommendations in written, oral and graphical form to a wide variety of audience;</li></ol>
Lifelong learning skills	<ol style="list-style-type: none"><li>1. be aware of the importance of hydraulic engineering to society and be able to co-operate within a multidisciplinary and interdisciplinary framework with due consideration of ethical and social aspects related to the application of their knowledge and skills;</li><li>2. have adopted the academic attitude and learning skills to enhance and broaden the acquired knowledge and applications in an independent manner.</li></ol>

## 4.2 Coastal Engineering and Port Development

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

Knowledge and understanding	<ol style="list-style-type: none"> <li>1. have advanced level of understanding of the hydraulics, coastal processes and nautical and logistic aspects and their interactions with the nearshore and offshore structure;</li> <li>2. develop strategies to cope effectively with problems related to natural hazards (e.g. coastal floods) and shoreline erosion problems and understand the conflict between coastal developments and natural coastal processes;</li> <li>3. develop an understanding of the application of modern analysis and design techniques to coastal problems and gain the expertise necessary to make effective engineering interventions in the coastal environment;</li> <li>4. be equipped with various analytical and computational expertise necessary to solve problems in coastal and port engineering;</li> </ol>
Applying knowledge and understanding	<ol style="list-style-type: none"> <li>1. apply sophisticated design techniques using theoretical concepts of coastal hydraulics and various principles and approaches of coastal engineering design to advance the needs of society for shelter, infrastructure and a safe environment and be able to evaluate and implement the solutions in a multidisciplinary and interdisciplinary environment;</li> <li>2. apply hydraulic and nautical, logistic and economic theories in the planning and design of coastal and ports layout and port logistics;</li> <li>3. have the skills to undertake academic research that contributes to the better understanding of coastal and/or port engineering;</li> <li>4. have developed the talents and skills for problem formulation and solutions synthesizing different fields of knowledge to formulate solutions to relevant technical problems using modern engineering tools</li> </ol>
Making judgements	<ol style="list-style-type: none"> <li>1. place a coastal engineering and/or port project in its environment (social, ecological and physical environment), be able to quantify and understand the interactions between the project and the environment, and is able to communicate the interactions with experts of a different background;</li> </ol>
Communication	
Lifelong learning skills	<ol style="list-style-type: none"> <li>1. have developed the skills to undertake independent creative academic activities and research and the ability to extend them leading to new knowledge that addresses problems of national and international importance;</li> <li>2. have experienced different aspects of learning which are integrated through different teaching methods and through independent study experiences;</li> <li>3. possess critical thinking skills, the ability of both independent and team problem-solving and the sense of engineering creativity and design;</li> <li>4. have acquired sufficient skills in using information and communication technology for conducting research, studies and analyses, in addition to presentation and communication;</li> <li>5. develop a sense of professionalism and an appreciation for the obligations of a professional engineer;</li> <li>6. be aware of the professional and ethical issues encountered in engineering practice</li> </ol>



### 4.3 Hydroinformatics– Modelling and Information Systems for Water Management

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

Knowledge and understanding	<ol style="list-style-type: none"> <li>1. have in-depth understanding of the information cycle in relation to the management of water based systems, and have a thorough awareness of the flow of information from data acquisition to modelling, to support for decision making;</li> <li>2. have a critical understanding of the theories and concepts of physical, chemical and biological processes relating to the flow of water in the natural environment, including river basins, coastal waters and urban water systems, as necessary to generate safe and reliable models for water based systems;</li> <li>3. have an understanding of advanced and appropriate information and communication technologies and their application to manage information relating to water management;</li> <li>4. have a good knowledge of the relevant literature and the contemporary research questions in the field of Hydroinformatics;</li> </ol>
Applying knowledge and understanding	<ol style="list-style-type: none"> <li>1. master the theory and practice of different modelling paradigms, and, in particular, physically based and data driven modelling, and be able to integrate them in hydroinformatics systems applied to a wide variety of hydraulic, hydrological and environmental situations;</li> <li>2. to select and apply software tools available on the market, and critically assess their advantages and disadvantages in application to water resources management, hazard risk assessment and forecasting, environmental planning and asset management;</li> <li>3. provide considered advice to managers and users of advanced Hydroinformatics tools;</li> <li>4. appreciate and discuss the ethics and nature of the postmodern society and the role of water within it as a "right" and an "asset";</li> </ol>
Making judgements	<ol style="list-style-type: none"> <li>1. make critical use of advanced theories and concepts in Hydroinformatics to research creative solutions for new problems and situations, either independently or within a team;</li> <li>2. critically judge and evaluate their own work and results, as well as prior research or investigations carried out by others;</li> </ol>
Communication	<ol style="list-style-type: none"> <li>1. develop a range of personal and communication skills, including the use of appropriate information and communication technologies, for oral and written presentation of methodologies, results, evaluations, conclusions and recommendations to a wide variety of audiences;</li> </ol>
Lifelong learning skills	<ol style="list-style-type: none"> <li>1. be aware of the importance of the relationship of Hydroinformatics with related disciplines such as hydraulics, hydrology, ecology and information science, and be able to co-operate within a multidisciplinary and interdisciplinary framework;</li> <li>2. have adopted the academic attitude and learning skills to enhance and broaden the acquired knowledge and application skills in a largely independent manner;</li> <li>3. be aware of the professional and ethical issues encountered in Hydroinformatics practice directed towards issues facing developing countries and countries in transition.</li> </ol>

## 4.4 Hydrology and Water Resources

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

Knowledge and understanding	<ol style="list-style-type: none"> <li>1. have in-depth understanding of the current theories and concepts in both surface and subsurface hydrology, the relevant physical, chemical and biological process interactions between the hydrosphere, the lithosphere, the biosphere and the atmosphere, and have a thorough awareness of the natural and human-induced variability in space and time of hydrological systems;</li> <li>2. master the major hydrological methodologies and applications with regard to both water quantity and water quality, including techniques for data collection, processing and analysis, and the application of catchment hydrological modelling and aquifer modelling techniques;</li> <li>3. have a good knowledge of the relevant literature and the contemporary research questions in the field of hydrology;</li> </ol>
Applying knowledge and understanding	<ol style="list-style-type: none"> <li>1. apply and integrate the relevant physical, chemical, applied mathematical, computational and earth-scientific principles and concepts, and to use information and communication technology within a hydrological context;</li> <li>2. design and conduct hydrological research and experiments for both application and scientific purposes, either independently or within a team-based framework;</li> </ol>
Making judgements	<ol style="list-style-type: none"> <li>1. evaluate and analyse hydrological systems and processes at a wide range of scales in both space and time for the purpose of water resources assessment, natural hazards assessment and mitigation, and environmental planning and management;</li> <li>2. critically judge and evaluate their own work and results, as well as prior research or investigations carried out by others;</li> </ol>
Communication	<ol style="list-style-type: none"> <li>1. adequately communicate methodologies, results, evaluations, conclusions and recommendations in oral, written and graphical form to a wide variety of audience;</li> </ol>
Lifelong learning skills	<ol style="list-style-type: none"> <li>1. be aware of the importance of hydrology to society, the relationship of hydrology with related disciplines such as ecology, meteorology and climatology, and be able to co-operate within a multidisciplinary and interdisciplinary framework with due consideration of ethical and social aspects related to the application of their knowledge and skills; and</li> <li>2. have adopted the academic attitude and learning skills to enhance and broaden the acquired knowledge and application skills in a largely independent manner.</li> </ol>

## 4.5 Land and Water Development

After successful completion of the programme graduates will be able to:

Knowledge and understanding	<ol style="list-style-type: none"> <li>1. Describe the latest concepts and theories of irrigation and drainage design, modernisation and management, flood protection and land reclamation for sustainable development and food security;</li> <li>2. Explain the cross-sectoral linkages related to land and water development comprehending wider aspects of society, economy, human health and environment and its contributions to food security;</li> <li>3. Acquire knowledge and understanding of contemporary research issues in the field of land and water development for food security;</li> </ol>
Applying knowledge and understanding	<ol style="list-style-type: none"> <li>1. Apply the latest hydraulic engineering and hydrological methods in planning, design and implementation of irrigation and drainage schemes, independently or in a multidisciplinary team;</li> <li>2. Apply innovative tools like Remote Sensing and GIS in planning and performance management of land and water development schemes for enhanced food security;</li> </ol>
Making judgements	<ol style="list-style-type: none"> <li>1. Identify options for participatory land and water development, and critically assess their technical, socio-economic and environmental performance;</li> <li>2. Evaluate aspects of planning, design, modernization, operation &amp; maintenance and financing of irrigation and drainage schemes.</li> <li>3. Identify, develop and conduct independent research including formulation of hypotheses, selection and application of research methodologies, planning and executing of data gathering and analysis, and formulation of conclusions and recommendations;</li> </ol>
Communication	<ol style="list-style-type: none"> <li>1. Clearly and systematically communicate, argue and defend research proposal and findings orally and written to a wide variety of audience;</li> </ol>
Lifelong learning skills	<ol style="list-style-type: none"> <li>1. Independently acquire knowledge, critically assess data, and acquire critical reading and writing skills whereby distinguishing between minor and major issues.</li> <li>2. Contribute to the development of innovative approaches for adequate and sustainable land and water development for food security;</li> </ol>

#### 4.7 Learning objectives Agricultural Water Management for Enhanced Land and Water Productivity (joint specialisation with AIT)

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

Knowledge and understanding	<ol style="list-style-type: none"> <li>1. have in-depth understanding and specific knowledge of the latest concepts and theories of irrigation, drainage, flood management, land reclamation and consolidation technologies for increased returns from land and water resources in a sustainable manner;</li> <li>2. have in-depth understanding and specific knowledge of the cross-sectoral linkages between land and water development and wider aspects of society, economy and the environment</li> <li>3. acquire knowledge and understanding of contemporary research issues in the fields of land and water development and agricultural water management;</li> </ol>
Applying knowledge and understanding	<ol style="list-style-type: none"> <li>4. use latest hydraulic engineering and hydrological methods to apply in planning, design, implementation and management of irrigation, drainage and flood protection schemes, independently or in a multidisciplinary team;</li> <li>5. identify and cross-evaluate alternative land and water development options for areas under different land uses and assess their technical, economical, institutional and environmental feasibility;</li> <li>6. engage in or advise the developers, system managers and water users on the participatory development, management and modernisation, including planning, design, implementation, operation and maintenance, as well as on modernisation of the irrigation, drainage and flood management schemes;</li> <li>7. formulate and conduct hydraulic and agronomic research, plan development and designs in the field of enhanced land and water productivity, experiments and tests for both practical and scientific purposes, either independently or within a team-based framework;</li> </ol>
Making judgements	
Communication	<ol style="list-style-type: none"> <li>8. formulate research questions, articulate research methodologies, develop study plans, and adequately communicate research results and conclusions in written and oral forms to a wide variety of audience;</li> </ol>
Lifelong learning skills	<ol style="list-style-type: none"> <li>9. develop the academic attitude and learning skills to enhance and broaden the acquired knowledge and application skills in a largely independent manner.</li> </ol>

#### 4.8 Learning objectives of the Advanced Water Management for Food Production Program specialization, (joint specialisation with Nebraska)

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

Knowledge and understanding	<ol style="list-style-type: none"> <li>1. understand in-depth the latest concepts and theories of irrigation, drainage, flood protection, land reclamation and consolidation technologies for food production;</li> <li>2. describe the cross-sectoral linkages comprehending wider aspects of society, economy and the environment;</li> <li>3. understand and formulate water management methodologies to enhance crop production with limited water supplies;</li> <li>4. acquire knowledge and understanding of contemporary research issues in the field of land and water development and water for food;</li> </ol>
Applying knowledge and understanding	<ol style="list-style-type: none"> <li>1. use latest hydraulic engineering and hydrological methods to apply in planning, design and implementation of irrigation, drainage and flood protection schemes, independently or in a multidisciplinary team;</li> <li>2. identify and cross-evaluate alternative land and water development options for areas under different land uses and assess their feasibility; technologically, economically, and environmentally;</li> <li>3. formulate research questions, articulate research methodologies, develop study plans, and adequately communicate research results and conclusions in written and oral forms to a wide variety of audience.</li> </ol>
Making judgements	<ol style="list-style-type: none"> <li>1. engage in or advise developers, system managers and water users on the participatory development and management, including operation and maintenance of the irrigation, drainage and flood protection schemes;</li> <li>2. identify and develop available water resources for food production;</li> <li>3. enhance the of on-farm irrigation systems through better design and management;</li> </ol>
Communication	
Lifelong learning skills	

## 4.10 Flood Risk management

After successful completion of the programme, graduates will have:

Knowledge and understanding	<ol style="list-style-type: none"> <li>1. a broad and cross-boundary scientific knowledge on flood risk management;</li> <li>2. a comprehensive knowledge base and understanding of the current theory and practice relating to flooding and flood management;</li> <li>3. the fundamental knowledge leading to the understanding of socio-economic issue related to flooding;</li> <li>4. a broad scientific knowledge about conservation, restoration and management measures to overcome challenges imposed on water by humans and by climate change, and;</li> <li>5. an extended knowledge on a basin-wide approach to flood risk management.</li> </ol>
Applying knowledge and understanding	<ol style="list-style-type: none"> <li>1. analyse the reciprocal relationships between the physical system, the institutional framework and the socio-economic environment, identifying future social and climatic pressures and needs and the consequent trends in system management;</li> <li>2. apply specific practical skills, such as identifying the major physical processes in a given river basin or coastal zone and their interaction with the associated assets and receptors;</li> <li>3. identify the links between all issues related to flooding in order to apply an integrated approach using the best tools to support decision making for the sustainable management of floods;</li> <li>4. review scientific literature and carry out independent research (such as writing a state of the art paper based on research and practice literature);</li> <li>5. apply sophisticated hydroinformatics and modelling tools and best practices to address the problems of flood risk management;</li> </ol>
Making judgements	
Communication	<ol style="list-style-type: none"> <li>1. communicate his/her knowledge and research results to the scientific and non-scientific communities (such as presenting papers/posters to scientific congresses, general lectures to policy makers and interested non-specialists);</li> </ol>
Lifelong learning skills	<ol style="list-style-type: none"> <li>1. occupy an independent and responsible position as a flood risk professional;</li> <li>2. acquire independently further knowledge and techniques, and</li> <li>3. operate in a team.</li> </ol>

#### 4.11 Groundwater and Global Change - Impacts and Adaptation

At the end of the programme students are able to:

Knowledge and understanding	<ol style="list-style-type: none"><li>1. explain in detail how groundwater systems function;</li><li>2. describe the interactions between groundwater systems, climate, surface waters and land use;</li></ol>
Applying knowledge and understanding	<ol style="list-style-type: none"><li>1. use modelling tools for climate and groundwater systems;</li><li>2. plan groundwater-related adaptation solutions for global change.</li></ol>
Making judgements	<ol style="list-style-type: none"><li>1. identify the consequences of global and climate change impacts for groundwater management under uncertainty;</li></ol>
Communication	
Lifelong learning skills	

## Appendix B Examination Procedures

### GENERAL RULES

Students taking part in an examination are expected to have taken notice of these procedures and are expected to understand the implied meaning of these procedures.

### WRITTEN EXAMINATIONS

#### PROCESS:

1. the student brings his student card and displays it on his table;
2. the invigilator verifies the card and confirms attendance by the student by ticking the box of the student on the attendance list;
3. students hand in their exam papers at the end of the session; this is their own responsibility;
4. invigilators bring the exam papers to the Education Office (immediately after the exam);
5. Education Officers verify which exam papers have been received and record this on a list;
6. the list produced by the Education Officers serves as the evidence that the exam papers have been handed in;
  - a. if exam papers get lost and they have been recorded on the list of Education Office, UNESCO-IHE has the responsibility to propose an adequate alternative assessment to the student.
  - b. if a student claims that an exam paper got lost and the exam paper is not recorded on the list of Education Office, then the Institute considers the exam paper not to have been handed in by the student. There will be no alternative assessment proposed.

**Invigilators:** The invigilators (examination supervisors) ensure proper conduct of the examination and maintain order in the examination room. They will announce the beginning and the duration of the examination, and will warn the students 10 minutes before the ending of the examination.

**Communication:** During the examination, students are not allowed to exchange materials or to communicate with other students. If something is unclear, students have to inform the invigilator, who will contact the programme coordinator, the examiner or education officer if necessary.

**Attendance list:** Students are considered to have taken part in an examination from the moment they receive the examination papers from the invigilators, whether or not they submit any answers.

**Bags:** Bags and carrying cases, including penholders, are to be placed along the side of the room before the start of the examination.

**Exam paper:** Answer and scratch paper will be provided to the students. Students provide the answers in clearly readable English, with proper indication of the question label. All answer papers must carry the student number and locker number of the student. Unreadable answers or unidentified answer papers may be discarded for assessment by the examiner.

**Pen:** Students are required to bring the necessary writing and drawing tools. The answer papers to be submitted must be written with a pen, a pencil is not allowed.



**Dictionary:** The use of a printed language dictionary without any additional written annotations is allowed (all languages are allowed). Invigilators are allowed to check the dictionaries for hand-written annotations during the exam (spot checks while they are walking around). Electronic dictionaries are not allowed.

**Calculators:** Only self contained calculators with a single-line display or dual-line display are allowed, provided that these devices are battery operated, that any audio functions are switched off, and that these devices are exclusively built for calculation purposes only and do not have internet access.

**Cell phones:** Use of cell phones is not allowed and must be switched off

**Other materials:** The use of materials other than listed above, including blank paper, texts, laptops, computing and communication devices, personal audio and video devices, of any kind, is not allowed.

Examiners may nevertheless allow students to use specified text matter or other effects in a so-called 'open book' examination. These materials shall not include previous or example examinations and solutions.

**Toilet visit:** Only one student at a time will be allowed by the invigilator to leave the examination room for a short visit to the lavatory, except during the first 15 and the last 15 minutes of the examination. Examination materials and requirements may not be taken outside the examination room. Before leaving the examination room, students have to hand over their cell phone to the invigilator.

**Submission of exam papers:** Students who finish the examination at least 15 minutes after the start and at least 15 minutes before the ending of the examination are allowed to submit their work to the invigilator and quietly leave the examination room.

Students have to ensure that all required papers are submitted to the invigilator. Papers cannot be submitted after the student has left the examination room.

#### **ASSIGNMENT REPORTS AND INDIVIDUAL DISCUSSIONS**

For designated subjects students have to submit an assignment report, which will be assessed as part of the subject examination. The examiner may discuss the assignment report with the student as part of the assessment.

The examiner will set a deadline for submitting assignment reports. The deadline cannot be set at a date after the examination period for the subject, as indicated in the academic calendar. Students submit assignments to either the lecturer or the responsible coordinator.

## Appendix C - GRADING SYSTEMS used by partner institutes

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### 1. Kwame Nkrumah University of Science & Technology (KNUST)

Grading scale of 0 to 100%, where 50% or higher implies a pass.

The minimum grade needed to have a postgraduate degree conferred upon an individual is a CWA of 55%.

CWA (Cumulative Weighted Average) =  $\text{sum} [\text{credits} \times \text{mark}] / \text{sum of all credits}$

Example:

Module	Credit	Mark obtained	Total Module mark
A	3	60	180
B	2	70	140
C	1	65	65
Total Credit of Student A	<b>6</b>		
Cumulative Mark			<b>385</b>

**CWA** = Cumulative Mark/Total Credit =  $385/6 = 64.17$

### 2. Asian Institute of Technology

Grade	Grade Points	Description
A	4	Excellent
B+	3.5	
B	3	Good
C+	2.5	
C	2	Fair
D	1	Deficient
F	0	Fail
I		Incomplete

### 3. Universidad del Valle

0.0	Given when absent from the exam without valid reason, when blank exam is submitted, or when caught cheating.
1.0 - 2.9	Non-pass, resit needed
3.0	Acceptable
4.0	Good
5.0	Excellent

Degree is awarded when

- GPA for the taught part is 3.5 or higher, and
- a pass is obtained for the thesis. (pass / non-pass)

## 5. Egerton University

70% and above	A (Excellent)
60-69%	B (Good)
50-59%	C (Average)...
0-49%	F (Fail)

Grading systems approved by the University Senate, with 50% as the pass mark.

## 6. BOKU

is using the Austrian grading system, which is a five step grading system ranging from (1, very good to 5, not sufficient). Grade 1 to 4 indicate a successful result.

The following grading scale is used:

Austrian grade	ECTS grade	Verbal
1 (sehr gut)	A/B	excellent/very good
2 (gut)	C	good
3 (befriedigend)	D	satisfactory
4 (genügend)	E	pass

## 6. Gent, Prague

ECTS	Gent University	UNESCO-IHE*	ICTP
A++ (exceptional only 1%)	19 or 20	10	100
A (top 5%)	18	9.2	90-100 A
A (top 10%)	17	8.8	
B (top 20%)	16	8.4	80-89 B
B (top 35%)	15	8	
C (top 50%)	14	7.6	70-79 C
C (top 65%)	13	7.2	
D (top 80%)	12	6.8	60-69 D
E (top 90%)	11	6.4	50-59 E
E (just pass)	10	6	
F (fail)	9	5.4	0-49 F
	8	4.8	
	7	4.2	
	6	3.6	
	5	3	
	4	2.4	
	3	1.8	

		2		1.2		
		1		0.6		
		0		0		

### 7. TU Dresden:

A = 1 "very good"

B = 2 "good"

C = 3 "satisfactory"

D = 4 "sufficient"

E = 5 "insufficient"

All courses have to be lower than 4 for a degree.

### 8. University of Ljubljana

10 excellent: outstanding results with negligible mistakes,

9 very good: high pass with minor mistakes,

8 very good: sound knowledge,

7 good: sound knowledge with major mistakes,

6 satisfactory: adequate knowledge suiting minimum criteria,

5 – 1 insufficient: failure, poor knowledge below minimum criteria.

Candidates with grades satisfactory (6) or more, have passed the examinations successfully.

The student has two grades per subject: separately theory and lab exercise (seminar work).

For thesis there are also two grade: written report and presentation, both should be more than

6. Finally we have one grade for thesis and common final grade of study (special formula).

### 9 TU-Catalonia

Scale from 0-10

MH Honors (is given on exceptional cases)

9.0 - 10.0 excellent

7.0 - 8.9 very good

5.0 - 6.9 satisfactory

4.0 - 4.9 marginal fail

0.0 - 3.9 fail

NP not examined

R recognition

### 10 University of Lisbon

A (excellent) 20-18

B (very good, with few errors) 17-16

C (good, with some errors) 15-14

D (satisfactory, with many errors) 13-12

E (sufficient) 11-10

## **Appendix D MSc modules: names, credits & assessment methods**

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## 1. Urban Water and Sanitation programme

SANITARY ENGINEERING		C1349								
Module number	Module Name	Code	Module coordinator	ECTS	Written exam (%)	Oral exam (%)	Assignments (%)	Oral presentation (%)	Lab Report (%)	Home work (%)
1	Hydrology, Water supply and water demand management and GIS	M1386	Salinas	5	75		25			
2	Chemistry and public health	M3043	Slokar	5	60		35		5	
3	EPT, Microbiology and Integrated Urban Water	M3030	vd Steen	5	70		30			
4	Urban drainage and sewerage	M3074	Sanchez Torres	5	60		40			
5	Conventional wastewater treatment	M1802	Lopez	5	80		20			
6	Resource oriented wastewater treatment and sanitation	M2384	Ronteltap	5	80		20			
7	Wastewater treatment plants design and engineering	M2373	Lopez	5	50	25	25			
8	Modelling of wastewater treatment processes and plants	M3054	Hooymans	5	60		40			
9	International fieldtrip and fieldwork	M1421	Slokar	5			100			
12	Summer course			1						
13	Groupwork Sint Maarten	M3114	Slokar	5			80	20		
14	MSc research methodology and proposal development	M3040	Garcia	9		100				
15	MSc thesis research and thesis writing	M2927	various	36		100				
	Electives modules:									
10	Industrial effluents treatment and residuals management	M3102	Garcia	5	60		40			
10	Water treatment processes and plants	M2371	Sharma	5		60	40			
10	Urban water systems	M3006	Voijnovic	5	40		60			
11	Solid waste management	M1331	Siebel	5	60		35	5		
11	Strategic Planning for River Basins and Deltas	M3086	Yong	5	50		50			
11	IWRM as a tool for adaptation to climate change	M2155	de Ruyter	5	70		30			
11	Wetlands for livelihoods and conservation	M3089	Hes	5			80	20		
11	Urban water governance	M1568	Acevedo Guerre	5			100			
11	Advanced water transport and distribution	M2602	Trifunovic	5	60		40			
11	Faecal Sludge Management	M2873	Ronteltap	5	85		15			
11	Decentralised Water Supply and Sanitation	M2810	Sharma	5	60		30	10		
11	Hydroinformatics for Decision Support	M3001	Jonoski	5			100			
11	Water Sensitive Cities	M3048	Pathirana	5						
11	Modelling river systems and lakes	M3075	Cattapan	5	60		40			
11	Flood Protection in Lowland Areas	M3104	Roelvink	5	60		40			
11	Remote sensing, GIS and modelling for agricultural water use	M3027	Karimi	5	25		75			

WATER SUPPLY ENGINEERING		C1352								
Module number	Module Name	Code	Module coordinator	ECTS	Written exam (%)	Oral exam (%)	Assignments (%)	Oral presentation (%)	Lab Report (%)	Home work (%)
1	Hydrology, Water supply and water demand management and GIS	M1386	Salinas	5	75		25			
2	Chemistry and public health	M3043	Slokar	5	60		35		5	
3	EPT, Microbiology and Integrated Urban Water	M3030	vd Steen	5	70		30			
4	Surface water treatment I	M2550	Kennedy	5	60		20		20	
5	Surface water treatment II	M1577	Ferrero	5	70		10		20	
6	Groundwater resources and treatment	M3033	Petrusevski	5	70		15		15	
7	Water transport and distribution	M2553	Trifunovic	5	60		40			
8	Advanced water treatment and reuse	M2335	Salinas	5	70		20		10	
9	International fieldtrip and fieldwork	M1421	Slokar	5			100			
12	Summer course									
13	Groupwork Sint Maarten	M3114	Slokar	5			80	20		
14	MSc research methodology and proposal development	M3040	Garcia	9		100				
15	MSc thesis research and thesis writing	M2927	various	36			100			
	Electives modules:									
10	Industrial effluents treatment and residuals management	M3102	Garcia	5	60		40			
10	Water treatment processes and plants	M2371	Sharma	5		60	40			
10	Urban water systems	M3006	Voijnovic	5	40		60			
11	Solid waste management	M1331	Siebel	5	60		35	5		
11	Strategic Planning for River Basins and Deltas	M3086	Yong	5	50		50			
11	IWRM as a tool for adaptation to climate change	M2155	de Ruyter	5	70		30			
11	Wetlands for livelihoods and conservation	M3089	Hes	5			80	20		
11	Urban water governance	M1568	Acevedo Guerre	5			100			
11	Advanced water transport and distribution	M2602	Trifunovic	5	60		40			
11	Faecal Sludge Management	M2873	Ronteltap	5	85		15			
11	Decentralised Water Supply and Sanitation	M2810	Sharma	5	60		30	10		
11	Hydroinformatics for Decision Support	M3001	Jonoski	5			100			
11	Water Sensitive Cities	M3048	Pathirana	5						
11	Modelling river systems and lakes	M3075	Cattapan	5	60		40			
11	Flood Protection in Lowland Areas	M3104	Roelvink	5	60		40			
11	Remote sensing, GIS and modelling for agricultural water use	M3027	Karimi	5	25		75			

URBAN WATER ENGINEERING AND MANAGEMENT												
Location	Module number	Module Name	Code	Module coordinator	AIT credits / ECTS	Written exam (%)	Oral exam (%)	Assignments (%)	Oral presentation (%)	Lab Report (%)	Home work (%)	
AIT		Watershed hydrology			3 (7.5)	x		x				
		Drinking water treatment			3 (7.5)	x						
		Wastewater treatment			3 (7.5)	x		x				
		Integrated water resources management			3 (7.5)	x		x				
U-IHE	4	Urban drainage and sewerage	M3074	Sanchez Torres	E	5	60		40			
	5	Asset management	M3047	Pathirana	2 (5.0)		50	50				
	6	Managing water organisations	M3103	Schwartz	2 (5.0)			100				
	7	Water transport and distribution	M2553	Trifunovic	2 (5.0)	60		40				
	8	Urban flood management and disaster risk mitigation	M1710	Vojinovic	2 (5.0)	40		60				
	9	International fieldtrip and fieldwork	M1421	Slokar	2 (5.0)			100				
		Electives:										
	10	Industrial effluents treatment and residuals management	M3102	Garcia	2 (5.0)	60		40				
	10	Water treatment processes and plants	M2371	Sharma	2 (5.0)		60	40				
	10	Urban water systems	M3006	Voijnovic	2 (5.0)	40		60				
		Summer course				0.4 (1)						
		Total coursework				26 (65)						
		MSc research proposal development for UWEM/EtSUD/AWMELW		M3040	Garcia	0			x	x		
AIT	MSc thesis work				22 (55)			x	x			
	Grand total (coursework + thesis)				48 (120)							



Joint MSc programme in Urban Water and Sanitation with KNUST			C1030 /C1039								
Location	Module number	Module Name	Code	Module coordinator	ECTS	Written exam (%)	Oral exam (%)	Assignments (%)	Oral presentation	Lab Report (%)	Home work (%)
KNUST	KN1	Module (KN) 1 Introduction to Environmental Sanitation			5	70		30			
	KN2	Module (KN) 2 Mathematical and research methods			4	70		30			
	KN3	Module (KN) 3 Environmental science and process technology			6	70		30			
	KN4	Module (KN) 4 Environmental quality			3	70		30			
	KN5	Module (KN) 5 water supply			2	70		30			
U-IHE	6	Resource oriented wastewater treatment and sanitation	M2384	Ronteltap	5	80		20			
	7	Wastewater treatment plants design and engineering	M2373	Lopez	5	50	25	25			
	8	Modelling of wastewater treatment processes and plants	M3054	Hooymans	5	60		40			
	OR										
	6	Groundwater resources and treatment	M3033	Petrusevski	5	70		15		15	
	7	Water transport and distribution	M2553	Trifunovic	5	60		40			
	8	Advanced water treatment and reuse	M2335	Salinas	5	70		20		10	
	9	International fieldtrip and fieldwork	M1421	Slokar	5			100			
	12	Summer course			1						
	13	Groupwork Sint Maarten	M3114	Slokar	5			80	20		
		Electives modules:									
	10	Industrial effluents treatment and residuals management	M3102	Garcia	5	60		40			
	10	Water treatment processes and plants	M2371	Sharma	5		60	40			
10	Urban water systems	M3006	Vojnovic	5	40		60				
11	MSc proposal preparation	M3040	Garcia	5							
U-IHE / KNUST	15	MSc thesis research and thesis writing	M2384	various	36		100				

