

ITC STUDY GUIDE 2009/2010

**Master of Science degree and
Postgraduate diploma courses
in Geo-information Science and
Earth Observation for**

**Water Resources and
Environmental Management**

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Master of Science course code : C09-WREM-MSc-01
Postgraduate diploma course code : C09-WREM-PG-01

Foreword

Dear course participants,

Welcome to ITC.

Having left your family and country, you have come to ITC to further your education. We hope that the course you have selected will fulfil your expectations.

A major change will take place during your studies at ITC. From 1 January 2010 ITC will become a faculty of the University of Twente (UT). Hence, ITC students will receive an UT degree from that date onwards. ITC education, however, will continue to be offered at the present location of our Institute.

Education at ITC is characterised by:

- a modular set-up,
- a mixture of theory and practice, often including participants' own experiences
- a core curriculum for Remote Sensing (RS) and Geo-information Systems (GIS), common to all programmes, and
- choice options according to individual (research) interest and/or the needs of your own organisation.

We are pleased to present you this study guide for the 2009/2010 Postgraduate diploma and Master of Science degree programmes offered full-time at ITC Enschede. This study guide gives you information on the courses, an overview of the modules and the detailed content of the course modules. ITC is continuously modifying its courses to the needs of its students and their organisations.

Description of all elements of education at ITC and the descriptions of the modules of other courses are available on the ITC website (<http://www.itc.nl/education/courses/modules.aspx>).

But there is more to life at ITC than only education. You have arrived at an Institute with more than 400 students from over 70 countries. Furthermore, also ITC staff is originating from more than 25 countries: a truly international environment where you will be able to meet colleagues from all over the world. ITC is organising all sorts of social, cultural and sports activities. Well-known are the International Sports Tournament, the International Food Festival and the International Cultural Event. We would like to encourage you to participate in many if not all of these events and to make new friends in the process.

We will do our best to provide you with the quality of education that you expect from our Institute.

We wish you the best of success during your studies and a pleasant stay at ITC and in the Netherlands.

Prof. Dr. Ir. M. Molenaar, Rector ITC

**Introduction to the Master of
Science degree and the
Postgraduate diploma
programmes**

1. Introduction to the Master of Science degree and the Postgraduate diploma programmes

1.1 Curriculum

Master of Science

The duration of the Master of Science (MSc) degree programme is 18 months.

The MSc degree programme in Geo-Information Science and Earth Observation consists of eight courses, each with a specific orientation:

- Applied Earth Sciences
- Environmental Modelling and Management
- Geoinformatics
- Governance and Spatial Information Management
- Land Administration
- Natural Resources Management
- Urban Planning and Management
- Water Resources and Environmental Management

At successful completion of the Master of Science degree programme, the student is able to:

1. Analyse problems encountered in professional practice and develop appropriate methods for studying and/or solving these problems.
2. Apply appropriate methods for collecting, acquiring and verifying spatial data.
3. Use geo-information science and earth observation to generate, integrate, analyse and display spatial data.
4. Evaluate and apply relevant and appropriate methods and models for data analysis and problem solving.
5. Apply research skills to formulate and carry out an independent research project.
6. Communicate and defend findings of thesis work.

These objectives at programme level are worked out into objectives at course and module level. For more information on these, please check the domain specific part of this study guide or the module descriptions.

Successful completion of the MSc degree programme provides graduates with a qualification that enables them to continue to PhD level, either in the Netherlands or abroad.

All Master of Science degree courses lead to a degree with the title:
"Master of Science in Geo-Information Science and Earth Observation".

Postgraduate diploma

The nine month Postgraduate diploma course caters for young and mid-career professionals who need to be proficient in applying geo-information science and earth observation in their field of interest, analysing problems and applying new methods and techniques, and managing (multi)disciplinary scientific teams. The Postgraduate diploma course is equal to the taught part of the MSc course.

Postgraduate diploma courses are offered in:

- Applied Earth Sciences
- Geoinformatics
- Land Administration
- Natural Resources Management
- Urban Planning and Management
- Water Resources and Environmental Management

At successful completion of the Postgraduate diploma course, the student is able to:

1. Analyse problems encountered in professional practice and develop appropriate methods for studying and/or solving these problems.
2. Apply appropriate methods for collecting, acquiring and verifying spatial data.
3. Use geo-information science and earth observation to generate, integrate, analyse and display spatial data.
4. Evaluate and apply relevant and appropriate methods and models for data analysis and problem solving.

These objectives at course level are worked out into objectives at course and module level. For more information on these, please check the domain specific part of this study guide or the module descriptions.

The Postgraduate diploma course leads to a Diploma with the title:

"Postgraduate diploma in Geo-Information Science and Earth Observation"

1.2 Course Structure

All ITC courses are divided into three week periods (modules) or multiples of three weeks (blocks) in which one subject or related subjects are taught. The Postgraduate Degree programme is taught together with the MSc programme during the first nine months.

ITC's core business is the collection and handling of geo-information and its application in various fields involved in sustainable resource development. ITC has given its core business a prominent place in the courses. The first modules in all degree courses contain ITC's core curriculum: (at least) three weeks of these core modules are spent on Geographic Information Systems (GIS) and (at least) three weeks are spent on Remote Sensing. In addition to these core modules all programmes offer more advanced modules in geo-information and earth observation techniques that vary per course.

The Master of Science programme is split up in four *blocks*. The Postgraduate diploma programme is equal to the MSc programme during Block 1 and 2. MSc and PGD students follow these blocks together in class.

Figure 1

Structure of MSc and PGD programmes

Block 1 Principles of RS and GIS (4 modules)	Block 2 Scientific domain (6 modules)	Block 3 Research profile (5 modules)	Block 4 Individual MSc research (8 modules)
MSc programme →			
PGD programme →			

Figure 2

**Master of Science degree and Postgraduate diploma programmes
Structure in detail**

			MSc	PGD
Block 1	1	Introduction, Principles of RS and GIS, Application in domain		
	2			
	3			
	4			
Block 2	5	Domain modules, different per course (AES, GFM, GSIM, LA, NRM, UPM, WREM)		
	6			
	7			
	8			
	9			
	10			
Block 