Joint MSc programme in Urban Water and Sanitation with specialisation Sanitary Engineering with Universidad del Valle, Colombia			C1033								
Location	Module number	Module Name	Code	Module coordinator	UVC /ECTS	Written exam (%)	Oral exam (%)	Assignments (%)	Oral presentation (%)	Lab Report (%)	Home work (%)
Univalle	C1	C1 Chemistry of Environmental Pollution			3 /5.13	50		20		30	
	C2	C2 Environmental Pollution Microbiology			3 /5.13	x		x	x	x	
	C3	C3 Fundamentals of Environmental Processes			3 /5.13	60		20		20	20
	C4	C4 Environmental and Development			3 /5.13	35		30	35		
	C5	C5 Engineering Research Introduction			2/3.42			100		20	
U-IHE	4	Urban drainage and sewerage	M3074	Sanchez Torres	5	60		40			
	5	Conventional wastewater treatment	M1802	Lopez	5	80		20			
	6	Resource oriented wastewater treatment and sanitation	M2384	Ronteltap	5	80		20			
	7	Wastewater treatment plants design and engineering	M2373	Lopez	5	50	25	25			
	8	Modelling of wastewater treatment processes and plants	M3054	Hooymans	5	60		40			
	9	International fieldtrip and fieldwork	M1421	Slokar	5			100			
	12	Summer course			1						
	13	Groupwork Sint Maarten	M3114	Slokar	5			80	20		
			Electives modules:								
		10	Industrial effluents treatment and residuals management	M3102	Garcia	5	60		40		
	10	Water treatment processes and plants	M2371	Sharma	5		60	40			
	10	Urban water systems	M3006	Vojnovic	5	40		60			
	11	MSc proposal preparation	M3040	Garcia	5						
Univalle	C9	Engineering research I (4 UVC)			4/6.84						
	C10	Engineering Research II (8 UVC)			8/13.68						
		MSc thesis (14 UVC)			14/23.94						

Joint MSc programme in Urban Water and Sanitation with specialisation Water Supply Engineering with Universidad del Valle, Colombia												
Location	Module number	Module Name	Code	Module coordinator	UVC /ECTS	Written exam (%)	Oral exam (%)	Assignments (%)	Oral presentation (%)	Lab Report (%)	Home work (%)	
Univalle	C1	C1 Chemistry of Environmental Pollution			3/5.13	50		20		30		
	C2	C2 Environmental Pollution Microbiology			3/5.13	x		x	x	x		
	C3	C3 Fundamentals of Environmental Processes			3/5.13	60		20		20	20	
	C4	C4 Environmental and Development			3/5.13	35		30	35			
	C5	C5 Engineering Research Introduction			2/3.42			100		20		
U-IHE	4	Surface water treatment I	M2550	Kennedy	5	60		20		20		
	5	Surface water treatment II	M1577	Ferrero	5	70		10		20		
	6	Groundwater resources and treatment	M3033	Petrusevski	5	70		15		15		
	7	Water transport and distribution	M2553	Trifunovic	5	60		40				
	8	Advanced water treatment and reuse	M2335	Salinas	5	70		20		10		
	9	International fieldtrip and fieldwork	M1421	Slokar	5			100				
	12	Summer course										
	13	Groupwork Sint Maarten	M3114	Slokar	5			80	20			
		Electives modules:										
	10	Industrial effluents treatment and residuals management	M3102	Garcia	5	60		40				
	10	Water treatment processes and plants	M2371	Sharma	5		60	40				
10	Urban water systems	M3006	Vojnovic	5	40		60					
11	MSc proposal preparation	M3040	Garcia	5								
Univalle	C9	Engineering research I (4 UVC)			4/6.84							
	C10	Engineering Research II (8 UVC)			8/13.68							
		MSc thesis (14 UVC)			14/23.94							

## 2. Environmental Science programme

ENVIRONMENTAL SCIENCE AND TECHNOLOGY		C1140									
Module number	Module Name	Code	Module coordinator	ECTS	Written exam (%)	Oral exam (%)	Assignments (%)	Oral presentation (%)	Lab Report (%)	Home work (%)	Integrated in modules (%)
1	Introduction to environmental science 1+2	M3026	de Ruyter	5	80+20		20+35				
3	Introduction to environmental science 3	M3038	de Ruyter				100				
4	Integrated project environmental science	M3031	vd Steen	5			70	30			
5	Industrial Resource Management & Cleaner Production	M1953	Raj	5	60		35	5			
6	Environmental systems analysis	M3034	Irvine	5	30		60	10			
7	Environmental engineering	M3081	Raj	5	75		25				
8	Environmental monitoring and modelling	M2658	Irvine	5	70		15		15		
9	Foreign fieldtrip and fieldwork ES	M1766	de Ruyter	5			100				
12	Summer courses			1			100				
13	Groupwork ES	M2240	van Bruggen	5			100				
14	MSc research methodology and proposal development	M1288	van Bruggen	9			100				
15	MSc research	M2927	various	36			100				
	Elective modules:										
10	Aquatic ecosystems: processes and applications	M2122	Gettel	5			90	10			
10	Environmental assessment for water related policies and develo	M3080	Mendoza	5	50		50				
11	Solid waste management	M1331	Siebel	5	60		35	5			
11	Strategic Planning for River Basins and Deltas	M3086	Yong	5	50		50				
11	IWRM as a tool for adaptation to climate change	M2155	de Ruyter	5	70		30				
11	Wetlands for livelihoods and conservation	M3089	Hes	5			80	20			
11	Urban water governance	M1568	Acevedo Guerre	5			100				
11	Advanced water transport and distribution	M2602	Trifunovic	5	60		40				
11	Faecal Sludge Management	M2873	Ronteltap	5	85		15				
11	Decentralised Water Supply and Sanitation	M2810	Sharma	5	60		30	10			
11	Hydroinformatics for Decision Support	M3001	Jonoski	5			100				
11	Water Sensitive Cities	M3048	Pathirana	5							
11	Modelling river systems and lakes	M3075	Cattapan	5	60		40				
11	Flood Protection in Lowland Areas	M3104	Roelvink	5	60		40				
11	Remote sensing, GIS and modelling for agricultural water use	M3027	Karimi	5	25		75				

ENVIRONMENTAL POLICY MAKING		C1127										
Module number	Module Name	Code	Module coordinator	ECTS	Written exam (%)	Oral exam (%)	Assignments (%)	Oral presentation (%)	Lab Report (%)	Home work (%)	Integrated in modules (%)	
1	Introduction to environmental science 1 +2	M3026	de Ruyter	5	80+20		20+35					
3	Introduction to environmental science 3	M3038	de Ruyter				100					
4	Integrated project environmental science	M3031	vd Steen	5			70	30				
5	Water and environmental law	M1003	Jaspers	5	70		30					
6	Environmental systems analysis	M3034	Irvine	5	30		60	10				
7	Water and environmental policy making	M3082	Douven	5	50		50					
8	Environmental planning and implementation	M3021	Evers	5	50		50					
9	Foreign fieldtrip and fieldwork ES	M1766	de Ruyter	5			100					
12	Summer courses			1			100					
13	Groupwork ES	M2240	van Bruggen	5			100					
14	MSc research methodology and proposal development	M1288	van Bruggen	9			100					
15	MSc research	M2927	various	36			100					
	Elective modules:											
10	Aquatic ecosystems: processes and applications	M2122	Gettel	5			90	10				
10	Environmental assessment for water related policies and develo	M3080	Mendoza	5	50		50					
11	Solid waste management	M1331	Siebel	5	60		35	5				
11	Strategic Planning for River Basins and Deltas	M3086	Yong	5	50		50					
11	IWRM as a tool for adaptation to climate change	M2155	de Ruyter	5	70		30					
11	Wetlands for livelihoods and conservation	M3089	Hes	5			80	20				
11	Urban water governance	M1568	Acevedo Guerre	5			100					
11	Advanced water transport and distribution	M2602	Trifunovic	5	60		40					
11	Faecal Sludge Management	M2873	Ronteltap	5	85		15					
11	Decentralised Water Supply and Sanitation	M2810	Sharma	5	60		30	10				
11	Hydroinformatics for Decision Support	M3001	Jonoski	5			100					
11	Water Sensitive Cities	M3048	Pathirana	5								
11	Modelling river systems and lakes	M3075	Cattapan	5	60		40					
11	Flood Protection in Lowland Areas	M3104	Roelvink	5	60		40					
11	Remote sensing, GIS and modelling for agricultural water use	M3027	Karimi	5	25		75					

WATER QUALITY MANAGEMENT		C1166										
Module number	Module Name	Code	Module coordinator	ECTS	Written exam (%)	Oral exam (%)	Assignments (%)	Oral presentation (%)	Lab Report (%)	Home work (%)	Integrated in modules (%)	
1	Introduction to environmental science 1 +2	M3026	de Ruyter	5	80+20		20+35					
3	Introduction to environmental science 3	M3038	de Ruyter				100					
4	Integrated project environmental science	M3031	vd Steen	5			70	30				
5	Water and environmental law	M1003	Jaspers	5	70		30					
6	Water quality assessment	M2835	de Ruyter	5	60		30		10			
7	Constructed wetlands for wastewater treatment	M2216	van Bruggen	5	60		40					
8	Environmental planning and implementation	M3021	Evers	5	50		50					
9	Foreign fieldtrip and fieldwork ES	M1766	de Ruyter	5			100					
12	Summer courses			1			100					
13	Groupwork ES	M2240	van Bruggen	5			100					
14	MSc research methodology and proposal development	M1288	van Bruggen	9			100					
15	MSc research	M2927	various	36			100					
	Elective modules:											
10	Aquatic ecosystems: processes and applications	M2122	Gettel	5			90	10				
10	Environmental assessment for water related policies and develo	M3080	Mendoza	5	50		50					
11	Solid waste management	M1331	Siebel	5	60		35	5				
11	Strategic Planning for River Basins and Deltas	M3086	Yong	5	50		50					
11	IWRM as a tool for adaptation to climate change	M2155	de Ruyter	5	70		30					
11	Wetlands for livelihoods and conservation	M3089	Hes	5			80	20				
11	Urban water governance	M1568	Acevedo Guerre	5			100					
11	Advanced water transport and distribution	M2602	Trifunovic	5	60		40					
11	Faecal Sludge Management	M2873	Ronteltap	5	85		15					
11	Decentralised Water Supply and Sanitation	M2810	Sharma	5	60		30	10				
11	Hydroinformatics for Decision Support	M3001	Jonoski	5			100					
11	Water Sensitive Cities	M3048	Pathirana	5								
11	Modelling river systems and lakes	M3075	Cattapan	5	60		40					
11	Flood Protection in Lowland Areas	M3104	Roelvink	5	60		40					
11	Remote sensing, GIS and modelling for agricultural water use	M3027	Karimi	5	25		75					

ENVIRONMENTAL SCIENCE AND TECHNOLOGY WITH UNIVALLE			C1019										
Location	Module number	Module Name	Code	Module coordinator	UVC /ECTS	Written exam (%)	Oral exam (%)	Assignments (%)	Oral presentation (%)	Lab Report (%)	Home work (%)	Integrated in modules (%)	
Univalle	C1	C1 Chemistry of Environmental Pollution			3 /5.13	50		20		30			
	C2	C2 Environmental Pollution Microbiology			3 /5.13	x		x	x	x			
	C3	C3 Fundamentals of Environmental Processes			3 /5.13	60		20		20	20		
	C4	C4 Environmental and Development			3 /5.13	35		30	35				
	C5	C5 Engineering Research Introduction			2 /3.42			100		20			
U-IHE	4	Integrated project environmental science	M3031	vd Steen	5			70	30				
	5	Industrial Resource Management & Cleaner Production	M1953	Raj	5	60		35	5				
	6	Environmental systems analysis	M3034	Irvine	5	30		60	10				
	7	Environmental engineering	M3081	Raj	5	75		25					
	8	Environmental monitoring and modelling	M2658	Irvine	5	70		15		15			
	9	Foreign fieldtrip and fieldwork ES	M1766	de Ruyter	5			100					
	12	Summer courses			1			100					
	13	Groupwork ES	M2240	van Bruggen	5			100					
Univalle		MSc thesis (14 UVC)		various	14 / 23.94								
		Total ECTS			113.5								
U-IHE		Elective modules:											
	10	Aquatic ecosystems: processes and applications	M2122	Gettel	5			90	10				
	10	Environmental assessment for water related policies and develo	M3080	Mendoza	5	50		50					
	11	Solid waste management	M1331	Siebel	5	60		35	5				
	11	Strategic Planning for River Basins and Deltas	M3086	Yong	5	50		50					
	11	IWRM as a tool for adaptation to climate change	M2155	de Ruyter	5	70		30					
	11	Wetlands for livelihoods and conservation	M3089	Hes	5			80	20				
	11	Urban water governance	M1568	Acevedo Guerre	5			100					
	11	Advanced water transport and distribution	M2602	Trifunovic	5	60		40					
	11	Faecal Sludge Management	M2873	Ronteltap	5	85		15					
	11	Decentralised Water Supply and Sanitation	M2810	Sharma	5	60		30	10				
	11	Hydroinformatics for Decision Support	M3001	Jonoski	5			100					
	11	Water Sensitive Cities	M3048	Pathirana	5								
	11	Modelling river systems and lakes	M3075	Cattapan	5	60		40					
	11	Flood Protection in Lowland Areas	M3104	Roelvink	5	60		40					
	11	Remote sensing, GIS and modelling for agricultural water use	M3027	Karimi	5	25		75					

ENVIRONMENTAL SCIENCE WITH AIT			C1029									
Location	Module number	Module Name	Code	Module coordinator	AIT credits / ECTS	Written exam (%)	Oral exam (%)	Assignments (%)	Oral presentation (%)	Lab Report (%)	Home work (%)	Integrated in modules (%)
AIT		Environmental chemistry and laboratory			3 (7.5)	x		x				
		Environmental quality management			3 (7.5)	x		x				
		Any two course out of:										
		- Air pollution and management			6 (15.0)	x		x				
		- Solid waste management										
		- Environmental impact assessment										
		- Industrial waste abatement and management										
U-IHE	4	Integrated project environmental science	M3031	vd Steen	2 (5.0)			70	30			
	5	Industrial Resource Management & Cleaner Production	M1953	Raj	2 (5.0)	60		35	5			
	6	Environmental systems analysis	M3034	Irvine	2 (5.0)	30		60	10			
	7	Constructed wetlands for wastewater treatment	M2216	van Bruggen	2 (5.0)	60		40				
	8	Environmental monitoring and modelling	M2658	Irvine	2 (5.0)	70		15		15		
	9	Foreign fieldtrip and fieldwork ES	M1766	de Ruyter	2 (5.0)			100				
		Elective modules:										
	10	Aquatic ecosystems: processes and applications	M2122	Gettel	2 (5.0)			90	10			
	10	Environmental assessment for water related policies and develop	M3080	Mendoza	2 (5.0)	50		50				
	11	MSc research proposal development for UWEM/EtsUD/AWMELW	M3039	Raj	0			x	x			
		Total coursework				26 (65)						
AIT		Elective			2 (5.0)	x		x				
		MSc thesis work			22 (55)			x	x			
		<b>Grand total (coursework + thesis)</b>				50 (125)						



ENVIRONMENTAL TECHNOLOGY ERASMUS MUNDUS			C1024									
<b>1 General Courses</b>												
Location	Module number	Module name	Code	Module coordinator	74 ECTS	Written exam (%)	Oral exam (%)	Assignments (%)	Oral presentation (%)	Lab Report (%)	Home work (%)	Integrated in modules (%)
U-IHE	1	Introduction to environmental science 1+2	M3026	de Ruyter	5	80+20		20+35				
	3	Introduction to environmental science 3	M3038	de Ruyter				100				
	4	Integrated project environmental science	M3031	vd Steen	5			70	30			
		Seminars Environmental Technology and Engineering I			2							
Prague		Environmental Microbiology			4							
		Environmental Engineering			4							
		Wastewater Treatment			5							
		Sludge Management			3							
		Atmosphere Protection Technology			2							
		Waste Management and Treatment			4							
		Elective Project			5							
		Laboratory Training in Environmental Technology			3							
Ghent		Scientific Skills			4							
		Clean Technology			3							
		Environmental Fate and Management of Heavy Metals and Metalloids			5							
		Basics of Control Engineering and Process Engineering			4							
		Microbial Re-use Technology			3							
		Seminars Environmental Technology and Engineering II			3							
<b>2 Elective Courses</b>					<b>16 ECTS</b>							
Prague		Basics of Czech			2							
Ghent		Advanced Waste Gas Treatment			3							
		Applied Isotopes			5							
		Applied Statistics			5							
		Ecological Risk Assessment			7							
		Environmental Constructions			5							
		Environmental Ecology			7							
		Environmental Noise			3							
		Geostatistics			5							
		Life Cycle Assessment			3							
		Membrane Processes in Environmental Technology			3							
		Modeling and Control of Waste Water Treatment Plants			3							
		Quality of Groundwater Resources			5							
		Soil Degradation			3							
		Soil Water Management			3							
		Urban and Indoor Air Pollution			5							
		Internship			6							
		Environmental Legislation			3							
U-IHE		Basic Dutch for Foreigners	M1380	vd Vossenbergh	2	50	50					
		Cleaner Production and the Water Cycle			5							
		Constructed Wetlands for Wastewater Treatment	M2216	van Bruggen	5	60		40				
		Ecological Sanitation			5							
		Modelling Sanitation Systems			5							
<b>3 Master Dissertation</b>					<b>30</b>							

LIMNOLOGY AND WETLAND MANAGEMENT			C1155									
Location	Module number	Module Name	Code	Module coordinator	ECTS	Written exam (%)	Oral exam (%)	Assignments (%)	Oral presentation (%)	Lab report (%)	Home work (%)	Integrated in modules (%)
BOKU	LWM1	Basics in Limnology			9							
	LWM2	Ecology of Aquatic Organisms			6							
	LWM3	Basics in Applied Limnology			6							
	LWM4	Aquatic Ecosystem Management			4							
	LWM5	Scientific Methods			3							
EGERTON	ES05bL	Lake Ecology			5.6	60		10	20	10		
	ES06L	Stream & River Ecology			5.6	60			20	20		
	ES07L	Wetlands for Water Quality			5.6	60		10	20			10
	ES08L	Fisheries & Aquaculture			5.6	60			20			20
UNESCO-IHE	9	Data Analysis and Modeling for Aquatic Ecosystems	M1212	van Dam	5.6	40		40	20			
	10	Aquatic ecosystems: processes and applications	M2122	Gettel	5			90	10			
	11	Wetlands for livelihoods and conservation	M3089	Hes	5			80	20			
	12	Summer courses			1			100				
	13	Groupwork ES	M2240	van Bruggen	5			100				
	14	MSc research methodology and proposal development	M1288	van Bruggen	9			100				
	15	MSc research	M2927	various	36							
		TOTAL			120							

### 3. Water Science and Engineering programme

RIVER BASIN DEVELOPMENT		C1477									
Module number	Module Name	Code	Module coordinator	ECTS	Written exam (%)	Oral exam (%)	Assignments (%)	Oral presentation (%)	Lab Report (%)	Home work (%)	Integrated in modules (%)
1	Introduction to Water Science and Engineering	M2131	Foppen	5	55		45				
2	Hydrology and hydraulics	M2208	Maskey	5	80		20				
3	River basin hydraulics, geotechnics and remote sensing	M2307	Paron	5	75		25				
4	River morphodynamics	M2730	Crosato	5	80		20				
5	Data collection and analysis and design	M3090	Werner	5	70		30				
6	River Basin Development and EIA	M1703	Masih	5	50		50				
7	River structures	M1171	Cattapan	5	100						
9	Fieldtrip and fieldwork WSE	M3101	Duker	5						100	
12	Summer courses			1			100				
13	Groupwork WSE	M1284	Veerbeek	5				100			
14	MSc preparatory course and thesis research proposal	M1679	Foppen	9			100				
15	MSc research	M2927	various	36			100				
Elective modules:											
8	Dams and hydropower	M3009	Marence	5		50		50			
8	Planning and delivery of flood resilience	M2135	Gersonius	5		50		50			
10	Applied Groundwater Modelling	M2841	Zhou	5			100				
10	Flood Risk Management	M3083	Bhattacharya	5	30		70				
10	Drought Management and Reservoir Operations	M3036	Werner								
10	Geotechnical Engineering and Dredging	M2214	vd Wegen	5		60	40				
10	Innovative Water Systems for Agriculture	M3092	Karimi	5	40		60				
11	Solid waste management	M1331	Siebel	5	60		35	5			
11	Strategic Planning for River Basins and Deltas	M3086	Yong	5	50		50				
11	IWRM as a tool for adaptation to climate change	M2155	de Ruyter	5	70		30				
11	Wetlands for livelihoods and conservation	M3089	Hes	5			80	20			
11	Urban water governance	M1568	Acevedo Guerrero	5			100				
11	Advanced water transport and distribution	M2602	Trifunovic	5	60		40				
11	Faecal Sludge Management	M2873	Ronteltap	5	85		15				
11	Decentralised Water Supply and Sanitation	M2810	Sharma	5	60		30	10			
11	Hydroinformatics for Decision Support	M3001	Jonoski	5			100				
11	Water Sensitive Cities	M3048	Pathirana	5							
11	Modelling river systems and lakes	M3075	Cattapan	5	60		40				
11	Flood Protection in Lowland Areas	M3104	Roelvink	5	60		40				
11	Remote sensing, GIS and modelling for agricultural water use	M3027	Karimi	5	25		75				

COASTAL ENGINEERING AND PORT DEVELOPEMENT		C1427									
Module number	Module Name	Code	Module coordinator	ECTS	Written exam (%)	Oral exam (%)	Assignments (%)	Oral presentation (%)	Lab Report (%)	Home work (%)	Integrated in modules (%)
1	Introduction to Water Science and Engineering	M2131	Foppen	5	55		45				
2	Hydrology and hydraulics	M2208	Maskey	5	80		20				
3	Introduction to coastal science and engineering	M1026	Semedo	5	90		10				
4	Port planning and infrastructure design	M1433	Dastgheib	5			100				
5	Coastal systems	M1553	Ranasinghe	5	70		30				
6	Coastal and port structures	M2033	Dastgheib	5			100				
7	Environmental aspects of coasts and ports	M2831	vd Wegen	5	60		40				
9	Fieldtrip and fieldwork WSE	M3101	Duker	5						100	
12	Summer courses			1			100				
13	Groupwork WSE	M1284	Veerbeek	5				100			
14	MSc research proposal development for WSE	M1679	Foppen	9			100				
15	MSc research	M2927	various	36			100				
Elective modules:											
8	Management of coasts and ports (International Port Seminar)	M3078	van Schuylenburg	5				100			
8	Management of coasts and ports (ICZM)	M3079	vd Wegen	5		100					
8	Dams and hydropower	M3009	Marence	5	90		10				
10	Applied Groundwater Modelling	M2841	Zhou	5			100				
10	Flood Risk Management	M3083	Bhattacharya	5	30		70				
10	Drought Management and Reservoir Operations	M3036	Werner								
10	Geotechnical Engineering and Dredging	M2214	vd Wegen	5		60	40				
10	Innovative Water Systems for Agriculture	M3092	Karimi	5	40		60				
11	Solid waste management	M1331	Siebel	5	60		35	5			
11	Strategic Planning for River Basins and Deltas	M3086	Yong	5	50		50				
11	IWRM as a tool for adaptation to climate change	M2155	de Ruyter	5	70		30				
11	Wetlands for livelihoods and conservation	M3089	Hes	5			80	20			
11	Urban water governance	M1568	Acevedo Guerrero	5			100				
11	Advanced water transport and distribution	M2602	Trifunovic	5	60		40				
11	Faecal Sludge Management	M2873	Ronteltap	5	85		15				
11	Decentralised Water Supply and Sanitation	M2810	Sharma	5	60		30	10			
11	Hydroinformatics for Decision Support	M3001	Jonoski	5			100				
11	Water Sensitive Cities	M3048	Pathirana	5							
11	Modelling river systems and lakes	M3075	Cattapan	5	60		40				
11	Flood Protection in Lowland Areas	M3104	Roelvink	5	60		40				
11	Remote sensing, GIS and modelling for agricultural water use	M3027	Karimi	5	25		75				

LAND AND WATER DEVELOPMENT		C1505										
Module number	Module Name	Code	Module coordinator	ECTS	Written exam (%)	Oral exam (%)	Assignments (%)	Oral presentation (%)	Lab Report (%)	Home work (%)	Integrated in modules (%)	
1	Introduction to Water Science and Engineering	M2131	Foppen	5	55		45					
2	Hydrology and hydraulics	M2208	Maskey	5	80		20					
3	Principles and practices of land and water development	M3024	Karimi	5	30		80					
4	Design aspects of irrigation and drainage	M3087	Hayde	5	30		70					
5	Tertiary unit design and hydraulics	M2255	Hayde	5	40		60					
6	Socio-economic and environmental aspects of land and water de	M3023	Duker	5	30		70					
7	Conveyance and irrigation structures	M3025	Suryadi	5	35		65					
8	Management of irrigation and drainage systems	M3022	Duker	5	60		40					
9	Fieldtrip and fieldwork WSE	M3101	Duker	5						100		
12	Summer courses			1			100					
13	Groupwork WSE	M1284	Veerbeek	5				100				
14	MSc research proposal development for WSE	M1679	Foppen	9			100					
15	MSc research	M2927	various	36			100					
Elective modules:												
10	Applied Groundwater Modelling	M2841	Zhou	5			100					
10	Flood Risk Management	M3083	Bhattacharya	5	30		70					
10	Drought Management and Reservoir Operations	M3036	Werner									
10	Geotechnical Engineering and Dredging	M2214	vd Wegen	5		60	40					
10	Innovative Water Systems for Agriculture	M3092	Karimi	5	40		60					
11	Solid waste management	M1331	Siebel	5	60		35	5				
11	Strategic Planning for River Basins and Deltas	M3086	Yong	5	50		50					
11	IWRM as a tool for adaptation to climate change	M2155	de Ruyter	5	70		30					
11	Wetlands for livelihoods and conservation	M3089	Hes	5			80	20				
11	Urban water governance	M1568	Acevedo Guerrero	5			100					
11	Advanced water transport and distribution	M2602	Trifunovic	5	60		40					
11	Faecal Sludge Management	M2873	Ronteltap	5	85		15					
11	Decentralised Water Supply and Sanitation	M2810	Sharma	5	60		30	10				
11	Hydroinformatics for Decision Support	M3001	Jonoski	5			100					
11	Water Sensitive Cities	M3048	Pathirana	5								
11	Modelling river systems and lakes	M3075	Cattapan	5	60		40					
11	Flood Protection in Lowland Areas	M3104	Roelvink	5	60		40					
11	Remote sensing, GIS and modelling for agricultural water use	M3027	Karimi	5	25		75					

LAND AND WATER DEVELOPMENT WITH NEBRASKA												
	Module number	Module Name	Code	Module coordinator	UNL credits/ECTS	Written exam (%)	Oral exam (%)	Assignments (%)	Oral presentation (%)	Lab Report (%)	Home work (%)	Integrated in modules (%)
UNESCO-IHE	1	Introduction to Water Science and Engineering	M2131	Foppen	5	55		45				
	2	Hydrology and hydraulics	M2208	Maskey	5	80		20				
	3	Principles and practices of land and water development	M3024	Karimi	5	30		80				
	4	Design aspects of irrigation and drainage	M3087	Hayde	5	30		70				
	5	Tertiary unit design and hydraulics	M2255	Hayde	5	40		60				
	6	Socio-economic and environmental aspects of land and water de	M3023	Duker	5	30		70				
	7	Conveyance and irrigation structures	M3025	Suryadi	5	35		65				
	8	Management of irrigation and drainage systems	M3022	Duker	5	60		40				
	9	Fieldtrip and fieldwork WSE	M3101	Duker	5						100	
University of Nebraska, Lincoln, USA		Field Course: Measurement Techniques in Hydrology and Irrigation			3 (5)							
		Research Methodology & Thesis Research Proposal			2 (14)							
		Plant-Water Relations			3 (5)							
		Groundwater Geology			3 (5)							
		Advanced Irrigation and Drainage Systems Engineering			3 (5)							
		Advanced Irrigation Management			3 (5)							
		Water Law, Planning and Policy			3 (5)							
	Masters Research Project			4 (28)			100					

LAND AND WATER DEVELOPMENT WITH AIT												
	Module number	Module Name	Code	Module coordinator	ECTS	Written exam (%)	Oral exam (%)	Assignments (%)	Oral presentation (%)	Lab Report (%)	Home work (%)	Integrated in modules (%)
AIT		Watershed Hydrology			7.5	30+40		30				
		Hydrodynamics			7.5	40+50		10				
		Irrigation and Drainage Engineering			7.5	30+40		30				
		Integrated Water Resources Management			7.5	20+30		50				
U-IHE	4	Design aspects of irrigation and drainage	M3087	Hayde	5	30		70				
	5	Tertiary unit design and hydraulics	M2255	Hayde	5	40		60				
	6	Socio-economic and environmental aspects of land and water de	M3023	Duker	5	30		70				
	7	Conveyance and irrigation structures	M3025	Suryadi	5	35		65				
	8	Management of irrigation and drainage systems	M3022	Duker	5	60		40				
	9	Fieldtrip and fieldwork WSE	M3101	Duker	5						100	
AIT	11	MSc research proposal development for UWEM/EtSUD/AWMELW	M3039	Raj	0			x	x			
		MSc research work			22							
		Elective modules:										
	10	Applied Groundwater Modelling	M2841	Zhou	5			100				
	10	Flood Risk Management	M3083	Bhattacharya	5	30		70				
	10	Drought Management and Reservoir Operations	M3036	Werner								
	10	Geotechnical Engineering and Dredging	M2214	vd Wegen	5		60	40				
	10	Innovative Water Systems for Agriculture	M3092	Karimi	5	40		60				

HYDROINFORMATICS		C1490									
Module number	Module Name	Code	Module coordinator	ECTS	Written exam (%)	Oral exam (%)	Assignments (%)	Oral presentation (%)	Lab Report (%)	Home work (%)	Integrated in modules (%)
1	Introduction to Water Science and Engineering	M2131	Foppen	5	55		45				
2	Hydrology and hydraulics	M2208	Maskey	5	80		20				
3	Information technology and software engineering	M2191	Alfonso Segura	5	50		50				
4	Modelling theory and Computational Hydraulics	M1507	Popescu	5	55	25	20				
5	Modelling and information systems development	M2128	van Anandel	5			100				
6	Computational Intelligence and Operational water management	M2847	Solomatine	5	55		45				
7	River basin modelling	M2665	Jonoski	5	100						
9	Fieldtrip and fieldwork WSE	M3101	Duker	5						100	
12	Summer courses			1			100				
13	Groupwork WSE	M1284	Veerbeek	5				100			
14	MSc research proposal development for WSE	M1679	Foppen	9			100				
15	MSc research	M2927	various	36			100				
	Elective modules:										
8	River Flood Analysis and Modelling	M2709	Popescu	5	50		50				
8	Urban flood management and disaster risk mitigation	M1710	Vojnovic	5	60		40				
10	Applied Groundwater Modelling	M2841	Zhou	5			100				
10	Flood Risk Management	M3083	Bhattacharya	5	30		70				
10	Drought Management and Reservoir Operations	M3036	Werner								
10	Geotechnical Engineering and Dredging	M2214	vd Wegen	5		60	40				
10	Innovative Water Systems for Agriculture	M3092	Karimi	5	40		60				
11	Solid waste management	M1331	Siebel	5	60		35	5			
11	Strategic Planning for River Basins and Deltas	M3086	Yong	5	50		50				
11	IWRM as a tool for adaptation to climate change	M2155	de Ruyter	5	70		30				
11	Wetlands for livelihoods and conservation	M3089	Hes	5			80	20			
11	Urban water governance	M1568	Acevedo Guerrero	5			100				
11	Advanced water transport and distribution	M2602	Trifunovic	5	60		40				
11	Faecal Sludge Management	M2873	Ronteltap	5	85		15				
11	Decentralised Water Supply and Sanitation	M2810	Sharma	5	60		30	10			
11	Hydroinformatics for Decision Support	M3001	Jonoski	5			100				
11	Water Sensitive Cities	M3048	Pathirana	5							
11	Modelling river systems and lakes	M3075	Cattapan	5	60		40				
11	Flood Protection in Lowland Areas	M3104	Roelvink	5	60		40				
11	Remote sensing, GIS and modelling for agricultural water use	M3027	Karimi	5	25		75				

HYDROLOGY AND WATER RESOURCES		C1501										
Module number	Module Name	Code	Module coordinator	ECTS	Written exam (%)	Oral exam (%)	Assignments (%)	Oral presentation (%)	Lab Report (%)	Home work (%)	Integrated in modules (%)	
1	Introduction to Water Science and Engineering	M2131	Foppen	5	55		45					
2	Hydrology and hydraulics	M2208	Maskey	5	80		20					
3	Hydrogeology	M2166	Zhou	5	70		30					
4	Surface hydrology	M2367	Venneker	5	70		30					
5	Water quality	M2497	McClain	5	70		30					
6	Tracer hydrology and flow systems analysis	M1903	Foppen	5	100							
8	Integrated hydrological and river modelling	M1309	Maskey	5			85	15				
9	Fieldtrip and fieldwork WSE	M3101	Duker	5						100		
12	Summer courses			1			100					
13	Groupwork WSE	M1284	Veerbeek	5				100				
14	MSc research proposal development for WSE	M1679	Foppen	9			100					
15	MSc research	M2927	various	36			100					
Elective modules:												
7	Hydrological data collection and processing	M1554	Venneker	5	60				40			
7	Groundwater data collection and interpretation	M2227	Stigter	5	40		60					
10	Applied Groundwater Modelling	M2841	Zhou	5			100					
10	Flood Risk Management	M3083	Bhattacharya	5	30		70					
10	Drought Management and Reservoir Operations	M3036	Werner									
10	Geotechnical Engineering and Dredging	M2214	vd Wegen	5		60	40					
10	Innovative Water Systems for Agriculture	M3092	Karimi	5	40		60					
11	Solid waste management	M1331	Siebel	5	60		35	5				
11	Strategic Planning for River Basins and Deltas	M3086	Yong	5	50		50					
11	IWRM as a tool for adaptation to climate change	M2155	de Ruyter	5	70		30					
11	Wetlands for livelihoods and conservation	M3089	Hes	5			80	20				
11	Urban water governance	M1568	Acevedo Guerrero	5			100					
11	Advanced water transport and distribution	M2602	Trifunovic	5	60		40					
11	Faecal Sludge Management	M2873	Ronteltap	5	85		15					
11	Decentralised Water Supply and Sanitation	M2810	Sharma	5	60		30	10				
11	Hydroinformatics for Decision Support	M3001	Jonoski	5			100					
11	Water Sensitive Cities	M3048	Pathirana	5								
11	Modelling river systems and lakes	M3075	Cattapan	5	60		40					
11	Flood Protection in Lowland Areas	M3104	Roelvink	5	60		40					
11	Remote sensing, GIS and modelling for agricultural water use	M3027	Karimi	5	25		75					



FLOOD RISK MANAGEMENT			C1440									
Location	Module number	Module Name	Code	Module coordinator	ECTS	Written exam (%)	Oral exam (%)	Assignments (%)	Oral presentation (%)	Lab Report (%)	Home work (%)	Integrated in modules (%)
TU-Dresden		Introduction to Flood Risk Management			10	50		30 +20				
		Climatology and Hydrology			5	100						
		Geodesy			5	100						
		Two courses out of the following four:										
			Hydraulic Engineering			5	100					
			Hydromechanics			5						
			Ecology			5	75		25			
			Hydrochemistry			5						
			Courses without credits:									
			GIS and Remote Sensing			0						
			Statistics			0						
		Fieldtrip			0							
					<b>Total ECTS</b>	<b>30</b>						
U-IHE	6	Computational Intelligence and Operational water management	M2847	Solomatine	5	55		45				
	7	River basin modelling	M2665	Jonoski	5	100						
		One course out of the following two:										
	8a	River Flood Analysis and Modelling	M2709	Popescu	5	50		50				
	8b	Urban flood management and disaster risk mitigation	M1710	Vojnovic	5	40		60				
	9	International Fieldtrip (12 days)			5						100	
	10	Flood Risk Management	M3083	Bhattacharya	5	30		70				
	11	Hydroinformatics for Decision Support	M3001	Jonoski	5			100				
					<b>Total ECTS</b>	<b>30</b>						
UPC		Global warming effects, Flood and Drought			3		40	60				
		Coastal flooding: impacts, conflicts and risks			3	100						
		Fluvial morphodynamics			5							
		Debris flow and flash floods: risk, vulnerability, hazard and resilience concepts			5	40		55				5
		The application of radar-based rainfall observations and forecast in Early Warning			4	100						
					<b>Total ECTS</b>	<b>30</b>						
UL		Spatial planning for flood protection and resilience			5	20		80				
		Socio-economic and institutional framework of floods			5							
					<b>Total ECTS</b>	<b>30</b>						
TUD/IHE/UPC/UL		MSc thesis work			<b>Total ECTS</b>	<b>30</b>						

GROUNDWATCH			C1441										
Location	Module number	Module Name	Code	Module coordinator	ECTS	Written exam (%)	Oral exam (%)	Assignments (%)	Oral presentation (%)	Lab Report (%)	Home work (%)	Integrated in modules (%)	
IST Lisbon		Hydrogeology			4,5								
		Hydrology, Environment and Water Resources			6								
		Ocean and Atmospheric Physics			4,5								
		Integrated River Basin Management			4,5								
		Groundwater Pollution and Protection			6								
		Global Environmental Policies			4,5								
U-IHE	6	Tracer hydrology and flow systems analysis	M1903	Foppen	5	100							
	7	Groundwater data collection and interpretation	M2227	Stigter	5	40		60					
	8	Groundwater adaptation to global change impacts	M3096	Stigter	5			100					
	9	Fieldtrip and Fieldwork	M2440	Duker	5						100		
	10	Applied Groundwater Modelling	M2841	Zhou	5			100					
	11	IWRM as a Tool for Adaptation to Climate Change	M2155	de Ruyter	5	70			30				
TU-Dresden		Climate Systems and Climate Modelling			5								
		Soil Water			5								
		Study Project IWRM			10								
		Ecology (optional)			5								
		Advanced Watershed Management (optional)			5								
		Integrated Land Use Management in the Landscape (optional)			5								
		Drinking Water Supply (optional)			5								
		Water Quality and Water Treatment (optional)			5								
IST/IHE/TUD		MSc thesis work			30								

#### 4. Water Management programme

WATER RESOURCES MANAGEMENT		C1396									
Module number	Module Name	Code	Module coordinator	ECTS	Written exam (%)	Oral exam (%)	Assignments (%)	Oral presentation (%)	Lab Report (%)	Home work (%)	Integrated in modules (%)
1	Principles of integrated water resources management	M3084	Evers	5	45		55				
2	The water resources system	M3042	Susnik	5	70		30				
3	Water governance	M3032	Kemerink	5		40	60				
4	Water economics	M3028	Yong	5	70		30				
5	Water and environmental law	M1003	Jaspers	5	70		30				
6	Water resources assessment	M1617	Yasir	5	65		35				
7	Water systems modelling	M2054	Graas	5	60			40			
8	Water resources planning	M2535	Cauwenberg	5	60		40				
9	International fieldwork	M3045	Tutusaus Luque	5			100				
12	Summer course			1			100				
13	IWRM Groupwork	M2252	Susnik	5			100				
14	MSc preparatory course and thesis research proposal for WM	M2169	Kooy	9		100					
15	MSc thesis research and thesis writing	M2927	various	36		100					
	Elective modules:										
10	Partnerships for Water Supply and Sanitation	M2711	Schwartz	5		50	50				
10	Aquatic Ecosystems Processes and Applications	M2122	Gettel	5			90	10			
10	Institutional Analysis	M3007	Smit	5			80	20			
11	Solid waste management	M1331	Siebel	5	60		35	5			
11	Strategic Planning for River Basins and Deltas	M3086	Yong	5	50		50				
11	IWRM as a tool for adaptation to climate change	M2155	de Ruyter	5	70		30				
11	Wetlands for livelihoods and conservation	M3089	Hes	5			80	20			
11	Urban water governance	M1568	Acevedo Guerre	5			100				
11	Advanced water transport and distribution	M2602	Trifunovic	5	60		40				
11	Faecal Sludge Management	M2873	Ronteltap	5	85		15				
11	Decentralised Water Supply and Sanitation	M2810	Sharma	5	60		30	10			
11	Hydroinformatics for Decision Support	M3001	Jonoski	5			100				
11	Water Sensitive Cities	M3048	Pathirana	5							
11	Modelling river systems and lakes	M3075	Cattapan	5	60		40				
11	Flood Protection in Lowland Areas	M3104	Roelvink	5	60		40				
11	Remote sensing, GIS and modelling for agricultural water use	M3027	Karimi	5	25		75				

WATER CONFLICT MANAGEMENT		C1370									
Module number	Module Name	Code	Module coordinator	ECTS	Written exam (%)	Oral exam (%)	Assignments (%)	Oral presentation (%)	Lab Report (%)	Home work (%)	Integrated in modules (%)
1	Principles of integrated water resources management	M3084	Evers	5	45		55				
2	The water resources system	M3042	Susnik	5	70		30				
3	Water governance	M3032	Kemerink	5		40	60				
4	Water economics	M3028	Yong	5	70		30				
5	Water and environmental law	M1003	Jaspers	5	70		30				
6	Water conflict management 1	M3069	Shubber	5	50		50				
7	Water conflict management 2	M3070	Shubber	5	60		40				
8	Water resources planning	M2535	Cauwenberg	5	60		40				
9	International fieldwork	M3045	Tutusaus Luque	5			100				
12	Summer course			1			100				
13	IWRM Groupwork	M2252	Susnik	5			100				
14	MSc preparatory course and thesis research proposal for WM	M2169	Kooy	9		100					
15	MSc thesis research and thesis writing	M2927	various	36		100					
	Elective modules:										
10	Partnerships for Water Supply and Sanitation	M2711	Schwartz	5		50	50				
10	Aquatic Ecosystems Processes and Applications	M2122	Gettel	5			90	10			
10	Institutional Analysis	M3007	Smit	5			80	20			
11	Solid waste management	M1331	Siebel	5	60		35	5			
11	Strategic Planning for River Basins and Deltas	M3086	Yong	5	50		50				
11	IWRM as a tool for adaptation to climate change	M2155	de Ruyter	5	70		30				
11	Wetlands for livelihoods and conservation	M3089	Hes	5			80	20			
11	Urban water governance	M1568	Acevedo Guerre	5			100				
11	Advanced water transport and distribution	M2602	Trifunovic	5	60		40				
11	Faecal Sludge Management	M2873	Ronteltap	5	85		15				
11	Decentralised Water Supply and Sanitation	M2810	Sharma	5	60		30	10			
11	Hydroinformatics for Decision Support	M3001	Jonoski	5			100				
11	Water Sensitive Cities	M3048	Pathirana	5							
11	Modelling river systems and lakes	M3075	Cattapan	5	60		40				
11	Flood Protection in Lowland Areas	M3104	Roelvink	5	60		40				
11	Remote sensing, GIS and modelling for agricultural water use	M3027	Karimi	5	25		75				

WATER MANAGEMENT		C1362									
Code	Module Name	Code	Module coordinator	ECTS	Written exam (%)	Oral exam (%)	Assignments (%)	Oral presentation (%)	Lab Report (%)	Home work (%)	Integrated in modules (%)
1	Principles of integrated water resources management	M3084	Evers	5	45		55				
2	The water resources system	M3042	Susnik	5	70		30				
3	Water governance	M3032	Kemerink	5		40	60				
4	Water economics	M3028	Yong	5	70		30				
5	Water and environmental law	M1003	Jaspers	5	70		30				
9	International fieldwork	M3045	Tutusaus Luque	5			100				
12	Summer course			1			100				
13	IWRM Groupwork	M2252	Susnik	5			100				
14	MSc preparatory course and thesis research proposal for WM	M2169	Kooy	9		100					
15	MSc thesis research and thesis writing	M2927	various	36		100					
Elective modules:											
6	Water quality assessment	M2835	de Ruyter	5	60		30		10		
6	Water resources assessment	M1617	Yasir	5	65		35				
6	Water conflict management 1	M3069	Shubber	5	50		50				
6	Managing water organisations	M3103	Schwartz	5			100				
7	Environmental Engineering	M3081	Raj	5	75		25				
7	Water systems modelling	M2054	Graas	5	60			40			
7	Water conflict management 2	M3070	Shubber	5	60		40				
7	Environmental management and water services	M3041	Bichai	5		50	50				
8	Environmental planning and implementation	M3021	Evers	5	50		50				
8	Water resources planning	M2535	Cauwenberg	5	60		40				
8	Financial management in the water sector	M3044	Tutusaus Luque	5	50		50				
10	Partnerships for Water Supply and Sanitation	M2711	Schwartz	5		50	50				
10	Aquatic Ecosystems Processes and Applications	M2122	Gettel	5			90	10			
10	Institutional Analysis	M3007	Smit	5			80	20			
11	Solid waste management	M1331	Siebel	5	60		35	5			
11	Strategic Planning for River Basins and Deltas	M3086	Yong	5	50		50				
11	IWRM as a tool for adaptation to climate change	M2155	de Ruyter	5	70		30				
11	Wetlands for livelihoods and conservation	M3089	Hes	5			80	20			
11	Urban water governance	M1568	Acevedo Guerre	5			100				
11	Advanced water transport and distribution	M2602	Trifunovic	5	60		40				
11	Faecal Sludge Management	M2873	Ronteltap	5	85		15				
11	Decentralised Water Supply and Sanitation	M2810	Sharma	5	60		30	10			
11	Hydroinformatics for Decision Support	M3001	Jonoski	5			100				
11	Water Sensitive Cities	M3048	Pathirana	5							
11	Modelling river systems and lakes	M3075	Cattapan	5	60		40				
11	Flood Protection in Lowland Areas	M3104	Roelvink	5	60		40				
11	Remote sensing, GIS and modelling for agricultural water use	M3027	Karimi	5	25		75				

WATER SERVICES MANAGEMENT		C1409										
Module number	Module Name	Code	Module coordinator	ECTS	Written exam (%)	Oral exam (%)	Assignments (%)	Oral presentation (%)	Lab Report (%)	Home work (%)	Integrated in modules (%)	
1	Principles of integrated water resources management	M3084	Evers	5	45		55					
2	The water resources system	M3042	Susnik	5	70		30					
3	Water governance	M3032	Kemerink	5		40	60					
4	Water economics	M3028	Yong	5	70		30					
5	Water and environmental law	M1003	Jaspers	5	70		30					
6	Managing water organisations	M3103	Schwartz	5			100					
7	Environmental management and water services	M3041	Bichai	5		50	50					
8	Financial management in the water sector	M3044	Tutusaus Luque	5	50		50					
9	International fieldwork	M3045	Tutusaus Luque	5			100					
12	Summer course			1			100					
13	IWRM Groupwork	M2252	Susnik	5			100					
14	MSc preparatory course and thesis research proposal for WM	M2169	Kooy	9		100						
15	MSc thesis research and thesis writing	M2927	various	36		100						
	Elective modules:											
10	Partnerships for Water Supply and Sanitation	M2711	Schwartz	5		50	50					
10	Aquatic Ecosystems Processes and Applications	M2122	Gettel	5			90	10				
10	Institutional Analysis	M3007	Smit	5			80	20				
11	Solid waste management	M1331	Siebel	5	60		35	5				
11	Strategic Planning for River Basins and Deltas	M3086	Yong	5	50		50					
11	IWRM as a tool for adaptation to climate change	M2155	de Ruyter	5	70		30					
11	Wetlands for livelihoods and conservation	M3089	Hes	5			80	20				
11	Urban water governance	M1568	Acevedo Guerre	5			100					
11	Advanced water transport and distribution	M2602	Trifunovic	5	60		40					
11	Faecal Sludge Management	M2873	Ronteltap	5	85		15					
11	Decentralised Water Supply and Sanitation	M2810	Sharma	5	60		30	10				
11	Hydroinformatics for Decision Support	M3001	Jonoski	5			100					
11	Water Sensitive Cities	M3048	Pathirana	5								
11	Modelling river systems and lakes	M3075	Cattapan	5	60		40					
11	Flood Protection in Lowland Areas	M3104	Roelvink	5	60		40					
11	Remote sensing, GIS and modelling for agricultural water use	M3027	Karimi	5	25		75					

WATER QUALITY MANAGEMENT		C1383										
Module number	Module Name	Code	Module coordinator	ECTS	Written exam (%)	Oral exam (%)	Assignments (%)	Oral presentation (%)	Lab Report (%)	Home work (%)	Integrated in modules (%)	
1	Principles of integrated water resources management	M3084	Evers	5	45		55					
2	The water resources system	M3042	Susnik	5	70		30					
3	Water governance	M3032	Kemerink	5		40	60					
4	Water economics	M3028	Yong	5	70		30					
5	Water and environmental law	M1003	Jaspers	5	70		30					
6	Water quality assessment	M2835	de Ruyter	5	60		30		10			
7	Environmental Engineering	M3081	Raj	5	75		25					
8	Environmental planning and implementation	M3021	Evers	5	50		50					
9	International fieldwork	M3045	Tutusaus Luque	5			100					
12	Summer course			1			100					
13	IWRM Groupwork	M2252	Susnik	5			100					
14	MSc preparatory course and thesis research proposal for WM	M2169	Kooy	9		100						
15	MSc thesis research and thesis writing	M2927	various	36		100						
	Elective modules:											
10	Partnerships for Water Supply and Sanitation	M2711	Schwartz	5		50	50					
10	Aquatic Ecosystems Processes and Applications	M2122	Gettel	5			90	10				
10	Institutional Analysis	M3007	Smit	5			80	20				
11	Solid waste management	M1331	Siebel	5	60		35	5				
11	Strategic Planning for River Basins and Deltas	M3086	Yong	5	50		50					
11	IWRM as a tool for adaptation to climate change	M2155	de Ruyter	5	70		30					
11	Wetlands for livelihoods and conservation	M3089	Hes	5			80	20				
11	Urban water governance	M1568	Acevedo Guerre	5			100					
11	Advanced water transport and distribution	M2602	Trifunovic	5	60		40					
11	Faecal Sludge Management	M2873	Ronteltap	5	85		15					
11	Decentralised Water Supply and Sanitation	M2810	Sharma	5	60		30	10				
11	Hydroinformatics for Decision Support	M3001	Jonoski	5			100					
11	Water Sensitive Cities	M3048	Pathirana	5								
11	Modelling river systems and lakes	M3075	Cattapan	5	60		40					
11	Flood Protection in Lowland Areas	M3104	Roelvink	5	60		40					
11	Remote sensing, GIS and modelling for agricultural water use	M3027	Karimi	5	25		75					

## Appendix E MSc thesis marking guidelines

Criterion 1	9.0 - 10.0	8.0 - 8.9	7.0 - 7.9	6.0 - 6.9	5.9 and below
	Excellent	Very Good	Good	Sufficient	Fail
<b>Knowledge and understanding of the subject and answers to questions</b>	An excellent and informative introduction, well-researched, with appropriate and key references. Evidence of critical thinking. Clear aims and objectives, within an overall context, which identifies knowledge gaps. Sets the scene for the research succinctly and elegantly.	Good project background, with reference to key literature. A logical framework that identifies the research objectives, but may lack some thoroughness, or comprise a limited series of research questions. It might be competent but a little mundane.	Covers the main areas, but has minor flaws in logic or omissions of important detail, or minor flaws in structure. Aims and objectives comprehensible, but maybe slightly over or under ambitious, and/or lacking in clarity or precision. Objectives may be unrealistic.	Generally lacks some coherence; may be poorly referenced, but includes at least some points relevant to the research. Aims and objectives no more than adequate.	Poorly structured, with significant omissions of key background literature. No logical progression. Fails to set the context of the project. Research question not developed into appropriate or testable hypotheses

Criterion 2	9.0 - 10.0	8.0 - 8.9	7.0 - 7.9	6.0 - 6.9	5.9 and below	
	Excellent	Very Good	Good	Sufficient	Fail	
<b>Originality, analysis and interpretation</b>	Methods	Well-chosen and entirely appropriate and often novel methods identified clearly. Clear and easy to follow procedures and techniques. Where appropriate, good site description, with informative maps, diagrams etc.	Appropriate actions and methods identified and detailed. Where appropriate, setting of research well described with relevant maps etc	Methodology generally sound but with some lapses in detail of methods, and/or proposed analysis. Maps or diagrams may be poorly produced, or not clear in the context of the research	Significant gaps in methods, or methods not always appropriate to the research questions, or very difficult to comprehend. Lapses in detail in parts of methodology. Maps may be absent or poorly produced.	Methodology vague and poorly detailed. No obvious understanding of methodology relevant to research theme. Maps etc may be poorly produced or absent.
	Results	These are well analysed and presented with clarity, with clear and comprehensive relationship to the research questions.	Results reported well and with clarity. Some minor lapses in summary of findings. Shows ability to address methodological short-comings	Results comprehensible, generally linking with the research questions. Figures and tables convey adequate meaning, providing a summary of at least some of the key findings.	Some obvious flaws in analysis, but the general essence of the key findings conveyed.	Difficult to follow the results and analysis. Presentation careless and poor summary of the key findings
	Discussion	Elegant and well structured, placing the results in the context of the international literature and demonstrating a clear understanding of their significance, and/or shortcomings. Show some new ideas and novel interpretation.	Identifies the key finding and relevance of these to some key literature. A well ordered sequence to the chapter to produce a logical framework.	Recognises some interesting findings, but may be limited in placing these into a wider context. At least some use of key literature. There will likely to be some repetition with the results section.	Largely a repetition of the results section, with minimal context to wider understanding and relevant literature.	Fails to identify key findings and/or their wider significance. Little logical framework and lacking any individual ideas or interpretation.

Criterion 3	9.0 - 10.0	8.0 - 8.9	7.0 - 7.9	6.0 - 6.9	5.9 and below
	Excellent	Very Good	Good	Sufficient	Fail
<b>Organisation, style, presentation and communication</b>	Writing elegant and succinct. Uses precise language and correct terminology throughout. Figs and tables well laid out to a publishable quality with accurate and succinct legends.	A clear and well-written report that is technically proficient.	A generally well-written report that is understandable. Uses appropriate terminology. Occasional spelling or grammatical errors. Presentation generally neat	Language generally clear and uses correct terminology, but with some misunderstandings and lapses in grammar or spelling. Presentation and use of tables and figures may be sloppy.	Sentences and/or paragraphs poorly constructed. Language inexact or ambiguous. Contains numerous grammatical and spelling mistakes.

Criterion 4	9.0 - 10.0	8.0 - 8.9	7.0 - 7.9	6.0 - 6.9	5.9 and below
	Excellent	Very Good	Good	Sufficient	Fail
<b>Creativity, independence, work planning and critical attitude</b>	Student self-motivated and independent. Engages in intelligent discussion and responds well to suggestions.	Significant help may be given, but students show ability to learn from suggestions and develop ideas and research approaches accordingly.	Needs clear guidance and support, but gradually develops the required competencies.	A need to repeat instructions a number of times. Generally finds taking initiative difficult, and limited self-reliance.	Lacks motivation, or much ability to develop competencies. Shows little self-reliance or interest in the topic.



## Appendix F: Appeal procedure

(annex to the Examination Regulations 2015-17)

draft d.d. 28 April 2016

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A student has the right to lodge an appeal against:

- decisions by examiners, the MSc Examination Committee, or the Examination Board;
- termination of registrations by the Academic Registrar.

NB: An appeal against the decision of an Examiner or an MSc Examination Committee is lodged with the Examination Board. The Examination Board's decision is final and binding, and can therefore not be appealed against with the Academic Appeals Board.

Before starting an appeal procedure, the student has the obligation to attempt to solve the case amicably with the body or person who took the disputed decision.

### **Appeal against the decision of an Examiner or an MSc Examination Committee:**

1. The appeal shall be submitted in hard copy to the Examination Board (via its secretary) within 3 weeks following the date on which the decision was made known.
2. The appeal must be signed by the student (= appellant) and contain at least the following:
  - a. name and address, degree programme and student number of the appellant;
  - b. details of the Examiner or MSc Examination Committee concerned;
  - c. a clear description of the decision against which the appeal has been lodged, on submission of a copy of the decision, if possible, or, if the appeal has been lodged against a refusal to decide, a clear description of the decision which should have been taken in the appellant's opinion;
  - d. the grounds of the appeal;
  - e. an account of the initiatives taken by the appellant to come to an amicable agreement with the decision maker.
3. The chair of the Board will inform the appellant of any omissions on the appellant's part and will invite him to rectify these within a period of time to be set by the chair. In the event that the appellant fails to rectify the omissions on his part, the appeal may be declared inadmissible.
4. The Examination Board may decide to hear the concerned parties.
5. The Examination Board will take a decision within three (3) weeks of receipt of the letter of appeal and inform the parties concerned accordingly in writing, stating whether the initial decision is to be upheld or a new decision taken.
6. The decision of the Examination Board is final and binding.

### **Appeal against the decision of the Examination Board or the Academic Registrar:**

1. The appeal shall be submitted in hard copy to the Academic Appeals Board (via its secretary) within 3 weeks following the date on which the decision was made known.

2. The appeal must be signed by the student (= appellant) and contain at least the following:
  - a. name and address, degree programme and student number of the appellant;
  - b. details of the body or person who has taken the contested decision;
  - c. a clear description of the decision against which the appeal has been lodged, on submission of a copy of the decision, if possible, or, if the appeal has been lodged against a refusal to decide, a clear description of the decision which should have been taken in the appellant's opinion;
  - d. the grounds of the appeal;
  - e. an account of the initiatives taken by the appellant to come to an amicable agreement with the decision maker.
3. The chair of the Board will inform the appellant of any omissions on the appellant's part and will invite him to rectify these within a period of time to be set by the chair. In the event that the appellant fails to rectify the omissions on his part, the appeal may be declared inadmissible.
4. The Academic Appeals Board may decide to hear the concerned parties.
5. The Academic Appeals Board will take a decision within four (4) weeks of receipt of the letter of appeal and inform the parties concerned accordingly in writing, stating whether the initial decision is to be upheld or a new decision taken.
6. The decision of the Academic Appeals Board is final and binding.

## Appendix G Procedures when using eCampusXL for assessments

### GENERAL RULES

Students taking part in an examination are expected to have taken notice of these procedures and are expected to understand the implied meaning of these procedures.

Electronic examinations take place in lecture rooms A4, A5 and B6

In the examination room

1. The student brings his/her own laptop to the examination room.
2. When the examination takes place in rooms A4 and A5, students for safety reasons have to connect their laptops with the available network cables in that room instead of using the less stable Wi-Fi.
3. The student brings his/her student card and displays it on the table.
4. A check of attendance is required to proof that the student has taken part in the examination. The invigilator (examination supervisors) verifies the student card and confirms attendance by the student by ticking the box of the student on the attendance list.
5. The invigilators ensure a proper conduct of the examination and maintain order in the examination room. They will announce the beginning and the duration of the examination, and will warn the students 10 minutes before the ending of the examination.
6. The invigilators will instruct the students to log in to the safe browser environment for the examination.
7. At the start of the examination the invigilator announces the password to the students to get access to the examination.
8. The programme will automatically save all answers during an examination every 5 minutes. However during the examination students are strongly advised to save his/her current answers as well various times before the final submission to prevent loss of work in case the server goes down. Students remain responsible for the final submission of their work.
9. For a situation where the time of an examination expires without the final submission, for example when the server is not available on that specific moment, a grace period has been set where attempts can be submitted even after the deadline, but questions cannot be answered/changed.
10. When the laptop of the student stops working correctly, the student can restart the computer and will arrive at the same place in the examination. (this will also work when restart/login is made on a different machine).
11. At the end of the examination the invigilators return the attendance list to the Planning Office.

Other issues:

**Bags:** Bags and carrying cases, including penholders, are to be placed along the side of the room before the start of the examination.

**Dictionary:** The use of a printed language dictionary without any additional written annotations is allowed (all languages are allowed). Invigilators are allowed to check the dictionaries for hand-written annotations during the exam (spot checks while they are walking around).

Electronic dictionaries are not allowed.

**Calculators:** Use of calculators is not allowed and must be switched off. A scientific calculator inside the safe browser environment is available.

**Cell phones:** Use of cell phones is not allowed and must be switched off

**Communication:** During the examination, students are not allowed to exchange materials or to communicate with other students. If something is unclear, students have to inform the invigilator, who will contact the programme coordinator, the examiner or planning officer if necessary.

**Other materials:** The use of materials other than listed above, including blank paper, texts, of any kind, is not allowed.

Examiners may nevertheless allow students to use specified text matter or other effects in a so-called 'open book' examination. These materials shall not include previous or example examinations and solutions.

**Toilet visit:** Only one student at a time will be allowed by the invigilator to leave the examination room for a short visit to the lavatory, except during the first 15 and the last 15 minutes of the examination. Examination materials and requirements may not be taken outside the examination room. Before leaving the examination room, students have to hand over their cell phone to the invigilator.

# UNESCO-IHE - Academic Calendar 2016/2018

YEAR1	2016					2017					2017					2017																																																						
	October	November	December	January	February	March	April	May	June	July	August	September	October	Groupwork	August	September	October																																																					
Week	42	43	44	45	46	47	48	49	50	51	52	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42																	
Mon	17	24	31	07	14	21	28	05	12	19	26	02	09	16	23	30	06	13	20	27	03	10	17	24	01	08	15	22	29	05	12	19	26	03	10	17	24	31	07	14	21	28	04	11	18	25	02	09	16																					
Tue	18	25	01	08	15	22	29	06	13	20	27	03	10	17	24	31	07	14	21	28	04	11	18	25	02	09	16	23	30	06	13	20	27	04	11	18	25	01	08	15	22	29	05	12	19	26	03	10	17																					
Wed	19	26	02	09	16	23	30	07	14	21	28	04	11	18	25	01	08	15	22	29	05	12	19	26	03	10	17	24	31	07	14	21	28	05	12	19	26	02	09	16	23	30	06	13	20	27	04	11	18																					
Thu	20	27	03	10	17	24	01	08	15	22	29	05	12	19	26	02	09	16	23	02	09	16	23	30	06	13	20	27	04	11	18	25	01	08	15	22	29	06	13	20	27	03	10	17	24	31	07	14	21	28	05	12	19																	
Fri	21	28	04	11	18	25	02	09	16	23	30	06	13	20	27	03	10	17	24	03	10	17	24	31	07	14	21	28	05	12	19	26	02	09	16	23	30	07	14	21	28	04	11	18	25	01	08	15	22	29	06	13	20																	
Sat	22	29	05	12	19	26	03	10	17	24	31	07	14	21	28	04	11	18	25	04	11	18	25	01	08	15	22	29	06	13	20	27	03	10	17	24	01	08	15	22	29	05	12	19	26	02	09	16	23	30	07	14	21																	
Sun	23	30	06	13	20	27	04	11	18	25	01	08	15	22	29	05	12	19	26	05	12	19	26	02	09	16	23	30	07	14	21	28	04	11	18	25	02	09	16	23	30	06	13	20	27	03	10	17	24	01	08	15	22																	
	(2x5 ECTS)					(2x5 ECTS)					(2x5 ECTS)					(2x5 ECTS)					1 (1x5 ECTS)																																																	
	Module 1					Module 2					Module 3					Module 4					Module 5					Module 6					Module 7					Module 8					Module 9					Module 10					Module 11					Module 12					Module 13					Module 14				

YEAR2	2017					2018					M..																																																											
	October	November	December	January	February	March	April	May	June	July		August																																																										
Week	43	44	45	46	47	48	49	50	51	52	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18																																										
Mon	23	30	06	13	20	27	04	11	18	25	01	08	15	22	29	05	12	19	26	05	12	19	26	02	09	16	23	30																																										
Tue	24	31	07	14	21	28	05	12	19	26	02	09	16	23	30	06	13	20	27	06	13	20	27	03	10	17	24	01																																										
Wed	25	01	08	15	22	29	06	13	20	27	03	10	17	24	31	07	14	21	28	07	14	21	28	04	11	18	25	02																																										
Thu	26	02	09	16	23	30	07	14	21	28	04	11	18	25	01	08	15	22	01	08	15	22	29	05	12	19	26	03																																										
Fri	27	03	10	17	24	01	08	15	22	29	05	12	19	26	02	09	16	23	02	09	16	23	30	06	13	20	27	04																																										
Sat	28	04	11	18	25	02	09	16	23	30	06	13	20	27	03	10	17	24	03	10	17	24	03	10	17	24	01	08	15	22	29	06	13	20	27	04																																		
Sun	29	05	12	19	26	03	10	17	24	31	07	14	21	28	04	11	18	25	04	11	18	25	01	08	15	22	29	06																																										
	(2x5 ECTS)					(2x5 ECTS)					(2x5 ECTS)					(2x5 ECTS)					(1x5 ECTS)					(2x5 ECTS)																																												
	Module 1					Module 2					Module 3					Module 4					Module 5					Module 6					Module 7					Module 8					Module 9					Module 10					Module 11					Module 12					Module 13					Module 14				

Legend

- = Lecture period
- = Examination days
- = MSC thesis w riting
- = Holiday/free time
- = Opening acad. year
- = Diploma awarding
- = Summer course

- Christmas: Dec 25/26 2016
- Good Friday: April 14 2017
- Easter: April 16/17 2017
- Kingsday: April 27 2017
- Liberationday: May 5 2017
- Ascension: May 25 2017
- Pentecost: Juni 4/5 2017
- Christmas: Dec 25/26 2017
- Good Friday: March 30 2018
- Easter: April 1/2 2018
- Kingsday: 27 April 2018

# **Water Management**

**Certificate course**

**2016/2017**

**Online Course on**

**Governance of**

**Decentralized Sanitation**

# M3084

## Principles of Integrated Water Resources Management

<b>Term</b>	201617T01
<b>Coordinator</b>	J.G. Evers
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

Young and mid-career professionals, engineers and (mid-level) decision makers interested in a basic and broad understanding of main issues in the water management context.

### Prerequisites

Preferably a relevant water science or management related BSc degree; some experience in the water sector; good command of the English language (reading, writing, speaking).

### Learning Objectives

- 1 Summarize the latest insights, context and concepts in integrated water management that are under debate in international and regional forums.
- 2 Explain the main arguments for an integrated approach in the field of water management.
- 3 Describe the major natural functions and human uses of river systems.
- 4 Understand the concepts of Geographical Information Systems and apply them in practical examples relevant to water management.
- 5 Explain what science is and what scientific research entails including distinguishing the main methodological approaches (Research Path)

### Assessments

%	Type	Name
20	Assignment	GIS
35	Assignment	WM Research Methodologies (Annotated Bibliography Assignment; What is science)
45	Written examination (closed book)	

### Topics

#### 1 Introduction to the Module

General introduction to the module, learning objectives, learning activities, and assessment

## Topics

### 2 Principles of IWRM

Context, developments, perspectives, issues and debates in Integrated Water Resources Management. Water Resources: green water vs. blue water; catchment yield. Water Demand: demand projections; demand management; elasticity of water demand; the value of water. Water allocation. Water governance.

#### 2.1 Water Resources

Water resources; green water vs. blue water; catchment yield

#### 2.2 Water Demand

Water Demand: demand projections; demand management; elasticity of water demand; the value of water

#### 2.3 Water Allocation

Balancing demand and supply; Issues in water allocation; Water allocation in international river basins

#### 2.4 Water Governance

Water institutions, water allocations

#### 2.5 Emerging Issues

Water-energy-food nexus, upstream-downstream; virtual water

### 3 GIS and Remote Sensing

Basics of GIS and Remote Sensing. Vector-based geographic data processing with Arc-View GIS. GIS analysis and visualization. Grid data analysis and overlays including DEM and hydrological applications. Supervised and unsupervised classification.

#### 3.1 Introduction to GIS

Explain the basic concepts of GIS (raster, vector, projections, geospatial analysis). Vector-based geographic data processing with QGIS. GIS analysis and visualization.

#### 3.2 GIS for thematic mapping

GIS for thematic mapping

#### 3.3 Basic geo-processing and analysis

Basic geoprocessing and analysis

#### 3.4 DEM processing and catchment delineation

DEM processing and catchment delineation. Find open source software and open access data.

### 4 Research and Academic Skills Development

What is Science?; Different Approaches to Scientific Methodology; Referencing; Plagiarism; Critical Reading.

#### 4.1 What is Science?

What is Science?

#### 4.2 Different Approaches to Scientific Methodology

Different Approaches to Scientific Methodology

#### 4.3 Critical Reading

Critical Reading

#### 4.4 Referencing and Plagiarism

Referencing and plagiarism



## Study load

Nr	Topic	Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	Lecturers
1	Introduction to the Module	0	0	2	0	0	0	2	2	J.G. Evers
2	Principles of IWRM	0	0	0	0	0	0	0	0	
2.1	Water Resources	4	0	0	0	0	0	4	12	P. van der Zaag
2.2	Water Demand	4	0	0	0	0	0	4	12	P. van der Zaag
2.3	Water Allocation	4	0	0	0	0	0	4	12	P. van der Zaag
2.4	Water Governance	4	0	0	0	0	0	4	12	M.Z. Zwarteveen, P. van der Zaag
2.5	Emerging Issues	4	0	0	0	0	0	4	12	P. van der Zaag
3	GIS and Remote Sensing	0	0	0	0	0	0	0	0	
3.1	Introduction to GIS	2	0	0	0	0	0	2	6	J. van der Kwast, J.W. Wenninger
3.2	GIS for thematic mapping	0	2	2	0	0	0	2	4	J. van der Kwast, J.W. Wenninger
3.3	Basic geo-processing and analysis	0	3	2	0	0	0	2	5	J. van der Kwast, J.W. Wenninger
3.4	DEM processing and catchment delineation	0	3	2	0	0	0	2	5	J. van der Kwast, J.W. Wenninger
4	Research and Academic Skills Development	0	0	0	0	0	0	0	0	
4.1	What is Science?	4	0	0	0	0	0	4	12	K.A. Irvine, M.Z. Zwarteveen U.W.C. Wehn
4.2	Different Approaches to Scientific Methodology	4	0	0	0	0	0	4	12	K.A. Irvine, M.Z. Zwarteveen U.W.C. Wehn
4.3	Critical Reading	0	0	4	0	0	0	4	4	U.W.C. Wehn
4.4	Referencing and Plagiarism	0	0	4	0	0	0	4	4	L.P. Darvis
<b>Total</b>		<b>30</b>	<b>8</b>	<b>16</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>46</b>	<b>114</b>	

## Education Material

Lecture notes	Introduction to GIS and RS, Reader on GIS.
Handout	Other handouts and relevant articles.
Lecture notes	Water Resources Management

## Scientific Software

QGis

# M3042

## The Water Resources System

<b>Term</b>	201617T02
<b>Coordinator</b>	J. Susnik
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

Young and mid-career professionals, engineers and (mid-level) decision makers interested in understanding the bio-physical system as a sound basis for water management.

### Prerequisites

A relevant water science or water management related BSc degree; some experience in the water sector; good command of the English language. Good working knowledge of MS Excel is essential, as is basic mathematics. Knowledge of scientific units and unit conversion is essential. Basic knowledge of integrated water resources management is essential.

### Learning Objectives

- 1 Describe the key bio-chemo-physical processes that determine water quantity and quality within a general water resources system
- 2 Apply basic knowledge of the hydrological cycle, the water balance, precipitation, evapotranspiration, surface water discharge and groundwater movement to make a water balance and analyse rainfall and surface water and groundwater flows of water resources
- 3 Apply knowledge of basic chemistry and biology to analyse and explain eutrophication, stratification and the distribution of nutrients and ecological communities along water resources systems, and to relate these processes to water quality
- 4 Combine understanding and knowledge of water quantity (see objective 2) and water quality (see objective 3) to analyse a range of problems and potential solutions in water resources management
- 5 Measure basic water quality parameters and evaluate records with rainfall and flow data
- 6 Gain enhanced appreciation of the entire water resources system, recognising that quantity and quality issues affect each other in order to successfully undertake remaining Modules towards the UNESCO-IHE MSc degree.

### Assessments

%	Type	Name
10	Assignment	Evaporation
10	Assignment	Rating Curve Analysis
10	Assignment	Water Quality Analysis
70	Written examination (closed book)	Written Exam

## Topics

### 1 Introduction to the Water Resources System

Basic concepts for understanding a water resources system are introduced. Emphasis is placed on the idea of the system - this is, all elements in a water resources system should be considered as a whole. A case study is used to elaborate on the concepts and to introduce particular water quality and quantity problems.

1.1 Introduction to module

1.2 Introduction to Water Resources System

### 2 Water Quantity

Surface water hydrology: Hydrological cycle and water balance. Precipitation and evaporation. Principles of hydrology of surface and groundwater systems, hydrology of lakes and reservoirs including introduction to reservoir water balance and operations. Analysis of hydro-climatic data (e.g. precipitation, river flows), discharge rating curve and reservoir operation. Groundwater hydrology: Hydrogeology, groundwater zones, groundwater balance, hydraulic head, pressure head, elevation head, groundwater recharge and discharge, groundwater pollution.

2.1 Concepts of hydrology, hydrological cycle, water balance

2.2 Precipitation

2.3 Evaporation and Transpiration

2.4 Surface water resources

2.5 Groundwater resources

2.6 Reservoir water balance and operation

### 3 Water Quality

pH, BOD, nutrients, heavy metals, anaerobic waters, eutrophication, bio-accumulation

3.1 pH, BOD, anaerobic waters and stratification

3.2 Nutrients and Eutrophication

3.3 Heavy metals and bio-accumulation

### 4 Ecology (Case studies Water quality and quantity)

In a case study on the Nile river and lakes/reservoirs, knowledge about water quality and quantity is used to analyse real life problems in the Nile basin.

4.1 Fresh water ecology

4.2 Case study

### 5 Exam

### 6 Research methodology classes

## Study load

Nr	Topic									Lecturers
		Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	
1	Introduction to the Water Resources System	0	0	0	0	0	0	0	0	
1.1	Introduction to module	1	0	0	0	0	0	1	3	J. Susnik
1.2	Introduction to Water Resources System	3	0	0	0	0	0	3	9	J. Susnik
2	Water Quantity	0	0	0	0	0	0	0	0	
2.1	Concepts of hydrology, hydrological cycle, water balance	2	0	2	0	0	0	4	8	J. Susnik, Y.A. Mohamed
2.2	Precipitation	2	0	4	0	0	0	6	10	J. Susnik, Y.A. Mohamed
2.3	Evaporation and Transpiration	2	0	4	0	0	0	6	10	J. Susnik, Y.A. Mohamed
2.4	Surface water resources	2	0	0	0	0	2	4	12	J. Susnik, Y.A. Mohamed
2.5	Groundwater resources	4	0	4	0	0	0	8	16	T.Y. Stigter
2.6	Reservoir water balance and operation	2	0	0	0	0	0	2	6	Y.A. Mohamed
3	Water Quality	0	0	0	0	0	0	0	0	
3.1	pH, BOD, anaerobic waters and stratification	2	0	4	0	0	0	6	10	P Kelderman
3.2	Nutrients and Eutrophication	2	0	4	0	0	0	6	10	P Kelderman
3.3	Heavy metals and bio-accumulation	2	0	0	0	0	0	2	6	P Kelderman
4	Ecology (Case studies Water quality and quantity)	0	0	0	0	0	0	0	0	
4.1	Fresh water ecology	2	0	0	0	0	0	2	6	K.A. Irvine
4.2	Case study	2	4	0	0	0	0	2	10	K.A. Irvine
5	Exam	0	0	3	0	0	0	3	3	
6	Research methodology classes	2	2	0	0	0	0	2	8	
<b>Total</b>		<b>30</b>	<b>6</b>	<b>25</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>57</b>	<b>127</b>	

## Education Material

Lecture notes	J.C. Nonner. 2006. Introduction to Hydrogeology. UNESCO-IHE Lecture Notes Series. Taylor and Francis, Leiden.
Lecture notes	P.J.M. de Laat, Y.A. Mohamed. M.L. Mul, and J.W. Wenninger. 2010. Hydrology: An introductory course. UNESCO-IHE Lecture Notes.
Lecture notes	Pre-Lecture material on Basics of Chemistry, Kelderman, UNESCO-IHE lecture notes.
Lecture notes	Water Chemistry and Biology, Kelderman. UNESCO-IHE Lecture Notes.
Lecture notes	Y. Mohamed, P.J.M. de Laat, and L. Kewzi. Workshop Hydrology. 2010. UNESCO-IHE Lecture Notes.

**Scientific Software**  
ArcGIS

# M3032

## Water Governance

<b>Term</b>	201617T03
<b>Coordinator</b>	J.S. Kemerink - Seyoum
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

Students enrolled in the Water Management Master Programme, who ideally are young mid-career professionals working at middle and upper level in an organization in the water sector or employed in policy making institutions in the water sector or are working for organizations engaged in management of water resources and water services.

### Prerequisites

Good English command to read and discuss academic articles; willingness to engage in social science theory and new conceptual frameworks; willingness to engage in cross-disciplinary discussions and applications.

### Learning Objectives

- 1 Identify and analyse actors and decision making processes related to water governance
- 2 Distinguish and explain main discourses and theories on water governance
- 3 Identify context, purpose, perspective and arguments of scientific papers on water governance
- 4 Compare and contrast different scientific papers, case studies and theories on dynamic and political nature of water governance

### Assessments

%	Type	Name
40	Assignment	Group assignment: documentary on contemporary governance issue
20	Assignment	Individual assignment: literature study on contemporary governance issue
40	Oral examination	Oral examination on water governance literature

### Topics

- 1 **Introduction to water governance**
  - 1.2 Social-Nature
  - 1.5 Shifts in Governance
  - 1.6 Research methodology
- 2.1 Politics: an introduction
- 2.3 Everyday politics

## Topics

- 2.5 Politics of policy
- 2.6 Global politics
- 3 Tutorials**
- 4 Group assignment**
- 5 Exam**

## Study load

Nr	Topic									Lecturers
		Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	
1	Introduction to water governance	10	0	2	0	0	0	12	32	J.S. Kemerink - Seyoum, M.Z. Zwarteveen, T. Acevedo Guerrero
1.2	Social-Nature	4	0	0	0	0	0	4	12	J.S. Kemerink - Seyoum, T. Acevedo Guerrero
1.5	Shifts in Governance	4	0	0	0	0	0	4	12	J.S. Kemerink - Seyoum, K.H. Schwartz
1.6	Research methodology	2	10	0	0	0	0	2	16	J.G. Evers
2.1	Politics: an introduction	4	0	0	0	0	0	4	12	J.S. Kemerink - Seyoum, T. Acevedo Guerrero
2.3	Everyday politics	4	0	0	0	0	0	4	12	M.Z. Zwarteveen
2.5	Politics of policy	6	0	2	0	0	0	8	20	
2.6	Global politics	4	0	6	0	0	0	10	18	M.Z. Zwarteveen, T. Acevedo Guerrero
3	Tutorials	0	0	8	0	0	0	8	8	E. Fantini, J.G. Evers, J.S. Kemerink - Seyoum, K.H. Schwartz, M.E. Kooy, T. Acevedo Guerrero
4	Group assignment	0	20	0	0	0	0	0	20	J.S. Kemerink - Seyoum, T. Acevedo Guerrero
5	Exam	0	10	0	0	0	0	0	10	
<b>Total</b>		<b>38</b>	<b>40</b>	<b>18</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>56</b>	<b>172</b>	

## Education Material

- Scientific journal Bakker, K. (2002) 'From State to Market? Water Mercantilización in Spain', *Environment and Planning A*, 34: 767-790.
- Scientific journal Bridge, G. and Perreault, T. (2009) *Environmental Governance*. Chapter 28 in Castree, N., Demerit D., Liverman, D. and Rhoads B. (eds.) *A Companion to Environmental Geography*. Oxford, UK: Blackwell Publishing Inc.: 475-498.
- Scientific journal Castro J.E. (2007) 'Water Governance in the twentieth-first century.' *Ambiente & Sociedade* 10(2): 97-118.
- Scientific journal Cleaver, F. (1999) 'Paradoxes of Participation: Questioning Participatory Approaches to Development' *Journal of International Development* 11(4): 597-612.
- Lecture notes Powerpoints presentations of lectures
- Scientific journal Rap, E. (2006) 'The Success of a Policy Model: Irrigation Management Transfer in Mexico.' *Journal of Development Studies* 42 (8): 1301- 1324
- Scientific journal Swyngedouw, E. (2005) *Governance Innovation and the Citizen: The Janus Face of Governance-beyond-the-State*, *Urban Stud* 2005 42: 1991

## Scientific Software



# M3028

## Water Economics

<b>Term</b>	201617T04
<b>Coordinator</b>	Y. Jiang
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

### Prerequisites

### Learning Objectives

- 1 Describe the principles of economics and the relevance of economics to water management
- 2 Discuss and compare different economic perspectives/approaches with respect to water management
- 3 Characterize and explain water resource issues using economic concepts and theory
- 4 Describe the economic efficiency perspective for addressing water scarcity and allocation
- 5 Conduct simple cost-benefit analysis and policy analysis of water-related decision-making
- 6 List and review economic instruments for water management
- 7 Describe economic methods and techniques for estimating the value of water in different uses

### Assessments

%	Type	Name
30	Assignment	
70	Written examination (closed book)	

### Topics

- 1 Introduction to water economics**
  - 1.1 Introduction to module
  - 1.2 Water issues and management agenda
  - 1.3 Principles of economics, economist role and the relevance of economics to water management
- 2 Understanding water demand and supply**
  - 2.1 Economic concepts of demand and supply
  - 2.2 Empirics of water demand and supply
- 3 Characterizing water and use issues in socio-economic context**
  - 3.1 Typology of goods in economics

## **Topics**

3.2 Socio-economic conception of water

### **4 Economic approaches to water management**

4.1 Resource scarcity

4.2 Tradable water rights, markets

4.3 Water pricing

4.4 Application of economic instruments

4.5 Policy analysis of water demand and supply

4.6 Benefit-cost analysis

### **5 The economic value of water**

### **6 The role of economics in water management: synthesis and reflection**

7 Ravilla role play

8 Group assignment

9 Exam

## Study load

Nr	Topic									Lecturers
		Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	
1	Introduction to water economics	0	0	0	0	0	0	0	0	
1.1	Introduction to module	0	0	1	0	0	0	1	1	Y. Jiang
1.2	Water issues and management agenda	0	2	2	0	0	0	2	4	Y. Jiang
1.3	Principles of economics, economist role and the relevance of economics to water management	2	0	2	0	0	0	4	8	Y. Jiang
2	Understanding water demand and supply	0	0	0	0	0	0	0	0	
2.1	Economic concepts of demand and supply	2	0	4	0	0	0	6	10	Y. Jiang
2.2	Empirics of water demand and supply	2	0	2	0	0	0	4	8	Y. Jiang
3	Characterizing water and use issues in socio-economic context	0	0	0	0	0	0	0	0	
3.1	Typology of goods in economics	2	0	2	0	0	0	4	8	Y. Jiang
3.2	Socio-economic conception of water	0	3	2	0	0	0	2	5	Y. Jiang
4	Economic approaches to water management	0	0	0	0	0	0	0	0	
4.1	Resource scarcity	1	0	3	0	0	0	4	6	Y. Jiang
4.2	Tradable water rights, markets	2	0	2	0	0	0	4	8	
4.3	Water pricing	2	2	2	0	0	0	4	10	Y. Jiang
4.4	Application of economic instruments	0	2	4	0	0	0	4	6	Y. Jiang
4.5	Policy analysis of water demand and supply	0	0	4	0	0	0	4	4	Y. Jiang
4.6	Benefit-cost analysis	2	0	4	0	0	0	6	10	Y. Jiang
5	The economic value of water	4	0	0	0	0	0	4	12	Y. Jiang
6	The role of economics in water management: synthesis and reflection	0	4	4	0	0	0	4	8	Y. Jiang
7	Ravilla role play	0	0	21	0	0	0	21	21	I. Masih, S. Graas
8	Group assignment	0	12	0	0	0	0	0	12	Y. Jiang
9	Exam	0	3	0	0	0	0	0	3	
<b>Total</b>		<b>19</b>	<b>28</b>	<b>59</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>78</b>	<b>144</b>	

## Education Material

Lecture notes                      Lecture notes by Prof. M.P. van Dijk and Dr. Y. Jiang

## Scientific Software

# M1003

## Water and Environmental Law

<b>Term</b>	201617T05
<b>Coordinator</b>	F.G.W. Jaspers
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

Students of the Masters of Science Programmes of Water Management and Environmental Science and Technology .  
Practitioners with a relevant Bachelor's degree in a water related discipline

### Prerequisites

Preferably a relevant water science and engineering related bachelor's degree or equivalent; affinity with water management; good command of English.

### Learning Objectives

- 1 Critically investigate and grasp different dimensions of water and environmental law (including principles, rights, instruments, organizations) from local to global level.
- 2 Obtain proficiency in the review of contrasting legal arguments.
- 3 Practise treaty writing and contract writing skills.
- 4 Integrate legal knowledge within their existing water and environmental knowledge that try to address key issues of water sharing under the equity articles of the UN Watercourses Convention.

### Assessments

%	Type	Name
30	Assignment	Water and environmental law
70	Written examination (closed book)	

### Topics

- 1 **International Water Law**
  - 1.1 Introduction International Water Law
  - 1.2 International Water Law
  - 1.3 International Environmental Law
  - 1.4 Case studies
  - 1.5 Other international law
  - 1.6 Trans-boundary water and environmental law and related basin organizations

## Topics

### **2 National Water Law**

2.1 Introduction to legal concepts

2.2 Legal principles (including spatial planning law) in national water and climate change

2.3 Legal instruments for water quality management

2.4 Centralization, decentralization and subsidiarity: risks and advantages of each

2.5 Customary and statutory water and environmental rights, including rights of indigenous peoples

2.6 National river basin organizations; organizations for implementing climate change

2.7 National jurisprudence on water and environment

2.8 National dispute resolution issues

2.1 Intro National Water Law

2.2 Legal Instruments

2.3 River Basin Organizations (Intro)

2.4 Water Rights

2.5 Case: Customary Water Rights

2.6 Water Quality Management Regulations

### **3 Contract Management**

3.1 Contract law

3.2 Case study contract management on water related issues

3.3 Case study contract management for the Clean Development Mechanism or Reducing Emissions from Deforestation and Forestation Degradation

3.4 Group work contract law

## Topics

3.1 Contract Law

3.2 Contract Management Workshop

## Study load

Nr	Topic									Lecturers
		Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	
1	International Water Law	0	0	0	0	0	0	0	0	
1.1	Introduction International Water Law	2	0	0	0	0	0	2	6	J. Gupta
1.2	International Water Law	4	0	2	0	0	0	6	14	J. Gupta
1.3	International Environmental Law	4	0	2	0	0	0	6	14	J. Gupta
1.4	Case studies	0	0	4	0	0	0	4	4	J. Gupta
1.5	Other international law	2	0	0	0	0	0	2	6	Z.S. Shubber
1.6	Trans-boundary water and environmental law and related basin organizations	2	0	0	0	0	0	2	6	Z.S. Shubber
2	National Water Law	0	0	0	0	0	0	0	0	
2.1	Intro National Water Law	2	0	0	0	0	0	2	6	F.G.W. Jaspers
2.2	Legal Instruments	2	0	0	0	0	0	2	6	F.G.W. Jaspers
2.3	River Basin Organizations (Intro)	4	0	2	0	0	0	6	14	F.G.W. Jaspers
2.4	Water Rights	4	0	2	0	0	0	6	14	F.G.W. Jaspers
2.5	Case: Customary Water Rights	0	0	4	0	0	0	4	4	P. van der Zaag
2.6	Water Quality Management Regulations	4	0	4	0	0	0	8	16	
3	Contract Management	0	0	0	0	0	0	0	0	
3.1	Contract Law	2	0	2	0	0	0	4	8	F.G.W. Jaspers
3.2	Contract Management Workshop	0	0	4	0	0	0	4	4	F.G.W. Jaspers
<b>Total</b>		<b>32</b>	<b>0</b>	<b>26</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>58</b>	<b>122</b>	

## Education Material

Lecture notes

F.G.W. Jaspers - Chapters in Water and Environmental Resources Law, UNESCO-IHE Lecture Notes.

## Scientific Software

# M3103

## Managing Water Organisations

<b>Term</b>	201617T06
<b>Coordinator</b>	K.H. Schwartz
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

Young and mid-career professionals with an interest in strategic and operational management of water supply and sanitation organisations (including regulators).

### Prerequisites

Preferably experience in the water sector. A bachelors degree or equivalent. Basic PC-computer knowledge. Good command of English language.

### Learning Objectives

- 1 Relate academic debates concerning water supply and sanitation provisioning to the management of water organisations
- 2 Explain the position and strategy of a water organisation in relation to its institutional environment.
- 3 Diagnose challenges for a water organisation in relation to its context and develop strategic plans accordingly, including the management of change
- 5 The first block focuses on understanding the water services sector in which a water organisation develops. During this block the regulatory and policy context of water organisations is elaborated upon.
- 6 During the second block, the module focuses on specific elements of organisational management. This includes strategic management, change management, human resources management and customer management.

### Assessments

%	Type	Name
70	Assignment	Essay
20	Assignment	Research assignment
10	Assignment	Simulation game

### Topics

- 1 **Sector overview**
- 2 **Performance**
- 3 **Policy Analysis**
- 4 **Regulatory Models**

## Topics

- 5 Public Sector Reform
- 6 Strategic Management
- 7 Water Utility Simulation Game
- 8 Benchmarking
- 9 Benchmarking Game
- 10 Change Management
- 13 Water Utility Research Assignment
- 15 Introduction Exam

## Study load

Nr	Topic	Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	Lecturers
1	Sector overview	3	0	0	0	0	0	3	9	K.H. Schwartz
2	Performance	1	0	2	0	0	0	3	5	K.H. Schwartz
3	Policy Analysis	3	0	0	0	0	0	3	9	K.H. Schwartz
4	Regulatory Models	0	0	0	0	0	0	0	0	
5	Public Sector Reform	3	0	0	0	0	0	3	9	K.H. Schwartz
6	Strategic Management	3	0	0	0	0	0	3	9	K.H. Schwartz
7	Water Utility Simulation Game	1	7	0	0	0	0	1	10	A. Cabrera Flamini, K.H. Schwartz, M. Tutusaus Luque
8	Benchmarking	1	0	0	0	0	0	1	3	M. Tutusaus Luque
9	Benchmarking Game	0	0	4	0	0	0	4	4	M. Tutusaus Luque
10	Change Management	3	0	0	0	0	0	3	9	
13	Water Utility Research Assignment	1	23	0	0	0	0	1	26	K.H. Schwartz, M. Tutusaus Luque
15	Introduction Exam	1	0	0	0	0	0	1	3	M. Tutusaus Luque
<b>Total</b>		<b>20</b>	<b>30</b>	<b>6</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>26</b>	<b>96</b>	

## Education Material

## Scientific Software



# M3069

## Water Conflict Management I

<b>Term</b>	201617T06
<b>Coordinator</b>	Z.S. Shubber
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

Current and future water managers, decision-makers and others involved in water management wanting to broaden their scope in water management. Professionals involved in dispute resolution wanting to broaden the scope of their activities to include water.

Students need to have a first degree in a relevant subject (economics, social sciences, law, engineering, biology etc.) and preferably several years of relevant working experience.

### Prerequisites

Knowledge and appreciation of the principles of integrated water resources management, the water resources system and water governance.

Fluency in English is an absolute requirement.

### Learning Objectives

- 1 Explain, discuss and analyze the basic concepts of conflict management and conflicts related to water.
- 2 Critically analyse cases of water sharing and use among different actors at different levels and from different sectors, from a conflict and cooperation perspective.
- 3 Identify, explain and analyse the elements of a conflict transformation process applied to the management of a water conflict, and prepare, organise and engage in them as a party and as the process leader.
- 4 Identify, explain and analyse the elements of a mediation process applied to the management of a water conflict, and prepare, organise and engage in them as a party and as a mediator.

### Assessments

%	Type	Name
0,4	Assignment	Annotated Bibliography
0,1	Assignment	Skills Assessment
0,5	Written examination (closed book)	Written Exam

## Topics

### 1 **Theoretical background**

The module will start with an introduction to basic theoretical concepts and frameworks that apply to conflict. The spectrum of dispute resolution mechanisms will be presented as well as key skills for successful conflict resolution. Additionally, concepts, theories and tools will be drawn from water governance, water resources planning and institutional analysis in relation to water conflicts.

### 2 **Case studies**

Case studies of disputes around water, at different levels and between different sectors, are presented and discussed. They illustrate concepts set out in the theoretical background.

### 3 **Key theories and concepts on water conflict and cooperation**

This component considers the key theories and concepts that help explain and analyse conflict and cooperation over water. It particularly focuses on institutions and agency of water politics, especially in international transboundary river basins. In addition, discussion will cover scalar implications of water conflict and cooperation.

### 4 **Design and implement conflict resolution processes**

The lectures provide an opportunity to learn about current and leading-edge ways to work effectively in contentious water situations. It offers a place to practice new skills that are applicable from the individual level to the societal level and across a range of real-life situations.

### 5 **Mediation**

Environmental and water conflicts often involve more than two parties and are multi-layered in content. It is therefore crucial to suit the process to the conflict at hand. Mediation is among the processes well suited for two or more parties that are involved in a water-related conflict as a means to resolve the conflict. Participants will consider the advantages of mediation and learn and practice the components of the process.

### 7 **Annotated bibliography**

The students will develop an annotated bibliography on a topic related to cases of water sharing or disputes relating to water, from a list provided, and submit it at the end of the module. The annotated bibliography will be a stepping stone for the Essay assignment of the WCM II module.

### 8 **Exam**

## Study load

Nr	Topic	Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	Lecturers
1	Theoretical background	2	0	4	0	0	0	6	10	Z.S. Shubber
2	Case studies	0	0	4	0	0	0	4	4	
3	Key theories and concepts on water conflict and cooperation	2	0	4	0	0	0	6	10	
4	Design and implement conflict resolution processes	4	0	22	0	0	0	26	34	
5	Mediation	2	0	12	0	0	0	14	18	
7	Annotated bibliography	0	12	0	0	0	0	0	12	Z.S. Shubber
8	Exam	0	3	0	0	0	0	0	3	
<b>Total</b>		<b>10</b>	<b>15</b>	<b>46</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>56</b>	<b>91</b>	

## Education Material

- Handout                      Negotiation and Mediation, Theory and Skill. The Israel Centre for Negotiation and Mediation (2016), Haifa
- Book                              Sharing Waters, Sharing Benefits; UNESCO

## Scientific Software

# M2835

## Water Quality Assessment

<b>Term</b>	201617T06
<b>Coordinator</b>	E.D. de Ruijter van Steveninck
<b>Credit points</b>	5.000000000
<b>Specialization</b>	

### Target Group

Young and mid-career professionals (scientists, consultants, decision makers) with a background in Water management or Environmental science.

### Prerequisites

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

- 1 Describe different water pollutant groups, their risks and fates, and ways of modelling these fates
- 2 Describe and apply the different tools, criteria and assessment methods for succesful monitoring of surface waters in river basins
- 3 Describe and apply groundwater quality monitoring concepts
- 4 Design sustainable water quality monitoring programmes for river basins

### Assessments

%	Type	Name
15	Assignment	Groupwork: presentation on case study, design of a sustainable water quality monitoring programme in a specific river basin in a developing country
60	Written examination (closed book)	Topics: surface water quality monitoring, data handling; ground water monitoring
10	Lab. Report	Lab Report Written individual report on field/labwork
15	Assignment	Written individual report on exercise, GIS water quality model of the Scheldt river basin

## Topics

### 1 Water Quality Monitoring

Water quality variables.

Natural water quality and pollution variables.

The monitoring cycle. Items of the monitoring programme: why, what, where, how, how often. Physico-chemical and biological water quality monitoring.

Basic concepts and applications of Aquatic Ecotoxicology in Water quality monitoring.

Monitoring in the EU Water Framework Directive.

Workshop: Recent trends in Water Quality monitoring: use of mobile phones; GIS; low cost instruments such as sensors; case studies and examples.

Exercise: optimization of water quality monitoring programmes. Group work: design of a river basin monitoring network.

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

### 2 Data analysis and presentation

Use of statistics in water quality monitoring. Statistical tests: z-test; t-test, confidence intervals, etc. Hypothesis setting.

Non-parametric statistics. Applications: minimum sampling frequency; significant differences between data sets, correlation between variables, etc.

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

Presentation of data.

Hands-on computer exercises.

## Topics

### 3 Water Quality Modelling

Introduction to Modelling: types of models and model components.

BOD-DO modelling in a river.

Spatial-Dynamic Modelling of nitrate in the Scheldt Catchment, using a GIS based nutrient model. Modelling point and non-point sources.

In-class exercise.

### 4 Groundwater quality monitoring

Basics of hydrogeology. Pollutants reactions and transport in groundwater. Design of a groundwater monitoring network;

surveys; design and installation; locations; monitoring frequency; optimization.

### 5 Design of water quality monitoring network

(Liable to change): half-whole day visit(s) to water quality monitoring and modelling Institutions.

### 6 Exam

## Study load

Nr	Topic	Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	Lecturers
1	Water Quality Monitoring	10	0	11	8	0	4	33	69	G.F. Kruis, G.M. Gettel, J.L. Alfonso Segura
2	Data analysis and presentation	6	0	6	0	0	0	12	24	A.A. van Dam
3	Water Quality Modelling	0	0	2	8	0	0	10	18	J. van der Kwast
4	Groundwater quality monitoring	6	0	2	0	0	0	8	20	J.W.A. Foppen
5	Design of water quality monitoring network	0	0	0	0	6	0	6	6	
6	Exam	0	3	0	0	0	0	0	3	
<b>Total</b>		<b>22</b>	<b>3</b>	<b>21</b>	<b>16</b>	<b>6</b>	<b>4</b>	<b>69</b>	<b>140</b>	

## **Education Material**

Handout	C.A.M. van Gestel (2014) - Handout Aquatic Ecotoxicology
Handout	Compiled power point slides on all above topics; exercise materials; additional materials: relevant info, field trips materials, etc.
Handout	G.F. Kruis and P. Kelderman (2012) - Handout Fieldwork water quality monitoring and Laboratory QA/QC. Febr. 2012.
Handout	J. van der Kwast (2014)- Handout Introduction to Modelling/Nitrate modelling in the Scheldt basin
Handout	J.W.A. Foppen (2014) - Handout groundwater quality monitoring.
Lecture notes	P. Kelderman (2011) - Water quality and monitoring. UIHE lecture notes LN5/11/1.
Handout	P. Kelderman (2014) - Handout Data handling and presentation
Handout	P. Kelderman (2014) - Handout Design of a Water Quality Monitoring Network in a River Basin

## **Scientific Software**

# M1617

## Water Resources Assessment

<b>Term</b>	201617T06
<b>Coordinator</b>	Y.A. Mohamed
<b>Credit points</b>	5.000000000
<b>Specialization</b>	

### Target Group

Young and mid-career professionals, managers, engineers and technicians interested in water resources management in general, and in particular the assessment of quantity and quality of water resources. Processing and validation of both ground and remote sensing data is a key part of the module.

### Prerequisites

Successful completion of WM1, WM2 or equivalent is strongly recommended. Affinity with quantitative approaches is required. Good command of English.

### Learning Objectives

- 1 Describe different types of water resources data, generated from ground and RS measurements.
- 2 Apply diverse methods of data processing and data validation for water resources assessment.
- 3 Quantify the different components of the water resources spectrum (rainfall, river flow, groundwater), and assess availability and access at different scales.
- 4 Describe and apply different methods of water quality monitoring and assessment.
- 5 Analyse and quantify multiple uses of water for: agriculture, hydropower, domestic, environment and other uses
- 6 Apply water accounting techniques as a quick method for assessing water resources, water use, and water productivity in a river basin context.

### Assessments

%	Type	Name
35	Assignment	
65	Written examination (closed book)	Written Exam

### Topics

- 1 Introduction to WRA



## Topics

### 2 Water Resources Assessment

# Water Resources data: Different types of water resources data, monitoring, validation, archiving, and dissemination.

# Surface water resources assessment: time series analysis of WR data, including: flow duration curves, statistical distribution and trend analysis, extreme value analysis (floods and droughts).

# Groundwater resources assessment: Defining sustainable yield, occurrence of groundwater and investigation methods, methods of groundwater abstraction.

# Water quality monitoring and assessment: requirements for WQ assessment; WQ parameters; WQ monitoring program; Pollution; WQ assessment.

# Estimation of water resources data in un-gauged basins and regionalization.

*This includes field visits to the "Water Management Centre", The Netherlands, Lelystad, and to Deltares, Delft.*

2.1 Water resources data (case study)

2.2 Surface water resources assessment

2.3 Groundwater resources assessment

2.4 Water quality assessment

2.5 WRA in un-gauged basins

### 3 Water use activities

Agricultural water demand, crop water requirement, net irrigation requirement, yield analysis, domestic water use, hydropower water demand, environmental water requirement.

### 4 Water accounting

Introduction to remote sensing data for water resources management; Satellite image processing; Catchment water balance in GIS environment; Water productivity and water valuation; Water accounting.

4.1 GIS/RS applications in WRA

4.2 Processing of spatial data (Land use, precipitation, evapotranspiration, runoff)

4.3 Computation of catchment water balance

4.4 Water accounting at different scales

### 5 Field visit "Water Management Center"

### 6 Exam

## Study load

Nr	Topic	Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	Lecturers
1	Introduction to WRA	2	0	0	0	0	0	2	6	Y.A. Mohamed
2	Water Resources Assessment	0	0	0	0	0	0	0	0	
2.1	Water resources data (case study)	2	0	2	0	0	0	4	8	J. Susnik
2.2	Surface water resources assessment	4	0	4	0	0	0	8	16	Y.A. Mohamed
2.3	Groundwater resources assessment	4	0	4	0	0	0	8	16	T.Y. Stigter
2.4	Water quality assessment	6	0	0	0	0	0	6	18	A.L. Zuijidgeest
2.5	WRA in un-gauged basins	2	0	2	0	0	0	4	8	J. Susnik
3	Water use activities	4	0	2	0	0	0	6	14	S. Graas
4	Water accounting	0	0	0	0	0	0	0	0	H.H.G. Savenije, W.G.M. Bastiaanssen, Y.A. Mohamed
4.1	GIS/RS applications in WRA	2	0	2	0	0	0	4	8	W.G.M. Bastiaanssen
4.2	Processing of spatial data (Land use, precipitation, evapotranspiration, runoff)	2	0	4	0	0	0	6	10	Y.A. Mohamed
4.3	Computation of catchment water balance	2	0	4	0	0	0	6	10	H.H.G. Savenije, Y.A. Mohamed
4.4	Water accounting at different scales	2	0	4	0	0	0	6	10	Y.A. Mohamed
5	Field visit "Water Management Center"	0	0	0	0	6	0	6	6	
6	Exam	0	0	0	0	3	0	3	3	
<b>Total</b>		<b>32</b>	<b>0</b>	<b>28</b>	<b>0</b>	<b>9</b>	<b>0</b>	<b>69</b>	<b>133</b>	

## Education Material

- Book Water Resources Assessment Hand Book for review of national capabilities, 1997 (WMO, UNESCO)
- Lecture notes Water accounting at river basin scale, Mohamed, 2013. UNESCO-IHE lecture notes.

## Scientific Software

- ArcGIS
- Cropwat
- QGis

# M2216

## Constructed Wetlands for Wastewater Treatment

<b>Term</b>	201617T07
<b>Coordinator</b>	J.J.A. van Bruggen
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

Programme target group

### Prerequisites

Programme prerequisites

### Learning Objectives

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

### Assessments

%	Type	Name
40	Assignment	
60	Written examination (closed book)	

### Topics

- 1 Introduction into the module**  
Explanation of the contents of the module, the objectives, logistics etc.
- 2 Introduction Natural Wetlands**  
Definition, characteristics, types, relevance, human well being
- 3 Basics Wastewater Treatment**  
  
Wastewater: composition, principles.

Natural wetlands or constructed wetlands, limitations

## Topics

### 4 **Wetlands and Climate**

Climate change, Greenhouse effect, Solar energy, evaporation, condensation, airconditioning, case studies, solutions, waterparadigm

### 5 **Natural wetlands for water treatment**

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

### 6 **Types of Constructed Wetlands and Application**

Different types. Advantages and disadvantages. Constructed wetlands in The Netherlands, the tropics and the rest of the world.

Application for different types of wastewater.

### 7 **Integrated production systems**

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

### 8 **Design Constructed Wetlands**

Design of constructed wetlands

### 9 **Operation and Maintenance**

Operation and Maintenance Constructed Wetlands

### 10 **Economics**

Economics of constructed wetlands

### 11 **Case study**

Case study constructed wetland on Texel

### 12 **Fieldtrip 1**

Fieldtrip to constructed wetland at ZIN in Vught, and the forested wetland in Hapert

### 13 **Assignment**

Explanation of the assignment

### 14 **Presentations**

Final presentations on own design of a constructed wetland

### 15 **Exam**

Exam about the content of the module

## Study load

Nr	Topic									Lecturers
		Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	
1	Introduction into the module	1	0	0	0	0	0	1	3	J.J.A. van Bruggen
2	Introduction Natural Wetlands	6	3	0	0	0	0	6	21	E.M.A. Hes
3	Basics Wastewater Treatment	2	0	0	0	0	0	2	6	J.J.A. van Bruggen
4	Wetlands and Climate	2	0	0	0	0	0	2	6	J. Pokorny
5	Natural wetlands for water treatment	4	0	0	0	0	0	4	12	
6	Types of Constructed Wetlands and Application	4	0	0	0	0	0	4	12	J.J.A. van Bruggen
7	Integrated production systems	4	0	0	0	0	0	4	12	A.A. van Dam
8	Design Constructed Wetlands	8	0	0	0	0	0	8	24	DPL Rousseau
9	Operation and Maintenance	2	0	0	0	0	0	2	6	DPL Rousseau
10	Economics	2	0	0	0	0	0	2	6	DPL Rousseau
11	Case study	0	0	4	0	0	0	4	4	S Toet
12	Fieldtrip 1	0	0	0	0	8	0	8	8	J.J.A. van Bruggen
13	Assignment	1	10	0	0	0	0	1	13	J.J.A. van Bruggen
14	Presentations	0	0	4	0	0	0	4	4	J.J.A. van Bruggen
15	Exam	0	3	0	0	0	0	0	3	
<b>Total</b>		<b>36</b>	<b>16</b>	<b>8</b>	<b>0</b>	<b>8</b>	<b>0</b>	<b>52</b>	<b>140</b>	

## Education Material

Lecture notes                      Lecture notes and case studies

## Scientific Software

# M3081

## Environmental Engineering

<b>Term</b>	201617T07
<b>Coordinator</b>	E.R. Raj
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

Programme target groups (MSc and short course participants) having background in Environmental Sciences, Chemical or Civil Engineering

### Prerequisites

Basic knowledge in mathematics, including calculus, linear algebra and differential equations - Strong fundamentals in chemistry and biology - Fundamental understanding of different physical, chemical and biological processes of environmental significance - Confidence to solve problems involving chemical kinetics and design of bioprocesses - Ability to work in a group and contribute to specific assignments

### Learning Objectives

- 1 Describe different biological processes and their engineering applications for wastewater treatment;
- 2 Categorize different air pollutants and distinguish the different physico-chemical and biological air pollution control techniques for particulate and gaseous contaminants;
- 3 Apply basic thermodynamic principles to determine reaction rates of environmental processes under a given set of operating conditions
- 4 Describe the different water treatment methods and with the help of simple examples, evaluate the performance of water treatment plants;
- 5 Solve problems pertaining to the design and operation of different environmental systems

### Assessments

%	Type	Name
25	Written examination (closed book)	Environmental process technology
50	Written examination (closed book)	Wastewater treatment and air pollution control
25	Assignment	Water treatment

## Topics

### 1 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. The participant will be able to learn the following aspects: (i) Water treatment methods, and (ii) water treatment processes and plants.

### 2 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 taught under the topic wastewater treatment. The following topics will be covered; (i) Anaerobic reactors, (ii) Waste stabilization ponds, (iii) Activated sludge process, (iv) UASB reactor, (v) Photo-bioreactors, and (vi) Design and problem solving tutorials.

### 3 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 (EPT). During this lecture, the following topics will be covered; (i) Mass balance analysis, (ii) Ideal batch reactors, (iii) Plug flow reactor, (iv) Stirred tank reactor, (v) Tracer responses in reactors, (vi) Continuous flow reactors with recycle, (vii) Thermodynamics of environmental processes, and (viii) Problem solving tutorials.

### 4 Air pollution control

Air pollution and atmospheric air quality in developing countries has been a topic of major concern due to rapid industrialization. The nature of damages caused to human health and the environment due to air pollutants is worsening every year. Therefore, it is important to develop effective technologies for the management and control of air pollution. The following topics will be covered; (i) Classification of air pollutants, (ii) Air pollution control systems: particulate control & gaseous contaminants, and (iii) Biological odour control systems.

## Study load

Nr	Topic									Lecturers
		Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	
1	Water treatment	3	0	0	16	0	0	19	41	JP Buiteman
2	Wastewater treatment	9	0	0	15	8	0	32	65	E.R. Raj, J.J.A. van Brugger J.L.C.M. van de Vossenberg
3	Environmental process technology	8	0	0	0	0	0	8	24	N.P. van der Steen
4	Air pollution control	3	1	0	0	0	0	3	10	E.R. Raj
Total		23	1	0	31	8	0	62	140	

## **Education Material**

Lecture notes	Lecture notes Wastewater Treatment + Tutorials
Lecture notes	Lecture notes on Air Pollution Control and powerpoint presentations
Lecture notes	Lecture notes on EPT, Problem solving in class
Lecture notes	Lecture notes on Water Treatment and assignments topics
Book	Text book on "Air Pollution Prevention and Control: Bioreactors and Bioenergy" by Christian Kennes and Maria C. Veiga (Wiley).
Book	Text book titled "Chemical Reaction Engineering" by O. Levenspiel
Book	Text book titled "Wastewater Engineering: Treatment and Reuse" by George Tchobanoglous, Franklin L. Burton and H. David Stensel (Metcalf and Eddy)

## **Scientific Software**



# M3041

## Environmental Management and Water Services

<b>Term</b>	201617T07
<b>Coordinator</b>	A. Cabrera Flamini
<b>Credit points</b>	5.000000000
<b>Specialization</b>	

### Target Group

Mid-career professionals dealing with or interested in planning and management aspects of water supply and sanitation systems, especially under consideration of growing environmental pressures, e.g. working for municipalities, governments, water/wastewater agencies, or consulting groups and NGO's operating in that space.

### Prerequisites

Preferably experience in the water sector. A bachelor's degree or equivalent. Good command of English language.

### Learning Objectives

- 1 Discuss the components that make up the urban water cycle and urban water systems
- 2 Explain and employ the basic technical/ecological and institutional principles of integrated urban water management
- 3 Discuss the potential impacts of climate change and anthropogenic impacts on the urban water cycle
- 4 Discuss and use different risk assessment/management frameworks applied to urban water systems
- 5 Discuss potential strategies to improve the sustainability of water services, both in terms of water quantity and quality management

### Assessments

%	Type	Name
50	Assignment	
50	Oral examination	

### Topics

- 1 **Integrated Urban Water Management**
- 2 **Risk Management and Water Safety Planning**  
Introduction to Water Safety Plans/ Sanitation Safety Plans, Water Cycle Safety Planning, Source protection
- 3 **Urban Water Security and Resilience**  
Alternative water supply systems, Water-Energy nexus,
- 8 **Fieldvisit 1**  
Visit to Dutch water utilities: Integrated Urban Water Management, Green Utilities, Water Cycle Management

## Study load

Nr	Topic	Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	Lecturers
1	Integrated Urban Water Management	8	0	4	0	0	0	12	28	F. Bichai
2	Risk Management and Water Safety Planning	10	10	12	0	0	0	22	52	F. Bichai
3	Urban Water Security and Resilience	16	0	2	0	0	0	18	50	
8	Fieldvisit 1	0	0	0	0	8	0	8	8	F. Bichai
	<b>Total</b>	<b>34</b>	<b>10</b>	<b>18</b>	<b>0</b>	<b>8</b>	<b>0</b>	<b>60</b>	<b>138</b>	

## Education Material

## Scientific Software

# M3070

## Water Conflict Management II

<b>Term</b>	201617T07
<b>Coordinator</b>	Z.S. Shubber
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

Current and future water managers, decision-makers and others involved in water management wanting to broaden their scope in water management. Professionals involved in dispute resolution wanting to broaden the scope of their activities to include water.

Students need to have a first degree in a relevant subject (economics, social sciences, law, engineering, biology etc.) and preferably several years of relevant working experience.

### Prerequisites

Knowledge and appreciation of the principles of integrated water resources management, the water resources system and water governance.

### Learning Objectives

- 1 Explain, discuss and analyse the basic concepts of conflict management and conflicts related to water.
- 2 Critically analyse cases of water sharing and use among different actors at different levels and from different sectors, from a conflict and cooperation perspective.
- 3 Identify, explain and analyse the elements of a negotiation process applied to the management of a water conflict, and prepare, organise and engage in them as a negotiator.
- 4 Prepare, organise and engage in different types of conflict resolution processes related to water conflicts.

### Assessments

%	Type	Name
0,4	Assignment	Essay
0,6	Written examination (closed book)	Written

## Topics

### 1 Theoretical background

The module will start with a summary of the previous module. It will then introduce new concepts and theories not covered in the previous module.

### 2 Case studies

Case studies of disputes around water, at different levels and between different sectors, are presented and discussed. They illustrate concepts set out in the theoretical background.

### 3 Climate change negotiations

This section will discuss the law of treaties, the rules of procedures of international treaty negotiations, and the actual negotiation process as it unfolded in the climate change negotiations. It will discuss both practical issues related to negotiations within a UN framework as well as the more abstract and enduring challenges of negotiations involving 192 countries.

### 4 International negotiations

This four day lecture on international negotiation processes confronts the theory and practice of bargaining. It helps participants to get a better understanding of how to handle processes and procedures, people and parties and positions and products, while not forgetting about perception and power and other important factors in negotiations. Cultural aspects and personal behaviour in negotiations are also covered. Bilateral and multilateral negotiations are practiced, also around a water dispute, and there is also a debrief of multilateral negotiations.

### 5 Role play

The purpose of the role play is to make participants aware of the various aspects (technical, managerial, political) relating to the management of transboundary waters; the complexity of applying integrated and participatory approaches in decision making; and the complexity of technical and human aspects of negotiations, consensus building, stakeholder participation and dialogue processes relating to water resources management.

### 6 Essay

The students will be required to write an essay on a topic related to water conflict management based on relevant scientific literature. They will have to submit it after the end of the module. For the students who followed WCM I, the essay will be based on their work for the annotated bibliography.

### 7 Exam

## Study load

Nr	Topic	Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	Lecturers
1	Theoretical background	4	0	2	0	0	0	6	14	Z.S. Shubber
2	Case studies	0	0	6	0	0	0	6	6	
3	Climate change negotiations	2	0	2	0	0	0	4	8	J. Gupta
4	International negotiations	6	0	16	0	0	0	22	34	
5	Role play	0	0	12	0	0	0	12	12	
6	Essay	0	20	0	0	0	0	0	20	Z.S. Shubber
7	Exam	0	3	0	0	0	0	0	3	Z.S. Shubber
Total		12	23	38	0	0	0	50	97	

## Education Material

Handout                      Workbook of International Negotiations, The Clingendael Institute.

## Scientific Software

# M2054

## Water Systems Modelling

<b>Term</b>	201617T07
<b>Coordinator</b>	S. Graas
<b>Credit points</b>	5.000000000
<b>Specialization</b>	

### Target Group

Young and mid-career professionals, managers, engineers and technicians dealing with or interested in various aspects of water resources modelling.

### Prerequisites

Affinity with quantitative approaches is required. Good command of English.

### Learning Objectives

- 1 Describe the procedure of the modelling protocol.
- 2 Name and explain type of models used in different case studies.
- 3 Build water resources models that simulate river basin processes.
- 4 Clearly present the results of the water system models.
- 5 Critically analyse model outcomes.

### Assessments

%	Type	Name
40	Presentation	
60	Written examination (closed book)	Written Exam

### Topics

#### 1 Water system modelling - Concepts

Introduction to water system modelling concepts, including procedure in the modelling protocol, different types of models (prescriptive vs descriptive, stochastic vs conceptual, lumped vs distributed), calibration and validation procedures, performance indicators and available software packages.

- 1.1 Why model
- 1.2 Modelling process
- 1.3 Calibration and Uncertainty analysis
- 1.4 Types of models
- 1.5 Software Packages for Water Systems Modelling

## Topics

1.6 Explanation assignment and Q&A session

### 2 River Basin Simulations - Practice

Application of 3 different models. A hydrological model (HBV); a water allocation model (Waflex) and a hydraulic model (Mike-11) will be build and tested after which the output will be analysed and interpreted. The developed models will increase the understanding of the participants in the possible applications of water system modelling within the concept of integrated river basin management. One of the models has to be chosen to be presented and critically discussed during an oral exam.

2.1 HBV (rainfall-runoff)

2.2 Waflex (water allocation)

2.3 Mike 11 (flood)

### 3 Analysis of model results

### 4 Paper discussion

Read two journal articles on the topic (selected by the lecturers) which are discussed during a session. The discussion will focus on the relevance of the modelling theory applied to the article in question, to appreciate the advantages of modelling for water resources management and to be able to understand, analyse and interpret model results.

### 5 Case studies

Several guest lecturers will come and share their experience with respect to modelling water systems.

5.1 Land use modelling & optimisation

5.2 New data sources for modelling

5.3 Systems Dynamic Modelling

### 6 Exam

## Study load

Nr	Topic									Lecturers
		Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	
1	Water system modelling - Concepts	0	0	0	0	0	0	0	0	
1.1	Why model	2	0	0	0	0	0	2	6	S. Graas
1.2	Modelling process	4	0	0	0	0	0	4	12	S. Graas
1.3	Calibration and Uncertainty analysis	2	0	0	0	0	0	2	6	I. Masih
1.4	Types of models	2	0	0	0	0	0	2	6	I. Masih
1.5	Software Packages for Water Systems Modelling	2	0	0	0	0	0	2	6	I.I. Popescu
1.6	Explanation assignment and Q&A session	0	2	0	0	0	0	0	2	I. Masih, I.I. Popescu, S. Graas
2	River Basin Simulations - Practice	0	0	0	0	0	0	0	0	
2.1	HBV (rainfall-runoff)	0	0	0	12	0	0	12	24	I. Masih
2.2	Waflex (water allocation)	0	0	0	12	0	0	12	24	S. Graas
2.3	Mike 11 (flood)	0	0	0	12	0	0	12	24	I.I. Popescu
3	Analysis of model results	4	0	0	0	0	0	4	12	S. Graas
4	Paper discussion	4	0	0	0	0	0	4	12	I. Masih, S. Graas
5	Case studies	0	0	0	0	0	0	0	0	
5.1	Land use modelling & optimisation	0	0	4	0	0	0	4	4	Y. Jiang
5.2	New data sources for modelling	0	0	4	0	0	0	4	4	J.L. Alfonso Segura
5.3	Systems Dynamic Modelling	0	0	4	0	0	0	4	4	J. Susnik
6	Exam	0	3	0	0	0	0	0	3	
<b>Total</b>		<b>20</b>	<b>5</b>	<b>12</b>	<b>36</b>	<b>0</b>	<b>0</b>	<b>68</b>	<b>149</b>	

## Education Material

Lecture notes                      Mul, M.L. – Spreadsheet modelling, UNESCO-IHE Lecture Notes.  
 Handout                                Other handouts: Selected background reading.

## Scientific Software

HbV Light  
 Mike 11  
 WAFLEX



# M3021

## Environmental Planning and Implementation

<b>Term</b>	201617T08
<b>Coordinator</b>	J.G. Evers
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

Young and mid-career professionals (scientists, decision-makers) with a background in environmental management, water management and / or watershed management.

### Prerequisites

Affinity with environment policy and enforcement, development economics, and preferably experience in water management arena. Good command of English.

### Learning Objectives

- 1 Understand (partly) the complexities of the individual within the complex policy system
- 2 Develop (adaptive) strategies for network (stakeholder) and process management of water and environmental policy planning and implementation
- 3 Explain and critically reflect on the role of policy implementers (people) in the policy process
- 4 Reflect and further develop personal skills for policy planning and implementation
- 5 Apply and critically assess tools/approaches/strategies for (participatory) policy planning and implementation
- 6 Understand and apply economic valuation methods for environmental policy planning

### Assessments

%	Type	Name
25	Group assignment	Environmental Economics
50	Written examination (closed book)	Environmental Planning and Implementation
25	Group assignment	Policy Plan Analysis

### Topics

- 1 **Environmental planning and implementation**  
Introduction to the module, theories on policy (process) analysis, case studies and experiences on Environmental planning and implementation
  - 1.1 Introduction to EPI  
Introducing the module, learning objectives, learning activities, and assessment.
  - 1.2 Environmental Planning  
Introducing key concepts of environmental planning

## Topics

- 1.3 Policy Implementation  
Introducing concepts of Contextual Interaction Theory, Street-level bureaucracy, policy theory analysis
- 1.4 Assignment Policy plan analysis  
In the assignment student groups will analyze a policy plan of action using the Policy Theory concept of Hoogerwerff.
- 2 Personal skills and experiences in planning and implementation**  
Team roles in policy planning and implementation, Emotional Intelligence, roundtable discussion with professionals in planning and implementation, field trip
- 2.1 Personal Experiences in Water and Environmental policy implementation  
Guests are invited from to discuss with the participants their experiences and personal lessons learned from many years of being involved in environmental policy planning and implementation
- 2.2 Roundtable discussion  
A politician, civil servant, and NGO director will discuss with the participants their role around dealing with a specific environmental issue.
- 2.3 Personal skills in planning and implementation  
We organize 2 workshops to develop personal skills: Teamroles; and Emotional Intelligence
- 3 Environmental Economics**  
Economic valuation methods, and economic tools for the management of natural (water) resources.
- 4 Decision support tools for EPI**  
What is the role of DSS/planning tools in Environmental Planning
- 4.1 MOTA analysis  
In this session we use the MOTA framework to assess the implementation feasibility of proposed measures in de River Basin Game.
- 4.2 Tools for planning  
In this lecture we discuss the variety of tools which are used in planning processes, its role, and what tools do.

## Study load

Nr	Topic									Lecturers
		Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	
1	Environmental planning and implementation	0	0	0	0	0	0	0	0	
1.1	Introduction to EPI	2	0	0	0	0	0	2	6	J.G. Evers
1.2	Environmental Planning	4	0	0	0	0	0	4	12	J.G. Evers, W.J.A.M. Douve
1.3	Policy Implementation	4	0	0	0	0	0	4	12	J.G. Evers
1.4	Assignment Policy plan analysis	0	32	0	0	0	0	0	32	J.G. Evers, W.A.H. Thissen
2	Personal skills and experiences in planning and implementation	0	0	0	0	0	0	0	0	
2.1	Personal Experiences in Water and Environmental policy implemetation	0	0	4	0	0	0	4	4	J.G. Evers
2.2	Roundtable discussion	0	0	2	0	0	0	2	2	J.G. Evers
2.3	Personal skills in planning and implementation	0	0	12	0	0	0	12	12	J.G. Evers
3	Environmental Economics	14	8	0	0	0	0	14	50	Y. Jiang
4	Decision support tools for EPI	0	0	0	0	0	0	0	0	
4.1	MOTA analysis	0	0	4	0	0	0	4	4	J.G. Evers
4.2	Tools for planning	2	0	0	0	0	0	2	6	J.G. Evers, S. Hasan
<b>Total</b>		<b>26</b>	<b>40</b>	<b>22</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>48</b>	<b>140</b>	

## Education Material

Handout                      Additional Reading Materials  
Lecture notes              Lecture Notes

## Scientific Software

# M3044

## Finance in the Water Sector

<b>Term</b>	201617T08
<b>Coordinator</b>	M. Tutusaus Luque
<b>Credit points</b>	5.000000000
<b>Specialization</b>	

### Target Group

Young and mid-career professionals, (future) managers, and other operational functions in water utilities, NGOs or governmental organizations interested in the implication of financial reforms in the water sector to their operational work.

### Prerequisites

Preferably a relevant water science, economics or finance related bachelor degree; Some experience in the water sector; Good command of the English language. Preferably having (successfully) completed Managing Water Organizations (WSM05)

### Learning Objectives

- 1 Recognize the need for commercial accounting and identify the components of standard financial statements in water organisations.
- 2 Analyze the financial position of a water organisation through an analysis of financial statements
- 3 Recognize the implications of managerial decisions on the financial situation of the service provider
- 4 Place financial discussions in the greater context of water and sanitation provision services
- 5 Discuss ethical issues related to financial decisions in the water sector

### Assessments

%	Type	Name
10	Assignment	- Financial analysis report: the participant is requested to determine the financial situation of the company based on their financial statements and provide advice for a specific financial decisions/investment.
15	Assignment	Group assignments: the participants are requested to develop a project analysis for the implementation of a specific infrastructural development project.
25	Assignment	Individual essay: the participant is requested to elaborate in written form about a relevant and current dilemma related to water and finance.
50	Written examination (open book)	

**Topics**

**1 Introduction to Finance and financial tools: Corporate Finance**

Tools: financial analysis and performance indicators

Link to concepts: performance, cost recovery, efficiency, commercialization

Linking finance – operations: Impacts of global debates on daily operations:

**2 Finance in the water sector: (Project Finance/Corporate Finance)**

From State support to Innovative finance constructions:

Financialization of water/resources

Hybrid financial constructions:

Project Finance (partners, loan structuring, conditions, etc).

**Study load**

Nr	Topic									Lecturers
		Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	
1	Introduction to Finance and financial tools: Corporate Finance	10	5	0	0	8	0	18	43	
2	Finance in the water sector: (Project Finance/ Corporate Finance)	10	15	4	0	8	0	22	57	
<b>Total</b>		<b>20</b>	<b>20</b>	<b>4</b>	<b>0</b>	<b>16</b>	<b>0</b>	<b>40</b>	<b>100</b>	

**Education Material**

Lecture notes            Lecture notes, Powerpoint presentations.  
 Book                        Reference books.

**Scientific Software**

# M2535

## Water Resources Planning

<b>Term</b>	201617T08
<b>Coordinator</b>	N.J.M. van Cauwenbergh
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

Young and mid-career professionals, managers, engineers and technicians who have the ambition to judge, participate in and guide multi-disciplinary water resources planning studies.

### Prerequisites

Understanding of the water resources physical system. Understanding of water use for agriculture, water supply, hydropower and environment. Understanding of water governance. Computer literacy. Good command of English.

### Learning Objectives

- 1 Explain basic concepts and notions in water resources planning.
- 2 Describe major steps in the participatory and integrated water resources planning process.
- 3 Identify and apply tools and models, such as stakeholder integration, environmental impact assessment (EIA), decision support systems, role plays and water system models, while engaging in water resources planning activities.
- 4 Develop alternative water management strategies and compare and evaluate them by applying multi-criteria analysis.
- 5 Discuss water resources planning and implementation in basins for specific context with special attention to basin in a developing country context.

### Assessments

%	Type	Name
40	Assignment	
60	Written examination (closed book)	Written Exam

### Topics

#### 1 Introduction to Module and Framework for analysis

Principles of integrated water resources planning. Common notions used in planning (e.g. water resources system analysis, water policy, national/river basin/project plans, strategy, measures, scenarios, robustness, with and without project, sustainability). Planning scales and approaches. Introduction to the case studies used in the module. Introduction to planning and strategy development by using the LIBRA Role Play.

## Topics

### 2 Models, methods and tools for Water Resources Planning:

Comprehension of frameworks used in water resources planning with focus on key steps in the planning process, such as situation and function analysis including multi-level stakeholder and water sector analysis, planning objectives and criteria, scenario and strategy development, role of modelling in water resources planning, evaluation (screening) of alternatives and strategies and multi-criteria analysis. Importance of stakeholder participation in the planning process, opportunities and limitations. Tools and methods for stakeholder participation in key steps of the planning process including participatory decision support systems. Negotiation and compensation in group decision making. Plan implementation and evaluation. The evolution of and experience with participatory and integrated planning methods will be demonstrated through case study examples.

### 3 Use of models in WRP

### 4 LIBRA role play and MCA

### 5 Environmental Impact Assessment

Environmental impacts of water resources development projects, principles and methods of environmental impact assessment, introduction to strategic environmental assessment (SEA), environmental impact assessment (EIA) and its application in water resources planning.

### 6 Experience in water resources planning in the global south-case studies and discussion

Case studies and discussion on practices, challenges and opportunities for water resources planning in the global south.

### 7 Field trip

### 8 Exam

## Study load

Nr	Topic									Lecturers
		Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	
1	Introduction to Module and Framework for analysis	10	5	12	0	0	0	22	47	N.J.M. van Cauwenbergh
2	Models, methods and tools for Water Resources Planning:	0	0	0	0	0	0	0	0	
3	Use of models in WRP	4	0	0	0	0	0	4	12	I. Masih
4	LIBRA role play and MCA	0	0	10	0	0	0	10	10	I. Masih, J.C. Heun
5	Environmental Impact Assessment	4	5	8	0	0	0	12	25	H. Clouting
6	Experience in water resources planning in the global south-case studies and discussion	4	16	12	0	0	0	16	40	E. van Beek, W.J.A.M. Douven
7	Field trip	0	0	0	0	7	0	7	7	I. Masih, M Hofstra
8	Exam	0	3	0	0	0	0	0	3	
<b>Total</b>		<b>22</b>	<b>29</b>	<b>42</b>	<b>0</b>	<b>7</b>	<b>0</b>	<b>71</b>	<b>144</b>	

**Education Material**

- Lecture notes J.C. Heun and N. Van Cauwenbergh – Participatory Integrated Water Resources Planning: Framework for Analysis and Stakeholder integration, UNESCO-IHE Lecture Notes.
- Lecture notes L. C. Beevers and H. Clouting - Environmental Assessment: Environmental Impact Assessment (EIA) & Strategic Environmental Assessment (SEA), UNESCO-IHE Lecture Notes.
- Handout Other Handouts: Examples of case studies, Selected background reading.

**Scientific Software**

LIBRA



# M3045

## International Fieldwork

<b>Term</b>	201617T09
<b>Coordinator</b>	A. Cabrera Flamini
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

This module is required for all participants in the Water Management programme. Participants of the WQM specialisation may choose to participate in the fieldtrip of the Environmental Science. In this case, they will also follow the Environmental Science Groupwork.

### Prerequisites

Bachelor's degree. Basic computer skills (MS-Windows, Office) Good English command. Basic knowledge of IWRM and EU FWD.

### Learning Objectives

- 1 Develop and implement quantitative and qualitative data collection methods
- 2 Formulate a problem statement and related research questions
- 3 Develop a problem analysis using primary and secondary data
- 4 Compare the different water management regulations and practices (demand and supply management), sources (ie. Traditional sources, alternative sources) and uses (ie. Formal/informal, urban/agriculture/others) in Spain and Portugal.
- 5 Understand the ways in which the administration of water introduces changes in the distributions of power within families, regions and communities.

### Assessments

%	Type	Name
50	Presentation	Portugal
50	Assignment	Spain

### Topics

#### 1 General info

During two weeks, students will visit institutions and stakeholder groups in the Andarax basin in Spain and the Guadiana Basin in Spain/Portugal. The purpose of these visits is to familiarize students with technical (physical, chemical, biological and engineering) and non-technical (legal, social, economic, cultural, financial, institutional and managerial) aspects of water management and the interactions between them.



**Education Material**

**Scientific Software**

# M3020

## Research Methodology and Thesis Proposal

<b>Term</b>	201617T09
<b>Coordinator</b>	Z.S. Shubber
<b>Credit points</b>	3.000000000
<b>Specialization</b>	Water Cooperation and Peace

### Target Group

This module is for the participants in the Water Cooperation and Peace programme.

### Prerequisites

Knowledge on water governance, conflict management and scientific methods. Good communication skills in English language.

### Learning Objectives

- 1 Formulate a problem statement and research question
- 2 Collect and analyse data from field measurements and interviews
- 3 Compose an outline for a research proposal underpinned by the above work to conduct a Master of Science Thesis.

### Assessments

%	Type	Name
40	Presentation	Findings
30	Assignment	Report
30	Presentation	Research questions

## Topics

### 1 Activities

General info - Study concepts on scientific research and different research methods (e.g. field data collection and interviewing techniques), refreshing knowledge and skills on water balance, institutional analysis and conflict management gained in earlier modules. Expedite various research topics available in the water management MSc handbook and discuss the selected topics with respective lecturers. Participate in the field trip and conduct a short research work to develop an in-depth problem analysis.

Fieldwork - During six days field work, students will visit institutions and stakeholder groups in the Andarax basin in Spain. In addition to specific assignment on problem analysis around water conflict theme, these field visits familiarize students with technical (physical, chemical, biological and engineering) and non-technical (legal, social, economic, cultural, financial, institutional and managerial) aspects of water management and the interaction between them. Good water management is founded on reliable data. The person doing the data collection (both from primary and secondary sources) has the responsibility of ensuring that raw data of an acceptable quality is collected. During this fieldwork a number of interviews will be conducted, discharge measurements and physicochemical water quality parameters will be determined at selected points by direct measurements. The data collected will be analysed to gain insight into the topography (land use, geology, users, etc.), hydrology and water quality of the catchment, and identifying some of the mechanisms that determine this water quantity and quality, and identifying water management issues.

Problem analysis of Andarax basin - The fieldwork in the Andarax basin provides an opportunity for the students to in the Andarax basin. This problem analysis feeds into the groupwork done by the Water Management students in August where an integrated management plan for the Andarax basin will be developed. Prior to going to the Andarax basin, participants will prepare for the fieldwork through literature review, lectures and discussion. On the basis of these activities, the students will formulate research questions and methodology with a focus on conflict to support the problem analysis. During the fieldwork in the Andarax basin, data will be collected during the visits to various institutions and stakeholder groups. This means that participants have to ask questions, ask for data, collect information, etc. that will be used for the detailed problem analysis.

### Study load

Nr	Topic									Lecturers
		Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	
1	Activities	2	20	12	0	48	0	62	86	
<b>Total</b>		<b>2</b>	<b>20</b>	<b>12</b>	<b>0</b>	<b>48</b>	<b>0</b>	<b>62</b>	<b>86</b>	

### Education Material

## Scientific Software

# M2122

## Aquatic Ecosystems Processes and Applications

<b>Term</b>	201617T10
<b>Coordinator</b>	G.M. Gettel
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

Programme target group (Participants in the programmes at IHE) and qualified short course participants

### Prerequisites

Programme prerequisites (BSc in a topic appropriate to UNESCO-IHE programme) and basic knowledge of aquatic ecology.

### Learning Objectives

- 1 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;
- 2 measure and calculate primary production and community respiration, measure nutrient concentration and turbidity, calculate and measure ash free dry mass, and perform zooplankton counts.
- 3 Develop a research question based on the experimental design.
- 4 Analyze data using either statistical or modeling techniques to answer your research question.
- 5 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.
- 6 Critically analyze your colleagues work in the form of a professional peer review.

### Assessments

%	Type	Name
10	Assignment	The peer review will comprise 10% of the grade for this course.
80	Assignment	The scientific report serves as the exam and the bulk of the grade for this course.
10	Presentation	Presentation Students will be asked to present conclusions from in-class discussions and exercises.

## Topics

### 1 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, including introductory limnology, principles of primary production and bottom-up and top-down control, and benthic and pelagic primary production.

### 2 Fundamental Limnological Laboratory Skills

Laboratory analysis of physical-chemical and ecological characteristics including nutrients, phytoplankton, zooplankton, and primary production will be performed.

### 3 Data analysis

Students will analyse data using the necessary statistical approaches, including ANOVA and post-hoc tests (e.g. Tukey), regression, and non-parametric tests as required.

### 4 Report Writing

Skills in writing a scientific report, including developing a research question, the structure of Introduction, Methods and Materials, Results, and Discussion sections of a scientific report are described.

### 5 Critical understanding of literature and graph interpretation

Students are asked to interpret graphs and do a critical reading exercise as part of lecture tutorials. These examples come from the required reading.

## Study load

Nr	Topic									Lecturers
		Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	
1	Eutrophication in shallow-lake ecosystems	14	0	0	0	0	0	14	42	G.M. Gettel
2	Fundamental Limnological Laboratory Skills	0	0	22	0	0	0	22	22	E.R. Raj, G.M. Gettel
3	Data analysis	0	20	0	0	0	0	0	20	A.A. van Dam, G.M. Gettel
4	Report Writing	0	34	0	0	0	0	0	34	E.R. Raj, G.M. Gettel
5	Critical understanding of literature and graph interpretation	0	0	22	0	0	0	22	22	E.R. Raj, G.M. Gettel
<b>Total</b>		<b>14</b>	<b>54</b>	<b>44</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>58</b>	<b>140</b>	

## Education Material

### Scientific Software

stella



# M3104

## Flood Protection in Lowland Areas

<b>Term</b>	201617T10
<b>Coordinator</b>	J.A. Roelvink
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

### Prerequisites

Basic knowledge of hydraulics, basic knowledge of soil mechanics

### Learning Objectives

- 1 carry out a basic design of dikes, revetments and closure dams
- 2 understand concepts and advances of flood risk management with due consideration of societal aspects, including flooding issues in the floodplain and coastal zone, management of flood risk, planning aspects and a variety of non-structural measures
- 3 understand and apply concepts and advances in tools used for coastal flood modelling and flood forecasting
- 4 understand and apply the principles of flood frequency analysis and risk based approaches to design of hydraulic works
- 5 understand (the practical application of) probabilistic design theory

### Assessments

%	Type	Name
0,4	Written examination (closed book)	Dikes and Revetments (assignment, oral discussion)
0,2	Written examination (closed book)	Probabilistic Design
0,4	Assignment	Storm Impact Modelling

### Topics

#### 1 Dikes and Revetments

Seadikes in The Netherlands, philosophy of dike design, definition of frequency of failure, risk analysis, design methodology for dikes, hydraulic boundary conditions, wave run-up and overtopping, geometrical design of dikes and revetments, stability for rock, artificial units, design criteria for placed block revetment, other types (bituminous, asphalt.. etc), other design considerations, geotechnical aspects related to dikes, overall stability, design of granular filter, geotextiles, geosystems, improvement and maintenance of dikes and revetments, design of bottom protection, design methodology for closures; sand closures, stone closures, caisson closures.

#### 2 Dikes and Revetments

## Topics

### 3 Probabilistic design

Theoretical background of probability functions, practical application of probabilistic design, various levels of probability, examples of application of probabilistic design, the use of fault trees, exercise in the application of probabilistic design in coastal engineering problems.

### 4 Storm Impact modelling

This course focuses on prediction of flooding from the sea, due to tsunamis and storms. Subjects that are treated are causes, models, effects and warning systems related to tsunamis; storm types and characteristics in different areas in the world; storm surge and extreme wave modeling; storm erosion, overtopping and inundation modeling; predictive modeling vs. (probabilistic) modeling for design purposes. Case studies based on Katrina, Ivan, Sidr and the Indian Ocean tsunami. Hands-on exercises using Delft3D and XBeach.

### 5 Storm Impact modelling

## Study load

Nr	Topic								Lecturers	
		Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours		SUM: workload hours
1	Dikes and Revetments	8	0	4	0	0	0	12	28	C Dorst
2	Dikes and Revetments	12	0	0	0	0	0	12	36	JH van Dalen
3	Probabilistic design	6	0	6	0	0	0	12	24	M Kok
4	Storm Impact modelling	6	0	5	0	0	0	11	23	J.A. Roelvink
5	Storm Impact modelling	8	0	5	0	0	0	13	29	M van Ormondt
<b>Total</b>		<b>40</b>	<b>0</b>	<b>20</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>60</b>	<b>140</b>	

## Education Material

Handout	Groot, M.: Handouts, Geotechnical Aspects for Dikes, 2003
Handout	Handout: collection of tutorials and papers related to OpenEarth, Delft3D and XBeach applications
Handout	Hassan, R.M.: handouts, Dikes and Revetments, 2002
Lecture notes	Verhagen, H.J. : Design of closure of dams- Lecture notes In0052/02
Lecture notes	Verhagen, H.J.: Revetments, Sea Dikes and River Levees-Lecture notes hh292/99/1
Lecture notes	Vrijling, J.K.: Probabilistic Design, Lecture notes In0217/04/

## Scientific Software

Delft3D  
 Matlab  
 Xbeach

# M3007

## Institutional Analysis

<b>Term</b>	201617T10
<b>Coordinator</b>	H. Smit
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

Young and Mid-career professionals who are 1) working at middle and upper management level in an organization in the water sector, 2) employed in policy making institutions in the water sector or 3) working for organizations engaged in management of water resources and water services.

### Prerequisites

Mandatory: High level of ability to read and discuss academic articles and book chapters in English; willingness to engage in social science theory and analytical frameworks. Preferred: completion of the Water Governance module.

### Learning Objectives

- 1 Analyze the role of institutions in water management.
- 2 Summarize and compare different approaches to institutional analysis linked to different schools of thought.
- 3 Apply these approaches to better understand how water resources and the control thereof are distributed in specific water management cases.

### Assessments

%	Type	Name
20	Assignment	2 reading assignments
60	Assignment	Final Assignment, written essay
20	Presentation	Presentation

### Topics

#### 2 Approaches to Institutional Analysis

- **Week 1:**

- **Description:** This week we discuss what institutional arrangements are and why institutional analysis can be useful. Further we discuss different frameworks for analysis of institutional arrangements to better understand how water resources and the control thereof are distributed.
- **Activities:** Different approaches to do institutional analysis will be elaborated upon through presentations and tutorials about related scientific articles. One session will be organized to discuss and contrast different approaches to institutional analysis. In the second week two groups will do an institutional analysis using different predetermined frameworks. Both groups will present their analysis. The presentations will be followed by a debate to discuss the opportunities and limitations of the different frameworks used.

## Topics

### 3 Shaping institutions

- **Week 2:**

- **Description:** In this week we discuss how particular material, cultural specificities translate into institutions and how - in turn - institutions translate into practice. Moreover we will zoom in on the phenomena of isomorphism and legal pluralism in the shaping of the institutional landscape.
- **Activities:** Lectures will be given on the material and cultural shaping of institutions and on institutional isomorphism and legal pluralism.

### 4 Essay assignment

- **Week 3:**

- **Description:** In week 3 the focus is on writing the final essay in which participants use and critique the frameworks for institutional analysis which we discussed in class.
- **Activities:** The case study assignment will be introduced in a lecture and presentation during the second week of the module. During the third week of the module a session is organised in which questions about the essay assignment are answered.

## Study load

Nr	Topic	Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	Lecturers
2	Approaches to Institutional Analysis	0	0	0	0	0	0	0	0	H. Smit, J.S. Kemerink - Seyoum
3	Shaping institutions	0	0	0	0	0	0	0	0	
4	Essay assignment	0	0	0	0	0	0	0	0	
<b>Total</b>		<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	

## Education Material

### Handout

Students will be provided a list of articles that are required reading. It should be noted that student are expected to read and understand a considerable number of articles (approximately 15).

## Scientific Software

# M2711

## Partnerships for Water Supply and Sanitation

<b>Term</b>	201617T10
<b>Coordinator</b>	P.C. Torio
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

Professional staff active in water related institutions, such as governmental bodies, NGOs, consultancy firms, research institutions and water utilities. Future professionals, such as promising bachelor students.

### Prerequisites

Preferably a water science, economics or management related bachelor degree; Experience in the water sector; Good command of the English language.

### Learning Objectives

- 1 Explicate the rational for partnerships in the water sector.
- 2 Describe and explain the historical evolution of partnerships in the water sector.
- 3 Assess the suitability of the different type of partnerships in a given context
- 4 Differentiate between stages of the partnering cycle and anticipate challenging aspects in each stage

### Assessments

%	Type	Name
30	Assignment	
50	Oral examination	
20	Assignment	Skills Assignment

### Topics

- 1 Introduction**
  - 1.2 Rational for partnerships
  - 1.3 Historical evolution of partnerships in the water sector
- 2 Partnerships' diversity in the water sector**
  - 2.1 PPP typology and key issues
  - 2.2 PPP cases from a multinational private operator
  - 2.3 Partnerships for sanitation
  - 2.4 Peer support linked to investments

## Topics

2.6 10 years of Dutch WOPs' experience

### 3 Partnership management

3.1 Partnerships management and partnering skills

3.2 Partnership contract negotiation

3.3 Partnerships conflict management

3.4 Partnerships planning, monitoring and evaluation

3.5 Partnerships and capacity development

## Study load

Nr	Topic									Lecturers
		Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	
1	Introduction	0	0	0	0	0	0	0	0	
1.2	Rational for partnerships	2	0	2	0	0	0	4	8	M. Pascual Sanz
1.3	Historical evolution of partnerships in the water sector	2	0	0	0	0	0	2	6	K.H. Schwartz
2	Partnerships' diversity in the water sector	0	0	0	0	0	0	0	0	
2.1	PPP typology and key issues	2	0	1	0	0	0	3	7	
2.2	PPP cases from a multinational private operator	5	0	1	0	0	0	6	16	
2.3	Partnerships for sanitation	2	0	0	0	0	0	2	6	
2.4	Peer support linked to investments	2	0	2	0	0	0	4	8	M. Pascual Sanz
2.6	10 years of Dutch WOPs' experience	2	0	0	0	0	0	2	6	
3	Partnership management	0	0	0	0	0	0	0	0	
3.1	Partnerships management and partnering skills	3	0	2	0	0	0	5	11	M. Pascual Sanz
3.2	Partnership contract negotiation	2	3	1	0	0	0	3	10	M. Pascual Sanz
3.3	Partnerships conflict management	3	0	2	0	0	0	5	11	M. Pascual Sanz
3.4	Partnerships planning, monitoring and evaluation	4	0	3	0	0	0	7	15	M. Pascual Sanz
3.5	Partnerships and capacity development	3	0	2	0	0	0	5	11	M. Pascual Sanz
<b>Total</b>		<b>32</b>	<b>3</b>	<b>16</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>48</b>	<b>115</b>	

## Education Material

## Scientific Software

# M3027

## Remote Sensing, GIS and Modelling for Agricultural Water Use

<b>Term</b>	201617T10
<b>Coordinator</b>	P. Karimi
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

All WSE participants and from other programmes with specific interest.

### Prerequisites

General knowledge about GIS and remote sensing.

### Learning Objectives

- 1 Explain the use of modern tools as RS and GIS in combination with the use of computer models
- 2 Explain and use the principles of Surface Energy Balance in estimating Evapotranspiration
- 3 Reflect on the advanced applications of RS in irrigation management
- 4 Identify problems, constraints and potentials of lowland and flood prone areas for sustainable development
- 5 Discuss the design principles of the lowland, flood prone areas and polder water management systems
- 6 Reflect on the importance of environmental and socio-economic consideration in the low land and flood prone areas and prepare the operation and maintenance and management plans and options.

### Assessments

%	Type	Name
0,6	Assignment	Irrigation and remote sensing
0,25	Written examination (open book)	Low lands and flood prone areas
0,15	Assignment	Water system modeling & GIS

### Topics

#### 1 Water system modeling

Water management system of land and water development, the use of computer models in the design, operation and maintenance of hydraulic control structures, pumping stations, etc., calibration, verification and sensitivity analysis of the model, and hydraulic performance of the water management system. The use of GIS in analyzing and evaluating land suitability, drainability and irrigability of an area.

## Topics

### 2 Land use and Water in Flood Prone Areas

Basic principle of lowland and flood prone areas development; - to create optimal conditions for agriculture as well as urban; - components of polder water management systems; - to create an understanding of the consequences of applying certain infrastructural layouts and water management techniques; effect of sea level rise and land subsidence to lowland and flood prone areas; - design aspects of lowlands and flood prone areas; -operation, maintenance, socio-economic and environmental considerations of lowland and flood prone areas development; - modeling of polder water management systems

### 3 Remote sensing data for Agricultural Water Management

### 4 Remote sensing for Evapotranspiration assessment (SEBAL)

### 5 Remote sensing for irrigation performance assessment

### 6 Water productivity as a tool for design, management, and evaluation of irrigation systems

### 7 Remote Sensing for Water Accounting

## Study load

Nr	Topic									Lecturers
		Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	
1	Water system modeling	6	0	8	0	0	2	16	32	F.X. Suryadi
2	Land use and Water in Flood Prone Areas	8	0	0	0	0	0	8	24	F.X. Suryadi
3	Remote sensing data for Agricultural Water Management	4	0	2	0	0	0	6	14	X. Cai
4	Remote sensing for Evapotranspiration assessment (SEBAL)	6	0	4	0	0	0	10	22	J.D. van Opstal, P. Karimi
5	Remote sensing for irrigation performance assessment	2	0	4	0	0	0	6	10	P. Karimi
6	Water productivity as a tool for design, management, and evaluation of irrigation systems	2	0	2	0	0	0	4	8	X. Cai
7	Remote Sensing for Water Accounting	8	0	6	0	0	0	14	30	P. Karimi
<b>Total</b>		<b>36</b>	<b>0</b>	<b>26</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>64</b>	<b>140</b>	

## Education Material

- Book Man made lowlands, G.P. van de Ven (Ed), 2004
- Book Suryadi, 2010. GIS and computer modelling of Water Management Systems.
- Book Urban polder guideline, Vol 1,2, 3 and 4, UNESCO-IHE, 2009

## Scientific Software



# M3086

## Strategic Planning for River Basins and Deltas

<b>Term</b>	201617T10
<b>Coordinator</b>	J.G. Evers
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

Young and mid-career professionals (scientists, decision-makers) with a background in water management, environmental management, and / or watershed management.

### Prerequisites

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

- 1 Understand strategic planning concepts and principles
- 2 Describe social-physical relations and interdependencies, in particular among water and environmental systems, and socio-economic development
- 3 Use of the concepts of adaptive and strategic planning and design for developing river basin management and development plans.
- 4 Use Strategic Environmental Assessment (SEA) as a planning tool for developing sustainable river basin management and development plans.

### Assessments

%	Type	Name
50	Assignment	Case study
50	Written examination (closed book)	Written exam (closed book)

### Topics

#### 1 Introduction

In this session the participants are introduced to the modules learning objectives, learning activities , and the assessment (case study group assignment and written exam)

## Topics

### **2 River basins as socio-physical systems**

Human-water systems, driving forces and development dynamics, interdependencies of land use and development and water and environmental systems, complexity, cross-cutting models and modelling approaches, meta modelling.

### **3 Strategic planning and design for river basins and deltas**

Strategic planning versus programming and project planning; tiering; issues of scale; spatial quality and design, land use planning; design methods from plan development to implementation; river basin/delta governance issues.

Strategic impact assessment, including environmental (SEA), economic and social impact assessment

### **4 Dealing with Uncertainties**

Examples of key social, economic and physical uncertainties in river basin systems Concepts and methods for uncertainty identification and assessment, for system and policy design, and governance. This includes, for example, exploratory analysis, scenario planning, resilience and robustness, adaptive policy making and adaptation pathways. Uncertainties in strategic planning, concepts and methods for uncertainty identification and assessment, and for system and policy design. This includes, for example, exploratory analysis, scenario planning, resilience and robustness, and adaptive policy making.

### **5 Case study**

During the course, students will work on integrated application of the concepts, theories and methods introduced in this course on a case. A limited number of cases will be prepared, so that students can focus on a field of their interest. Case options may include deltas and/or basins with different characteristics, such as heavy urbanisation; flooding problems; drought and water scarcity, subsidence, pollution and water quality, etc.

## Study load

Nr	Topic	Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	Lecturers
1	Introduction	0	0	1	0	0	0	1	1	J.G. Evers, Y. Jiang
2	River basins as socio-physical systems	8	0	4	0	0	0	12	28	A. Mendoza - Sammet, J.G. Evers, W.A.H. Thissen, W.J.A.M. Douven, Y. Jiang
3	Strategic planning and design for river basins and deltas	8	0	4	0	0	0	12	28	A. Mendoza - Sammet, J.G. Evers, W.A.H. Thissen, W.J.A.M. Douven
4	Dealing with Uncertainties	8	0	4	0	0	0	12	28	A. Mendoza - Sammet, B. Gersonius, C. Zevenbergen, J.G. Evers, W.A.H. Thissen, W.J.A.M. Douven
5	Case study	0	55	0	0	0	0	0	55	A. Mendoza - Sammet, B. Gersonius, C. Zevenbergen, J.G. Evers, W.A.H. Thissen, W.J.A.M. Douven, Y. Jiang
<b>Total</b>		<b>24</b>	<b>55</b>	<b>13</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>37</b>	<b>140</b>	

## Education Material

Scientific journal	Additional reading materials
Lecture notes	Lecture Notes
Digital files	Lecture powerpoint slides

## Scientific Software

# M3048

## Water Sensitive Cities

<b>Term</b>	201617T10
<b>Coordinator</b>	P.D.A. Pathirana
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

All participants and external professionals dealing with urban water and flood risk management working for municipalities, water management organisation, consulting firms, educational institutions and NGOs.

### Prerequisites

BSc degree in Engineering or Social Sciences background; basic knowledge of urban water and flood risk management; good command of English.

### Learning Objectives

- 1 Describe the historical transition of cities from the viewpoint of water management. List salient features of that transition (both positive and negative). (ILO1:History)
- 2 Argue that the three main components of the urban water cycle (UWC) management are interdependent. Describe the interactions with other important aspects of UWC like groundwater, urban atmosphere, etc., and how they affect each. (ILO2:Integration)
- 3 Identify interactions between water system components, while following 'thematic' topics (e.g. urban hydrology, water transport and distribution). Describe how to exploit such interactions to enhance livability, sustainability and resilience of cities.
- 4 Argue that considering multiple aspects of the water systems could provide opportunities to add extra value and create substantial additional benefits related to water management projects. Estimate such benefits using toolkits. (ILO4:MultipleValues)
- 5 Illustrate the importance of 'mainstreaming' water sensitive elements to general urban development process. Describe concrete examples (real-world and hypothetical) of such mainstreaming. (ILO5: Mainstreaming)
- 6 Analyse the stakeholder involvement in the management of water in city. Argue that for effective embedding of water-sensitive features to urban development, stakeholders should also include traditionally 'non-water' domains. (ILO6:Stakeholders)
- 7 Reflect on the relationship of WSC principals and practice to existing cities and their sub-components (e.g. neighbourhoods). Propose (conceptual) next steps in moving towards a more water-sensitive state for a given concrete case-study. (ILO7:Vision)

### Assessments

%	Type	Name
50	Assignment	Case study reflection reports
25	Oral examination	
25	Presentation	

## Topics

## Study load

Nr	Topic	Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	Lecturers
	Total	0	0	0	0	0	0	0	0	

## Education Material

Lecture notes

Every year a set of scientific papers, reports and book chapters will be provided in addition to the slides used in the class.

## Scientific Software

# M3089

## Wetlands for Livelihoods and Conservation

<b>Term</b>	201617T10
<b>Coordinator</b>	E.M.A. Hes
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

Programme target group

### Prerequisites

Programme prerequisites

### Learning Objectives

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

### Assessments

%	Type	Name
10	Presentation	Group presentation
10	Attendance	Individual performance during fieldweek
80	Assignment	Individual written assignment

### Topics

- 1 **Ecosystem functions and services**
- 2 **Climate change as a driver of change in wetland management planning**
- 3 **Objective Oriented Planning**
- 4 **Stakeholder analysis and participatory approaches**
- 5 **Assignment**

## Study load

Nr	Topic	Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	Lecturers
1	Ecosystem functions and services	8	0	4	0	16	0	28	44	
2	Climate change as a driver of change in wetland management planning	8	0	4	0	0	0	12	28	
3	Objective Oriented Planning	2	0	16	0	16	0	34	38	
4	Stakeholder analysis and participatory approaches	2	0	14	0	8	0	24	28	
5	Assignment	0	2	0	0	0	0	0	2	
	<b>Total</b>	<b>20</b>	<b>2</b>	<b>38</b>	<b>0</b>	<b>40</b>	<b>0</b>	<b>98</b>	<b>140</b>	

## Education Material

## Scientific Software

# M2602

## Advanced Water Transport and Distribution

<b>Term</b>	201617T11
<b>Coordinator</b>	N. Trifunovic
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

Engineers and scientists with keen interest in modern methods, technologies and tools used in design, operation and maintenance of water transport & distribution networks.

### Prerequisites

BSc degree in Civil Engineering or similar; a few years of relevant experience; knowledge of steady-state hydraulics of pressurised flows; basic use of network models; good English command. Students without any WTD experience should first complete the module Water Transport and Distribution.

### Learning Objectives

- 1 distinguish between various sources of water quality problems in distribution networks; understand the basic corrosion mechanisms and suggest the list of preventive and reactive measures;
- 2 understand the theory of advanced hydraulic and water quality modelling; apply state-of-the-art network software for assessment of irregular operational scenarios and develop a reliability-based and cost effective design using computer model.
- 3 recognise the GIS and remote sensing technologies, and familiarise with the GIS-based techniques for sustainable planning and management of WTD systems;
- 4 understand the theory of transient flows, and plan the measures to prevent/control water hammer;
- 5 select modern tools for monitoring of operation, and planning of maintenance of WTD systems.

### Assessments

%	Type	Name
12	Assignment	GIS assignment on the exercise using ArcGIS
60	Written examination (closed book)	Multiple choice test covering theoretical aspects of (1) advanced water distribution modelling, (2) water quality and corrosion in distribution networks and (3) water hammer (20% each)
28	Assignment	Report on four short assignments regarding advanced water distribution modelling done in WaterGEMS software: (1) Network design using GA optimiser, (2) Network criticality analysis, (3) Water quality analysis,



## Topics

### 1 Water Quality in Distribution Networks

Corrosion of pipe materials, indices of measure, corrosion assessment, prevention and control, optimal water composition, principles of water quality modelling of distribution networks, modelling of chlorine residuals.

### 2 Advanced Water Distribution Modelling

Principles of genetic algorithm; pressure-driven demand calculations; network calibration; failure analysis and calculation of demand losses; economic aspects of capital investments and network operation.

### 3 GIS in Water Distribution

The aim of this course is to provide both a solid theoretical understanding and a comprehensive practical introduction of how to use geographic information systems and remote sensing technologies for the analysis and solution of water distribution related problems. The course focuses on the analysis of digital spatial data, preparation for numerical modelling, presentation of modelling results and support to the decision making process. The topics covered in the course include the following: introduction to geographic information systems and remote sensing technologies, active and passive remote sensing, data structures, map projections and coordinate systems, processing of digital geographic information, creation of digital elevation models, visualisation, mapping of water related features, delineation of pressure zone areas, digitisation, soil and land use mapping, map algebra, export of GIS layers into a modelling package, incorporation of modelling results in GIS.

### 4 Introduction to Water Hammer

Basic equations and applications; computer modelling: model building, simulations of simple cases (full pump trip, emergency shut down; protection devices: practical methods of surge suppression, direct action, diversionary tactics, choice of protection strategy.

### 5 Advanced O&M Practices in Water Distribution

Monitoring of network condition and operation; data collection and management; organisation of maintenance, emergency water supply, asset management plans, water company organisation.

## Study load

Nr	Topic									Lecturers
		Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	
1	Water Quality in Distribution Networks	6	0	0	0	0	4	10	30	N. Trifunovic, S Velickov, S.K. Sharma
2	Advanced Water Distribution Modelling	6	0	12	0	0	6	24	48	N. Trifunovic, S Velickov
3	GIS in Water Distribution	4	0	0	0	0	4	8	24	A. Sanchez Torres, Z. Vojinovic
4	Introduction to Water Hammer	6	0	4	0	4	0	14	26	N. Trifunovic, S Velickov
5	Advanced O&M Practices in Water Distribution	0	4	0	0	8	0	8	12	
<b>Total</b>		<b>22</b>	<b>4</b>	<b>16</b>	<b>0</b>	<b>12</b>	<b>14</b>	<b>64</b>	<b>140</b>	

## Education Material

Lecture notes

S.Sharma - Corrosion of Pipe Materials, lecture notes UNESCO-IHE 2009 (LN/0310/09/1)

**Scientific Software**  
WaterGEMS

# M2810

## Decentralised Water Supply and Sanitation

<b>Term</b>	201617T11
<b>Coordinator</b>	S.K. Sharma
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

Mid-career professionals, involved in planning and management aspects of decentralised, small-scale or low-cost water supply or sanitation systems, working for municipalities, universities, research institutes, government ministries, water supply agencies, NGOs and consultancies

### Prerequisites

MSc. programme entry requirements

### Learning Objectives

- 1 know different technologies/methods for small-scale water abstraction and water treatment that can be used at household or small community level
- 2 understand the basics of sustainable sanitation technologies including nutrient reuse in agriculture, soild waste management and fecal sludge management and their implementation in small towns, peri-urban and urban poor areas of developing countries
- 3 prepare concept design for small-scale water supply treatment and ecosan technology
- 4 facilitate planning, financing, implementation and operation and maintenance of decentralised water supply and sanitation infrastructures based on stakeholder participation and community management

### Assessments

%	Type	Name
30	Assignment	
10	Presentation	
60	Written examination (closed book)	

### Topics

#### 1 Introduction

Introduction to the module; Water Supply and Sanitation situations in small towns, peri-urban areas and urban poor areas. Rationale for decentralised water supply system

1.1 Module introduction

1.2 Introduction to decentralised water supply and sanitation

## Topics

### **2 Decentralised Water Supply and Treatment Systems**

Water Supply Systems (water sources, source selection, service levels, suitability of types of water supply systems under different conditions); Rainwater Harvesting (introduction, collection systems, advantages and limitations, design considerations). Small-scale Water Treatment Methods (design water treatment systems for small community or household. Roughing filtration, slow sand filters, small-scale disinfection)

2.1 Water supply systems

2.2 Rain water harvesting

2.3 Small-scale water treatment

### **3 Decentralised Sanitation Systems**

Ecological sanitation (introduction to ecosan approach; characteristics of urine, faeces and greywater; overview of technologies for ecosan; treatment aspects for urine, faeces and greywater; conventional on-site sanitation; storage and transport logistics; introduction to anaerobic treatment, composting and constructed wetlands; safe reuse of ecosan products in agriculture with WHO guidelines; financial institutional, social and policy aspects of ecosan). Faecal Sludge Management (treatment goals and standards, treatment options, faecal sludge management (planning, financial, economic, agronomic, institutional and legal aspects), transmission of excreta-related infections and risk management). Solid waste management in developing countries (technical and practical aspects of collection, transport, segregation, disposal and reuse)

3.1 Ecological sanitation

3.2 Solid waste management in small towns and urban poor areas

3.3 Sanitation planning and strategic tools

3.4 Fecal sludge management

### **4 Management Aspects of DWSS**

Participatory planning and evaluation of DWSS systems, demand responsive approach; Institutional arrangements (community based management; small-scale independent providers), Financial and Operational aspects (financing, cost recovery, operation and maintenance of DWSS systems)

4.1 Participatory planning and evaluation

4.2 Institutional arrangements

4.3 Financing and cost recovery aspects

4.4 Operation and maintenance aspects

### **5 Presentation of the Participants**

All participants make a presentation of 10 minutes in the field of decentralised water supply and sanitation in order to share experiences or problems they are facing now and learn from each others experience.

## Study load

Nr	Topic									Lecturers
		Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	
1	Introduction	0	0	0	0	0	0	0	0	S.K. Sharma
1.1	Module introduction	0	0	1	0	0	0	1	1	
1.2	Introduction to decentralised water supply and sanitation	2	0	0	0	0	0	2	6	
2	Decentralised Water Supply and Treatment Systems	0	0	0	0	0	0	0	0	S.K. Sharma
2.1	Water supply systems	3	0	0	0	0	0	3	9	
2.2	Rain water harvesting	2	0	2	0	0	0	4	8	
2.3	Small-scale water treatment	6	6	0	0	0	0	6	24	
3	Decentralised Sanitation Systems	0	0	0	0	0	0	0	0	
3.1	Ecological sanitation	6	0	2	0	4	0	12	24	M. Ronteltap
3.2	Solid waste management in small towns and urban poor areas	4	0	0	0	0	0	4	12	M.A. Siebel
3.3	Sanitation planning and strategic tools	2	0	2	0	0	0	4	8	
3.4	Fecal sludge management	2	0	4	0	0	0	6	10	M. Ronteltap
4	Management Aspects of DWSS	0	0	0	0	0	0	0	0	
4.1	Participatory planning and evaluation	2	2	0	0	0	0	2	8	M. Mulenga
4.2	Institutional arrangements	2	0	2	0	0	0	4	8	K.H. Schwartz
4.3	Financing and cost recovery aspects	2	0	2	0	0	0	4	8	
4.4	Operation and maintenance aspects	2	0	2	0	0	0	4	8	S.K. Sharma
5	Presentation of the Participants	0	0	6	0	0	0	6	6	S.K. Sharma
<b>Total</b>		<b>35</b>	<b>8</b>	<b>23</b>	<b>0</b>	<b>4</b>	<b>0</b>	<b>62</b>	<b>140</b>	

## Education Material

Handout

Schwartz, K. (2015) Institutional Arrangements (Handouts)

Handout

Siebel, M (2015) Solid Waste Management in Urban Poor Areas (Handouts)

## Scientific Software

# M2873

## Faecal Sludge Management

<b>Term</b>	201617T11
<b>Coordinator</b>	M. Ronteltap
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

This course is a specialist course fitting within Sanitary Engineering. It is designed for sanitary, civil / wastewater and environmental engineers who are facing challenges with faecal sludge. As on-site sanitation is by far the most applied sanitation technology, faecal sludge management is of paramount importance globally.

### Prerequisites

Preceding modules in Sanitary Engineering; an interest in and working knowledge of the business of faecal sludge management help to bring this module to a good end.

### Learning Objectives

- 1 Describe the way how excreta and faecal sludge are characterised.
- 2 Know which technologies can be applied for which type of faecal sludge (settling tanks, planted and unplanted drying beds, etc)
- 3 Name the key stakeholders in FSM.
- 4 Describe the relationship between sanitation and health.
- 5 Name the challenges in emergency sanitation and know how emergency sanitation can be addressed.
- 6 Be familiar with the latest developments in sustainable (on-site) sanitation solutions that can be applied in high density low income areas.

### Assessments

%	Type	Name
15	Assignment	
85	Written examination (closed book)	

## Topics

### 1 Faecal sludge management

Faecal sludge management (FSM) is incredibly important in sanitation. While the focus has been on the provision of toilets mainly in the light of the MDGs, the adequate collection and treatment of the remaining faecal sludge was not always a priority, to say the least. As so many factors play a role in faecal sludge management / climate, hardware, a vast number of stakeholders, willingness to pay, space to store and treat, groundwater pollution, different toilet types / a proper and well-functioning faecal sludge management system is hard to achieve. In this module we will address a holistic approach on FSM. There will be a focus on technology; however, technology cannot be seen separately from planning and management aspects; therefore, non-technical aspects will also be addressed in this module.

### 2 Public Health

### 3 Institutional Aspects

### 4 Collection and Transport

### 5 Emergency Sanitation

### 6 Co treatment

### 7 Sludge characterisation

### 8 Treatment Mechanisms

### 9 Operation and Maintenance

### 10 Financial Aspects

### 11 Slum sanitation

## Study load

Nr	Topic									Lecturers
		Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	
1	Faecal sludge management	0	0	0	0	0	0	0	0	
2	Public Health	6	0	0	0	0	0	6	18	
3	Institutional Aspects	4	0	4	0	0	0	8	16	
4	Collection and Transport	6	0	0	0	0	0	6	18	
5	Emergency Sanitation	4	0	0	0	0	0	4	12	C.M. Hooijmans
6	Co treatment	2	0	0	0	0	0	2	6	C.M. Lopez Vazquez
7	Sludge characterisation	2	0	0	0	0	0	2	6	M. Ronteltap
8	Treatment Mechanisms	6	6	0	0	0	0	6	24	M. Ronteltap
9	Operation and Maintenance	4	0	0	0	0	0	4	12	M. Mulenga
10	Financial Aspects	6	0	0	0	0	0	6	18	
11	Slum sanitation	2	0	0	0	0	0	2	6	M. Ronteltap
<b>Total</b>		<b>42</b>	<b>6</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>46</b>	<b>136</b>	

**Education Material**

Book Faecal Sludge Management Book (IWA; Editors Linda Strande, Mariska Ronteltap, Damir Brdjanovic)

Handout Handouts.

**Scientific Software**

SWMM  
sobek-RUR



# M3104

## Flood Protection in Lowland Areas

<b>Term</b>	201617T11
<b>Coordinator</b>	J.A. Roelvink
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

### Prerequisites

Basic knowledge of hydraulics, basic knowledge of soil mechanics

### Learning Objectives

- 1 carry out a basic design of dikes, revetments and closure dams
- 2 understand concepts and advances of flood risk management with due consideration of societal aspects, including flooding issues in the floodplain and coastal zone, management of flood risk, planning aspects and a variety of non structural measures
- 3 understand and apply concepts and advances in tools used for coastal flood modelling and flood forecasting
- 4 understand and apply the principles of flood frequency analysis and risk based approaches to design of hydraulic works
- 5 understand (the practical application of) probabilistic design theory

### Assessments

%	Type	Name
0,4	Written examination (closed book)	Dikes and Revetments (assignment, oral discussion)
0,2	Written examination (closed book)	Probabilistic Design
0,4	Assignment	Storm Impact Modelling

### Topics

#### 1 Dikes and Revetments

Seadikes in The Netherlands, philosophy of dike design, definition of frequency of failure, risk analysis, design methodology for dikes, hydraulic boundary conditions, wave run-up and overtopping, geometrical design of dikes and revetments, stability for rock, artificial units, design criteria for placed block revetment, other types (bituminous, asphalt.. etc), other design considerations, geotechnical aspects related to dikes, overall stability, design of granular filter, geotextiles, geosystems, improvement and maintenance of dikes and revetments, design of bottom protection, design methodology for closures; sand closures, stone closures, caisson closures.

#### 2 Dikes and Revetments

## Topics

### 3 Probabilistic design

Theoretical background of probability functions, practical application of probabilistic design, various levels of probability, examples of application of probabilistic design, the use of fault trees, exercise in the application of probabilistic design in coastal engineering problems.

### 4 Storm Impact modelling

This course focuses on prediction of flooding from the sea, due to tsunamis and storms. Subjects that are treated are causes, models, effects and warning systems related to tsunamis; storm types and characteristics in different areas in the world; storm surge and extreme wave modeling; storm erosion, overtopping and inundation modeling; predictive modeling vs. (probabilistic) modeling for design purposes. Case studies based on Katrina, Ivan, Sidr and the Indian Ocean tsunami. Hands-on exercises using Delft3D and XBeach.

### 5 Storm Impact modelling

## Study load

Nr	Topic								Lecturers	
		Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours		SUM: workload hours
1	Dikes and Revetments	8	0	4	0	0	0	12	28	C Dorst
2	Dikes and Revetments	12	0	0	0	0	0	12	36	JH van Dalen
3	Probabilistic design	6	0	6	0	0	0	12	24	M Kok
4	Storm Impact modelling	6	0	5	0	0	0	11	23	J.A. Roelvink
5	Storm Impact modelling	8	0	5	0	0	0	13	29	M van Ormondt
<b>Total</b>		<b>40</b>	<b>0</b>	<b>20</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>60</b>	<b>140</b>	

## Education Material

Handout	Groot, M.: Handouts, Geotechnical Aspects for Dikes, 2003
Handout	Handout: collection of tutorials and papers related to OpenEarth, Delft3D and XBeach applications
Handout	Hassan, R.M.: handouts, Dikes and Revetments, 2002
Lecture notes	Verhagen, H.J. : Design of closure of dams- Lecture notes In0052/02
Lecture notes	Verhagen, H.J.: Revetments, Sea Dikes and River Levees-Lecture notes hh292/99/1
Lecture notes	Vrijling, J.K.: Probabilistic Design, Lecture notes In0217/04/

## Scientific Software

Delft3D  
 Matlab  
 Xbeach

# M3001

## Hydroinformatics for Decision Support

<b>Term</b>	201617T11
<b>Coordinator</b>	A. Jonoski
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

Participants from all Master Programmes of UNESCO-IHE. The participants need to choose either *Software technologies for integration* OR *Flood resilience of urban areas and communities*.

### Prerequisites

Hydrological and hydraulic modelling concepts; Basic programming skills

### Learning Objectives

- 1 Understand the role of system analysis in water resources planning and management
- 2 Formulate and solve water resources problems as optimisation problems
- 3 Distinguish and properly use different types of decision support methods for water problems
- 4 Build simple software applications that integrate data and models across Internet OR Explain and analyse the key qualities of urban areas and communities that improve resilience for flooding
- 5 Understand the potential of newly available data sources (e.g. remote sensing, web resources, data generated from climate and meteorological models) in advanced integrated modelling and decision support

### Assessments

%	Type	Name
30	Assignment	Exercise report on Decision support systems
30	Assignment	Exercise report on Software technologies for integration OR Assignment Flood resilience
40	Assignment	Exercise report on Systems analysis in water resources

### Topics

#### 1 Systems analysis in water resources

Definition and role of systems analysis in engineering planning. Basic concepts. Linear and Dynamic programming for water resources problems. Development and use of static and dynamic stochastic simulation models of river systems. Introduction to decision support systems and their use. Exercises in multipurpose integrated river basin (or regional) water resources management modelling.

## Topics

### 2 Decision support systems

Introduction to decision making process; objectives and alternatives. Optimisation in decision support (single and multi-objective). Multi-attribute decision methods and tools: formulation of decision matrix, generating and using weights, compensatory and non-compensatory decision methods. Introduction to mDSS4 decision support software; exercises and assignments with case studies implemented in mDSS4.

### 3 Software technologies for integration OR Flood resilience of urban areas and communities

Introduction to methods and tools for software integration of models and data: Object-oriented integration approaches. Software integration across networks: Client-server programming, Web protocols, Web services. Technologies for integrating distributed resources: web-interfaces technologies; creating web-based and mobile phone applications with assignment exercise.

OR

Introduction to methods for explaining and analysing flood resilience: Manageability of flood impacts in an area. Set of adaptive capacities of a community. Preparedness and emergency response: Protection of critical infrastructure. Building community resilience. Flood insurance.

### 4 Integration of weather prediction and water models

Approaches and methods for integration of weather models with hydrological and hydraulic models. Integration of remote sensing data. Downscaling and upscaling issues.

## Study load

Nr	Topic	Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	Lecturers
1	Systems analysis in water resources	12	0	4	4	0	0	20	48	DP Loucks
2	Decision support systems	6	0	4	4	0	0	14	30	A. Jonoski, I.I. Popescu
3	Software technologies for integration OR Flood resilience of urban areas and communities	4	0	10	10	0	0	24	42	A. Jonoski, B. Gersonius, C. Zevenbergen, G.A. Corzo Perez, J.L. Alfonso Segura, J.S. Craven, K.A. Anema, S. Rath
4	Integration of weather prediction and water models	4	0	4	0	0	0	8	16	S.J. van Andel
Total		26	0	22	18	0	0	66	136	

## Education Material

Digital files	A. Jonoski, G. Corzo, L. Alfonso, J. Craven: Handouts - Software technologies for Integration exercises
Digital files	A. Jonoski: Introduction to Decision Making and Decision Support Systems (PowerPoint Slides)
Digital files	A. Jonoski: Software Technologies for Integration (PowerPoint Slides)
Digital files	B. Gersonius: Flood resilience of urban areas and communities (PowerPoint Slides)
Lecture notes	D.P. Loucks: Lecture Notes on Water Resource Systems Modelling: Its Role in Planning and Management (chapters 2, 3, 4, 10 and 11)
Handout	I.Popescu: Handout DSS exercises with mDSS4
Digital files	S.J van Andel: Integration of weather prediction and water models (PowerPoint Slides)
Digital files	Software for the subject Software technologies for integration: PMWin, Notepad++ text editor, Apache web server with PHP, Openlayers API, Phonegap

## Scientific Software

Lingo  
mDSS

# M2155

## IWRM as a Tool for Adaptation to Climate Change

<b>Term</b>	201617T11
<b>Coordinator</b>	E.D. de Ruijter van Steveninck
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

Programme target group (Participants in the programmes at IHE) and qualified short course participants.

### Prerequisites

Programme prerequisites (BSc in a topic appropriate to UNESCO-IHE programme) and basic knowledge of water management.

### Learning Objectives

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

### Assessments

%	Type	Name
30	Presentation	
70	Written examination (closed book)	

### Topics

- 1 **IWRM, climate change and the hydrological cycle**  
Introduction into the concept of IWRM. The climate system and the causes of climate change and variability. Impacts of climate change on the hydrological cycle. Integrating IWRM and climate change.
- 2 **Climate change: impacts and adaptation**  
Impacts of climate change on the environment and on water use sectors. Adaptation measures and economic aspects.

## Topics

### 3 Vulnerability and adaptation under uncertainty

What determines vulnerability to climate change. Adaptation strategies how to adapt under a high level of uncertainty.

### 4 Institutional aspects and stakeholder participation

The importance of involving stakeholders in water management and climate change adaptation and strategies on involving stakeholders.

### 5 Multi sector/multicriteria decision making

Modelling effects of climate change on water resources using Climateland as a case study.

### 6 Country presentations

Presentations by participants covering impacts of climate change and adaptation measures in their countries/ regions.

### 7 Field trip

Field trip to Dordrecht. Adaptation to climate change in an urban setting.

### 8 Examination

## Study load

Nr	Topic	Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	Lecturers
1	IWRM, climate change and the hydrological cycle	6	0	6	0	0	0	12	24	E.D. de Ruijter van Steveninck, S. Maskey
2	Climate change: impacts and adaptation	17	0	7	0	0	0	24	58	C.M.S. de Fraiture, E.D. de Ruijter van Steveninck, F van der Meulen, I.I. Popescu, P.D.A. Pathirana, T.Y. Stigter, Y. Jiang
3	Vulnerability and adaptation under uncertainty	4	0	2	0	0	0	6	14	A.H.M. Bresser, E.D. de Ruijter van Steveninck
4	Institutional aspects and stakeholder participation	0	0	6	0	0	0	6	6	J.S. Kemerink - Seyoum
5	Multi sector/multicriteria decision making	0	0	26	0	0	0	26	26	J.W. Wenninger, R.G.W. Venneker
6	Country presentations	0	0	3	0	0	0	3	3	E.D. de Ruijter van Steveninck
7	Field trip	0	0	0	0	6	0	6	6	B. Gersonius
8	Examination	0	0	3	0	0	0	3	3	
<b>Total</b>		<b>27</b>	<b>0</b>	<b>53</b>	<b>0</b>	<b>6</b>	<b>0</b>	<b>86</b>	<b>140</b>	

## Education Material

Lecture notes                      Lecture notes, power point presentations, background materials

**Scientific Software**  
WEAP



# M3077

## Modelling River Systems and Lakes

<b>Term</b>	201617T11
<b>Coordinator</b>	A. Cattapan
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

All participants in the WSE programme

### Prerequisites

Hydraulics & Basic mathematics

### Learning Objectives

- 1 Familiarize participants with structure of equations used to represent water phenomenas, numerical solution techniques and their representation in modelling systems and practical use of these.
- 2 Provide participants practical experience with standard models and develop an understanding of modelling in river and lake systems
- 3 Understanding rainfall run-off processes that will contribute to river flow and applying them to determine flow hydrographs as upstream conditions to a river
- 4 Develop critical assessment in assessing quality of model calibration and validation, verification and uncertainty

### Assessments

%	Type	Name
40	Assignment	This component is comprised of 3 components, assignments on modelling subjects of the module. (20%) Lake modelling + (10%) Hec-RAS modelling + (10%) Hec-HMS modelling
30	Written examination (closed book)	This component reffers to the Computational Hydraulics subject. (30%)
30	Written examination (closed book)	This component reffers to the hydrological and river modelling part of the course. (30%)

### Topics

#### 1 Computational Hydraulics

The course aims to introduce numerical aspects of modelling, so that students become aware of the limitations and characteristics of hydrodynamic numerical models. The course starts with a short overview of the differential equations used in hydraulics, principles of discretisation of shallow water equations in 1D and 2D. Further the concept of Courant number, stability and accuracy, will be introduced for both implicit and explicit schemes. Emphasis will be on river and lake applications and short wave propagation.

## Topics

### 2 Model quality assessment & uncertainty

Practical concepts for analysing quality of models used in modelling water resources. Techniques for calibration and validation. Sensitivity analysis and uncertainty estimation. Verification methods.

### 3 modelling river flow and corresponding hydrological run-off contributions

Description of rainfall run-off processes. Mathematical representation of flow processes both at catchment and river scales.

### 4 Modelling Applications: Hydrology

Practical experience with computational numerical models will be gained by students. The objective of this component will be the application of the theory gained in the theoretical components of the course using HEC-HMS for practical examples.

### 5 Modelling Applications: lakes

Practical experience with computational numerical models will be gained by students. The objective of this component will be the application of the theory gained in the theoretical components of the course.

### 6 Modelling Applications: rivers

Practical experience with computational numerical models will be gained by students. The objective of this component will be the application of the theory gained in the theoretical components of the course using HEC-RAS for practical examples.

## Study load

Nr	Topic									Lecturers
		Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	
1	Computational Hydraulics	6	0	8	0	0	0	14	26	I.I. Popescu
2	Model quality assessment & uncertainty	2	0	0	0	0	0	2	6	I.I. Popescu
3	modelling river flow and corresponding hydrological run-off contributions	2	0	0	0	0	0	2	6	I.I. Popescu
4	Modelling Applications: Hydrology	0	0	0	12	0	0	12	24	I.I. Popescu
5	Modelling Applications: lakes	4	0	0	14	0	0	18	40	FA Bastos da Cruz Martins
6	Modelling Applications: rivers	0	0	0	16	0	0	16	32	A. Cattapan
<b>Total</b>		<b>14</b>	<b>0</b>	<b>8</b>	<b>42</b>	<b>0</b>	<b>0</b>	<b>64</b>	<b>134</b>	

## Education Material

Handout	Handouts
Book	MOHID - Hydrodynamics user manual, 2009
Lecture notes	Martins, F., 2011: Modelling river and lakes using MOHID. UNESCO-IHE. Lecture notes
Lecture notes	Popescu, I., 2004: Differential Equations and Numerical Methods. UNESCO-IHE Lecture notes.

**Scientific Software**

HEC-HMS

HEC-RAS

Mohid

# M3027

## Remote Sensing, GIS and Modelling for Agricultural Water Use

<b>Term</b>	201617T11
<b>Coordinator</b>	P. Karimi
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

All WSE participants and from other programmes with specific interest.

### Prerequisites

General knowledge about GIS and remote sensing.

### Learning Objectives

- 1 Explain the use of modern tools as RS and GIS in combination with the use of computer models
- 2 Explain and use the principles of Surface Energy Balance in estimating Evapotranspiration
- 3 Reflect on the advanced applications of RS in irrigation management
- 4 Identify problems, constraints and potentials of lowland and flood prone areas for sustainable development
- 5 Discuss the design principles of the lowland, flood prone areas and polder water management systems
- 6 Reflect on the importance of environmental and socio-economic consideration in the low land and flood prone areas and prepare the operation and maintenance and management plans and options.

### Assessments

%	Type	Name
0,6	Assignment	Irrigation and remote sensing
0,25	Written examination (open book)	Low lands and flood prone areas
0,15	Assignment	Water system modeling & GIS

### Topics

#### 1 Water system modeling

Water management system of land and water development, the use of computer models in the design, operation and maintenance of hydraulic control structures, pumping stations, etc., calibration, verification and sensitivity analysis of the model, and hydraulic performance of the water management system. The use of GIS in analyzing and evaluating land suitability, drainability and irrigability of an area.

## Topics

### 2 Land use and Water in Flood Prone Areas

Basic principle of lowland and flood prone areas development; - to create optimal conditions for agriculture as well as urban; - components of polder water management systems; - to create an understanding of the consequences of applying certain infrastructural layouts and water management techniques; effect of sea level rise and land subsidence to lowland and flood prone areas; - design aspects of lowlands and flood prone areas; -operation, maintenance, socio-economic and environmental considerations of lowland and flood prone areas development; - modeling of polder water management systems

### 3 Remote sensing data for Agricultural Water Management

### 4 Remote sensing for Evapotranspiration assessment (SEBAL)

### 5 Remote sensing for irrigation performance assessment

### 6 Water productivity as a tool for design, management, and evaluation of irrigation systems

### 7 Remote Sensing for Water Accounting

## Study load

Nr	Topic									Lecturers
		Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	
1	Water system modeling	6	0	8	0	0	2	16	32	F.X. Suryadi
2	Land use and Water in Flood Prone Areas	8	0	0	0	0	0	8	24	F.X. Suryadi
3	Remote sensing data for Agricultural Water Management	4	0	2	0	0	0	6	14	X. Cai
4	Remote sensing for Evapotranspiration assessment (SEBAL)	6	0	4	0	0	0	10	22	J.D. van Opstal, P. Karimi
5	Remote sensing for irrigation performance assessment	2	0	4	0	0	0	6	10	P. Karimi
6	Water productivity as a tool for design, management, and evaluation of irrigation systems	2	0	2	0	0	0	4	8	X. Cai
7	Remote Sensing for Water Accounting	8	0	6	0	0	0	14	30	P. Karimi
<b>Total</b>		<b>36</b>	<b>0</b>	<b>26</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>64</b>	<b>140</b>	

## Education Material

- Book Man made lowlands, G.P. van de Ven (Ed), 2004
- Book Suryadi, 2010. GIS and computer modelling of Water Management Systems.
- Book Urban polder guideline, Vol 1,2, 3 and 4, UNESCO-IHE, 2009

## Scientific Software

# M1331

## Solid Waste Management

<b>Term</b>	201617T11
<b>Coordinator</b>	M.A. Siebel
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

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.

### Prerequisites

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

- 1 suggest options for waste reduction at source so as to reduce quantities of waste generated;
- 2 choose from an array of options to turn waste into economic goods;
- 3 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;
- 4 assess the impact of waste and waste management on other environmental compartments;
- 5 roughly assess financial consequences of proposed management aspects in SWM;
- 6 conceptually develop a solid waste management scheme for an urban area.

### Assessments

%	Type	Name
35	Assignment	All s together
60	Written examination (open book)	MOODLE multiple choice
5	Presentation	Presentation Participation in class or fora

### Topics

#### 1 Introduction

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

#### 2 Waste collection & stakeholders

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?

## Topics

3 Bioconversion processes

4 Composting & anaerobic digestion

5 Landfill processes

6 Landfill technology

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

7 Mechanical biological treatment

8 Incineration

9 Waste prevention & recycling

10 Finance & planning

11 Presentations

12 Assignments

13 Exam

## Study load

Nr	Topic									Lecturers
		Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	
1	Introduction	0	0	4	0	0	0	4	4	M.A. Siebel
2	Waste collection & stakeholders	1	0	9	0	0	0	10	12	M.A. Siebel, VS Rotter
3	Bioconversion processes	0	0	6	0	0	0	6	6	VS Rotter
4	Composting & anaerobic digestion	1	0	9	0	4	0	14	16	VS Rotter
5	Landfill processes	0	0	6	0	0	0	6	6	VS Rotter
6	Landfill technology	1	0	7	0	4	0	12	14	VS Rotter
7	Mechanical biological treatment	1	0	5	0	0	0	6	8	VS Rotter
8	Incineration	1	0	7	0	0	0	8	10	VS Rotter
9	Waste prevention & recycling	1	0	5	0	2	0	8	10	M.A. Siebel
10	Finance & planning	0	0	12	0	0	0	12	12	Abarca Guerrero
11	Presentations	0	0	4	0	0	0	4	4	M.A. Siebel, VS Rotter
12	Assignments	0	24	0	0	0	0	0	24	M.A. Siebel, VS Rotter
13	Exam	0	10	4	0	0	0	4	14	M.A. Siebel
<b>Total</b>		<b>6</b>	<b>34</b>	<b>78</b>	<b>0</b>	<b>10</b>	<b>0</b>	<b>94</b>	<b>140</b>	

## **Education Material**

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

## **Scientific Software**



# M3086

## Strategic Planning for River Basins and Deltas

<b>Term</b>	201617T11
<b>Coordinator</b>	J.G. Evers
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

Young and mid-career professionals (scientists, decision-makers) with a background in water management, environmental management, and / or watershed management.

### Prerequisites

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

- 1 Understand strategic planning concepts and principles
- 2 Describe social-physical relations and interdependencies, in particular among water and environmental systems, and socio-economic development
- 3 Use of the concepts of adaptive and strategic planning and design for developing river basin management and development plans.
- 4 Use Strategic Environmental Assessment (SEA) as a planning tool for developing sustainable river basin management and development plans.

### Assessments

%	Type	Name
50	Assignment	Case study
50	Written examination (closed book)	Written exam (closed book)

### Topics

#### 1 Introduction

In this session the participants are introduced to the modules learning objectives, learning activities , and the assessment (case study group assignment and written exam)

## Topics

### **2 River basins as socio-physical systems**

Human-water systems, driving forces and development dynamics, interdependencies of land use and development and water and environmental systems, complexity, cross-cutting models and modelling approaches, meta modelling.

### **3 Strategic planning and design for river basins and deltas**

Strategic planning versus programming and project planning; tiering; issues of scale; spatial quality and design, land use planning; design methods from plan development to implementation; river basin/delta governance issues.

Strategic impact assessment, including environmental (SEA), economic and social impact assessment

### **4 Dealing with Uncertainties**

Examples of key social, economic and physical uncertainties in river basin systems Concepts and methods for uncertainty identification and assessment, for system and policy design, and governance. This includes, for example, exploratory analysis, scenario planning, resilience and robustness, adaptive policy making and adaptation pathways. Uncertainties in strategic planning, concepts and methods for uncertainty identification and assessment, and for system and policy design. This includes, for example, exploratory analysis, scenario planning, resilience and robustness, and adaptive policy making.

### **5 Case study**

During the course, students will work on integrated application of the concepts, theories and methods introduced in this course on a case. A limited number of cases will be prepared, so that students can focus on a field of their interest. Case options may include deltas and/or basins with different characteristics, such as heavy urbanisation; flooding problems; drought and water scarcity, subsidence, pollution and water quality, etc.

## Study load

Nr	Topic	Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	Lecturers
1	Introduction	0	0	1	0	0	0	1	1	J.G. Evers, Y. Jiang
2	River basins as socio-physical systems	8	0	4	0	0	0	12	28	A. Mendoza - Sammet, J.G. Evers, W.A.H. Thissen, W.J.A.M. Douven, Y. Jiang
3	Strategic planning and design for river basins and deltas	8	0	4	0	0	0	12	28	A. Mendoza - Sammet, J.G. Evers, W.A.H. Thissen, W.J.A.M. Douven
4	Dealing with Uncertainties	8	0	4	0	0	0	12	28	A. Mendoza - Sammet, B. Gersonius, C. Zevenbergen, J.G. Evers, W.A.H. Thissen, W.J.A.M. Douven
5	Case study	0	55	0	0	0	0	0	55	A. Mendoza - Sammet, B. Gersonius, C. Zevenbergen, J.G. Evers, W.A.H. Thissen, W.J.A.M. Douven, Y. Jiang
<b>Total</b>		<b>24</b>	<b>55</b>	<b>13</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>37</b>	<b>140</b>	

## Education Material

Scientific journal	Additional reading materials
Lecture notes	Lecture Notes
Digital files	Lecture powerpoint slides

## Scientific Software

# M1568

## Urban Water Governance

<b>Term</b>	201617T11
<b>Coordinator</b>	T. Acevedo Guerrero
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

The module is elective, and therefore open to all students within the WM stream, but it will build on key concepts introduced in the Water Governance core module. Students who have not taken this previous module will be expected to do additional reading to familiarize themselves with necessary terms and concepts. This module is run on the style of a seminar class. Students will be required to do the majority of work (reading, assignments) outside of class. Class time will then be used to discuss and debate what students have learned through self-study.

### Prerequisites

Mandatory: High level of ability to read and discuss academic articles and book chapters in English; willingness to engage in social science theory and new conceptual frameworks; willingness to engage in cross-disciplinary discussions and applications.

Students outside the WM stream might take the module, but they will need to consult (have a short discussion with the coordinator) I am happily open to students registering in it from virtually any discipline. The key thing is that you love southern cities in all their speed and complexity. As AbdouMaliq Simone (in his 2004 epic *For the City Yet to Come*, p. 1) puts it: "African cities are works in progress, at the same time exceedingly creative and extremely stalled. In city after city, one can witness an incessant throbbing produced by the intense proximity of hundreds of activities: cooking, reciting, selling, loading and unloading, fighting, praying, relaxing, pounding, and buying, all side by side on stages too cramped, too deteriorated, too clogged with waste, history, and disparate energy, and sweat to sustain all of them. And yet they persist".

### Learning Objectives

- 1 Define key terms: the "urban", "urban waters", "governance", according to assigned readings, learning activities, and class lectures;
- 2 Identify implications of the above definitions for urban water governance (how to define and diagnose; identify stakeholders);
- 3 Analyze the ways in which urban waters channel the politics of the city in presented case studies.

### Assessments

%	Type	Name
30	Assignment	3 pre-class written assignments topics 1,2,3

30	Assignment	Final Essay
40	Assignment	Groupwork

## Topics

- 1 Introduction to the module**
- 2 Refresher: water governance**
- 3 Urban futures**  
What conditions characterize current and future urban conditions, in terms of ecological sustainability and social equity?
- 4 What is the urban?**  
How do we define the urban as something more than a spatial category, and what does thinking about the urban as a process imply for thinking about water?
- 5 Case study: planetary urbanization**
- 6 What is the Southern urban?**  
What is a southern urbanism; what conditions characterize processes happening in the global South; how do we need to think - and intervene - in Southern cities differently than in the North?
- 7 Case study: water in the southern city**
- 8 The politics of water in the southern city**
- 9 What then is urban water governance?**  
What are the implications for how we rethink the urban, and southern cities, for how we think about governing water in cities?
- 10 What then is urban water governance?**  
What are the implications for how we rethink the urban, and southern cities, for how we think about governing water in cities?
- 11 Tutorial**
- 12 Individual and group assignments**
- 13 Essay assignment**

## Study load

Nr	Topic	Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	Lecturers
1	Introduction to the module	1	0	0	0	0	0	1	3	M.E. Kooy
2	Refresher: water governance	1	0	0	0	0	0	1	3	M.E. Kooy
3	Urban futures	2	0	0	0	0	0	2	6	M.E. Kooy
4	What is the urban?	2	0	0	0	0	0	2	6	M.E. Kooy
5	Case study: planetary urbanization	2	0	0	0	0	0	2	6	
6	What is the Southern urban?	2	0	0	0	0	0	2	6	M.E. Kooy
7	Case study: water in the southern city	3	0	0	0	0	0	3	9	M.E. Kooy
8	The politics of water in the southern city	3	0	0	0	0	0	3	9	M.E. Kooy
9	What then is urban water governance?	2	0	0	0	0	0	2	6	M.E. Kooy
10	What then is urban water governance?	2	0	0	0	0	0	2	6	M.E. Kooy
11	Tutorial	0	1	0	0	0	0	0	1	
12	Individual and group assignments	0	48	0	0	0	0	0	48	
13	Essay assignment	0	30	0	0	0	0	0	30	
<b>Total</b>		<b>20</b>	<b>79</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>20</b>	<b>139</b>	

## Education Material

## Scientific Software

# M3048

## Water Sensitive Cities

<b>Term</b>	201617T11
<b>Coordinator</b>	P.D.A. Pathirana
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

All participants and external professionals dealing with urban water and flood risk management working for municipalities, water management organisation, consulting firms, educational institutions and NGOs.

### Prerequisites

BSc degree in Engineering or Social Sciences background; basic knowledge of urban water and flood risk management; good command of English.

### Learning Objectives

- 1 Describe the historical transition of cities from the viewpoint of water management. List salient features of that transition (both positive and negative). (ILO1:History)
- 2 Argue that the three main components of the urban water cycle (UWC) management are interdependent. Describe the interactions with other important aspects of UWC like groundwater, urban atmosphere, etc., and how they affect each. (ILO2:Integration)
- 3 Identify interactions between water system components, while following 'thematic' topics (e.g. urban hydrology, water transport and distribution). Describe how to exploit such interactions to enhance livability, sustainability and resilience of cities.
- 4 Argue that considering multiple aspects of the water systems could provide opportunities to add extra value and create substantial additional benefits related to water management projects. Estimate such benefits using toolkits. (ILO4:MultipleValues)
- 5 Illustrate the importance of 'mainstreaming' water sensitive elements to general urban development process. Describe concrete examples (real-world and hypothetical) of such mainstreaming. (ILO5: Mainstreaming)
- 6 Analyse the stakeholder involvement in the management of water in city. Argue that for effective embedding of water-sensitive features to urban development, stakeholders should also include traditionally 'non-water' domains. (ILO6:Stakeholders)
- 7 Reflect on the relationship of WSC principals and practice to existing cities and their sub-components (e.g. neighbourhoods). Propose (conceptual) next steps in moving towards a more water-sensitive state for a given concrete case-study. (ILO7:Vision)

### Assessments

%	Type	Name
50	Assignment	Case study reflection reports
25	Oral examination	
25	Presentation	

## Topics

## Study load

Nr	Topic	Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	Lecturers
	Total	0	0	0	0	0	0	0	0	

## Education Material

Lecture notes

Every year a set of scientific papers, reports and book chapters will be provided in addition to the slides used in the class.

## Scientific Software



# M3089

## Wetlands for Livelihoods and Conservation

<b>Term</b>	201617T11
<b>Coordinator</b>	E.M.A. Hes
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

Programme target group

### Prerequisites

Programme prerequisites

### Learning Objectives

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

### Assessments

%	Type	Name
10	Presentation	Group presentation
10	Attendance	Individual performance during fieldweek
80	Assignment	Individual written assignment

### Topics

- 1 **Ecosystem functions and services**
- 2 **Climate change as a driver of change in wetland management planning**
- 3 **Objective Oriented Planning**
- 4 **Stakeholder analysis and participatory approaches**
- 5 **Assignment**

## Study load

Nr	Topic	Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	Lecturers
1	Ecosystem functions and services	8	0	4	0	16	0	28	44	
2	Climate change as a driver of change in wetland management planning	8	0	4	0	0	0	12	28	
3	Objective Oriented Planning	2	0	16	0	16	0	34	38	
4	Stakeholder analysis and participatory approaches	2	0	14	0	8	0	24	28	
5	Assignment	0	2	0	0	0	0	0	2	
	<b>Total</b>	<b>20</b>	<b>2</b>	<b>38</b>	<b>0</b>	<b>40</b>	<b>0</b>	<b>98</b>	<b>140</b>	

## Education Material

## Scientific Software

# M3142

## Summer Course - Environmental and Social Management Systems for the Water Sector

<b>Term</b>	201617T12
<b>Coordinator</b>	A. Mendoza - Sammet
<b>Credit points</b>	1.000000000
<b>Specialization</b>	

### Target Group

The course is directed to professional interested in learning the basis of environmental and social management systems. This includes their application to improving the performance of water sector organizations, projects, and public or private organizations.

### Prerequisites

A basic understanding of these concepts is required as a foundation for the course

- Environmental Performance
- Environmental Impact
- Social Impact
- Mitigation measures

### Learning Objectives

- 1 Understand the principles of Environmental Management Systems (EMS), their evolution into Environmental and Social Management Systems (ESMS), and their application to improve the sustainable management of water resources and water development projects.
- 2 Describe differences and similarities between the key elements of an EMS and an ESMS, and explain the advantages that each one has for private and public water organizations.
- 3 Apply their learning to outline the elements of an ESMS for a water infrastructure development

### Assessments

%	Type	Name
1	Attendance	
1	Assignment	Draft Enviromental and Social Management system and plan

## Topics

### 1 Basis of Environmental Management Systems

Basic concepts in Environmental Management and environmental auditing

### 2 ESMS and sustainable development

Guidance for ESMS

- Role of ESMS to reduce and manage risks and impacts
- ISO standards for EMS, EMAS standard
- Development and International standards for ESMS

### 3 The Environmental and Social management Plan (ESMP): Applications of ESMS

From the EMS to the ESMP and follow-up

Examples of applications of ESMS/ESMP

- In the water sector and
- Project developments

### 4 Exercise

Drafting an ESMS for a case study

## Study load

Nr	Topic	Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	Lecturers
1	Basis of Environmental Management Systems	6	0	2	0	0	0	8	20	A. Mendoza - Sammet
2	ESMS and sustainable development	4	0	4	0	0	0	8	16	A. Mendoza - Sammet
3	The Environmental and Social management Plan (ESMP): Applications of ESMS	3	0	5	0	0	0	8	14	A. Mendoza - Sammet
4	Exercise	1	0	7	0	0	0	8	10	A. Mendoza - Sammet
Total		14	0	18	0	0	0	32	60	

## **Education Material**

Digital files

Handout

Journal articles and web resources

Lecture notes

## **Scientific Software**

# M3140

## Summer Course - Visual Methods for Water Communication

<b>Term</b>	201617T12
<b>Coordinator</b>	E. Fantini
<b>Credit points</b>	1.000000000
<b>Specialization</b>	

### Target Group

The course aims at offering an introduction to visual methods to students and water professionals with different backgrounds (engineering, social sciences, and natural sciences).

The course is trans-disciplinary since it builds not only on academic competences from different chairgroups (Water Governance, Hydro informatics, River Basin Development) but also on media and communication professionals.

### Prerequisites

Participants must have a smartphone (android or apple) capable of filming and a laptop for editing.

### Learning Objectives

- 1 The course aims at building students theoretical and practical skills to apply visual methods (photography and video) to communicate water issues related to their research or their professional work.
- 2 The course will equip students to communicate techno-scientific issues related to water to broader audiences and the general public.
- 3 The course will equip students to facilitate communication between different stakeholders involved in water governance and water conflicts by dint of visual tools (photos and documentary).

### Assessments

%	Type	Name
1	Attendance	
1	Presentation	Peer-evaluation: students will be invited to give feedback on the work of their peers during the public presentation of videos and photos.
1	Oral examination	Self-assessment: students will be invited to evaluate their own work and the overall course by dint of a video-box (a booth with a camera) where they can record their messages.

1	Presentation	Students will be assessed on the outputs of the workshops by the workshops coordinators.
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## Topics

### **E1 Special event: “Show and tell evening”**

Students will be invited to practice their presentation skills by sharing visual/artistic products to introduce their country and their work.

### **E2 Special event: Movie night**

Screening of video documentaries on water issues (in collaboration with

This event is organised in collaboration with "Let's talk about water" film festival and Filmhuis Lumen, and it will be open to the public.

### **E3 Special event: Final presentation**

Students will present and discuss their outputs (videos and photos) first in class and then during a session open to the public.

Courses activities, events and outputs will be shared through social media throughout the week.

### **L1 Introduction to participatory visual research on water governance**

The lecture will present the Photovoice, a participatory visual research method whose objectives are: (1) to enable people to record and reflect their community's strengths and concerns, (2) to promote critical dialogue and knowledge about important issues through large and small group discussion of photographs, and (3) to reach policymakers.

Photovoice method places the camera in the hands of research participants – usually small groups of maximum 20 persons - , asking them to take pictures about the matter of concern for at least one week. Pictures are later used to elicit information and reflection on participants' life experiences, both in individual interviews and group discussions, to raise awareness, trigger debate, and instigate social change. To these ends, visual outputs are often presented to the wider community or policy makers by dint of photo-exhibitions, publications or public events.

### **L2 Video as a tool for education in water governance**

### **L3 Video as a research tool on everyday waters in Mozambique**

### **L4 Visualisation for water communication**

## Topics

### **L5 Water from Above: how changing the viewing perspective let you understand reality from a different perspective**

The use of Unmanned Aerial Vehicles (UAV) or Commercial Drones has revolutionized the aerial photography and videography in recent years. It is used by Human Rights Associations as well as Environmental groups, Journalists and Natural Resource Managers among others. During this seminar you will learn the basics, potential and limitations of this technology and you will play with some data that have been collected by the Lecturer.

### **W1 Photovoice**

Student will apply the Photovoice methods to document and reflect on everyday water issues in Delft.

Output: a photo exhibition/presentation.

### **W2 Video storytelling**

Students will learn to report, shoot and edit short video stories.

Output: short videos designed specifically for the web.

Coordinator: Roland Postma (Ventoux-The Flow of Water)



## Study load

Nr	Topic	Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	Lecturers
E1	Special event: "Show and tell evening"	0	0	2	0	0	0	2	2	
E2	Special event: Movie night	0	0	3	0	0	0	3	3	
E3	Special event: FInal presentation	0	0	3	0	0	0	3	3	
L1	Introduction to participatory visual research on water governance	2	0	0	0	0	0	2	6	E. Fantini
L2	Video as a tool for education in water governance	2	0	0	0	0	0	2	6	J.S. Kemerink - Seyoum
L3	Video as a research tool on everyday waters in Mozambique	2	0	0	0	0	0	2	6	M. Rusca
L4	Visualisation for water communication	2	0	0	0	0	0	2	6	J.S. Craven
L5	Water from Above: how changing the viewing perspective let you understand reality from a different perspective	2	0	0	0	0	0	2	6	P. Paron
W1	Photovoice	0	0	4	0	0	0	4	4	E. Fantini
W2	Video storytelling	0	0	9	0	8	0	17	17	
<b>Total</b>		<b>10</b>	<b>0</b>	<b>21</b>	<b>0</b>	<b>8</b>	<b>0</b>	<b>39</b>	<b>59</b>	

## Education Material

## Scientific Software

# M3139

## Summer Course - Water Accounting Plus for Standardized Reporting of Water Resources in River Basins

<b>Term</b>	201617T12
<b>Coordinator</b>	E. Salvadore
<b>Credit points</b>	1.000000000
<b>Specialization</b>	

### Target Group

25-30 participants.

Academic IHE-Delft students and external participants from national and international, public and private water sector.

### Prerequisites

Basic knowledge of hydrology, GIS.

Knowledge of Remote Sensing can be an advantage.

### Learning Objectives

- 1 Becoming familiar with the concept of Water Accounting, and specifically with the Water Accounting Plus framework
- 2 Gain knowledge existing open access databases for (RS) water related data
- 3 Being able to perform simple spatial calculations (using QGIS for Water Accounting)
- 4 Learn how to compute water productivity
- 5 Being able to understand (interpret) the WA+ accounting sheets. How can I use WA+ fact sheets to support IWRM
- 6 Being able to understand and use Water-Pix (pixel-based RS water balance tool)
- 7 Learn how to separate evapotranspiration (ET) into green and blue ET

### Assessments

%	Type	Name
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## Topics

### 1 **FUNDAMENTAL CONCEPTS OF WATER ACCOUNTING PLUS (WA+)**

Introduction to the need of an open access data. Discussion of the power of having verified information on water budgets for water policy negotiations and water management in general. Introduction to the Water Accounting Plus system. Fundamental concepts: water balance, green and blue water consumption, Budyko theory, explain coupled radiation - energy - water - carbon balances, consumptive and non-consumptive use, return flows, atmospheric moisture recycling. Theory and excel exercises (ET separation, water budget, green and blue water).

### 2 **ACCOUNTING SHEETS AND SPATIAL DATA**

Group discussion on major challenges in water management. Computational steps of the Water Accounting Plus framework. Sheet 1,2 and 3: theory, exercise and group discussion. Discuss exploitable, available, utilized, non-utilized and utilizable flows in river basin. Introduction to earth observation science and the progress achieved on spatially identifying hydrological processes (rainfall, evapotranspiration, soil moisture, water levels, land use, net primary production) and water management (withdrawals, irrigation, drainage) from satellite measurements. Hands-on QGIS. DEMO on spatial data platform from where water resources related information can be collected. Introduction to the case study: Tonle Sap basin (Cambodia), QGIS exercise: coordinate reference system, basic statistics per land use using Remote Sensing Data

### 3 **ACCOUNTING SHEETS AND SPATIAL DATA (QGIS HANDS-ON)**

Sheet 4, 5, 6, 7, and 8: theory, exercises and group discussion. Spatial data analysis: QGIS hands-on exercises (bias correction of Remote Sensing Precipitation, ET separation into green and blue water, ET partitioning into beneficial and non-beneficial, Remote Sensing vegetation data)

### 4 **WATER PRODUCTIVITY AND HYDROLOGICAL MODELING**

Introduction to Water Productivity. Exercises on: Net Primary Production, accumulated biomass production and crop yield, biomass water productivity and crop water productivity (target values). Hydrological modelling of the earth systems with and without remote sensing assimilation. Exercise on soil moisture and surface runoff. Introduction to Water-Pix, pixel-based water balance, groundwater recharge and abstraction, exercises.

### 5 **CASE STUDY, DISCUSSION AND CLOSING REMARKS**

Group work: prepare and discuss Sheet 1, Sheet 2 and Sheet 3 for the Tonle Sap basin, accounting sheets interpretation and scenario analysis. Discuss the services and benefits from water depletion, including agricultural and ecosystem services. Discuss sustainability of basin current and future conditions. Link these processes to water flows and fluxes. DEMO: water accounting software repository (GitHub). Closing remarks and final group discussion

## Study load

Nr	Topic	Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	Lecturers
1	FUNDAMENTAL CONCEPTS OF WATER ACCOUNTING PLUS (WA+)	8	0	0	0	0	0	8	24	C.I.B. Michailovsky, E. Salvadore, W.G.M. Bastiaanssen
2	ACCOUNTING SHEETS AND SPATIAL DATA	8	0	0	0	0	0	8	24	C.I.B. Michailovsky, E. Salvadore, H.M. Coerver, W.G.M. Bastiaanssen
3	ACCOUNTING SHEETS AND SPATIAL DATA (QGIS HANDS-ON)	8	0	0	0	0	0	8	24	C.I.B. Michailovsky, E. Salvadore, H.M. Coerver, W.G.M. Bastiaanssen
4	WATER PRODUCTIVITY AND HYDROLOGICAL MODELING	0	0	0	0	0	0	0	0	E. Salvadore, G.E. Espinoza Davalos, J.D. van Opstal
5	CASE STUDY, DISCUSSION AND CLOSING REMARKS	8	0	0	0	0	0	8	24	C.I.B. Michailovsky, E. Salvadore, H.M. Coerver, W.G.M. Bastiaanssen
<b>Total</b>		<b>32</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>32</b>	<b>96</b>	

## Education Material

Handout	Accounting Sheets for the group exercise
Lecture notes	presentations and notes explaining the exercises
Digital files	various Remote Sensing spatial data

## Scientific Software

QGis

# M3161

## Groupwork WM

<b>Term</b>	201617T13
<b>Coordinator</b>	J. Susnik
<b>Credit points</b>	5.000000000
<b>Specialization</b>	Core Program

### Target Group

This module is required for all participants in the Water Management programme. Participants of the WQM specialisation may, however, choose to participate in the group work of the Environmental Science.

### Prerequisites

Bachelor`s degree. Basic computer skills (MS-Windows, Office) Good English command. Participation in the WM Fieldwork.

### Learning Objectives

- 1 Use data from a variety of sources in order to answer research questions relating to water management issues in specific locations in the Andarax Basin from a number of perspectives
- 2 To use appropriate assessment to judge the potential of many possible solutions for decision making, taking into account the local context
- 3 To address research questions in the context of a multidisciplinary team, accounting for many viewpoints held by different members
- 4 develop a synthesis report on a specific problem identified as part of the WM09 fieldtrip
- 5 present main findings to a group, and be able to argue for selected solutions for the issues identified

### Assessments

%	Type	Name
50		Group report, in accordance with the Terms of Reference
50	Assignment	Individual component (specific ToR, critical self-reflection, observation).

### Topics

- 1 Introduction and presentation of the Groupwork tasks
- 2 Using multicriteria analysis for decision making
- 3 Draft group presentations

## Study load

Nr	Topic									Lecturers
		Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	
1	Introduction and presentation of the Groupwork tasks	0	0	0	0	0	0	0	0	
2	Using multicriteria analysis for decision making	0	0	0	0	0	0	0	0	
3	Draft group presentations	0	0	0	0	0	0	0	0	
Total		0	0	0	0	0	0	0	0	

## Education Material

## Scientific Software

# M2169

## MSc Preparatory Course and Thesis Research Proposal for WM

<b>Term</b>	201617T14
<b>Coordinator</b>	M.E. Kooy
<b>Credit points</b>	9.000000000
<b>Specialization</b>	Core Program

### Target Group

This module is available to all WM participants. It is also open to participants of the WQM specialisations who started under the Environmental Science programme.

### Prerequisites

The successful completion of at least 9 of the first 11 modules of the Water Management Programme.

### Learning Objectives

- 1 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
- 2 List available literature and replicate main arguments expounded in the literature on the specified research topic
- 3 Demonstrate analytical problem-analysis skills and the ability to distil the strategic issues to be addressed in the research phase
- 4 Plan, using the project management approach, 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 st
- 5 Develop and formulate the research proposal in a clearly written, well argued and convincing report, submitted within a set deadline
- 6 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

### Assessments

%	Type	Name
100	Assignment	Research proposal

## Topics

### 1 MSc preparatory course

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

Proposal development and formulation - 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.

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

### 2 writing proposal

#### Study load

Nr	Topic									Lecturers
		Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	
1	MSc preparatory course	16	8	0	0	0	0	16	56	M. Rusca
2	writing proposal	0	196	0	0	0	0	0	196	
Total		16	204	0	0	0	0	16	252	

#### Education Material

#### Scientific Software



# M2927

## MSc research, thesis and defence

<b>Term</b>	201617T15
<b>Coordinator</b>	E.A. de Jong
<b>Credit points</b>	36.000000000
<b>Specialization</b>	Core Program

### Target Group

All students of the MSc programmes

### Prerequisites

### Learning Objectives

- 1 Explore the background of the research problem by critically reviewing scientific literature; Evaluate relevant theories and applying these theories to a relevant scientific problem; Assure adequate delineation and definition of the research topic
- 2 Formulate research questions and hypotheses
- 3 Conduct research, independently or in a multidisciplinary team by selecting and applying appropriate research methodologies and techniques, collecting and analysing data.
- 4 Formulate well-founded conclusions and recommendations based on a comprehensive discussion of the results.
- 5 Demonstrate academic attitude and learning skills (incl thinking in multidisciplinary dimensions & distinguishing main issues from minor ones), to enhance & keep up-to-date the acquired knowledge and application skills in a largely independent manner.
- 6 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.

### Assessments

%	Type	Name
100	Presentation	Defence

### Topics

## Study load

Nr	Topic	Lecture	Assignment	Exercise	Lab session and report	Fieldtrip	Design Exercise	SUM: contact hours	SUM: workload hours	Lecturers
	Total	0	0	0	0	0	0	0	0	

## Education Material

## Scientific Software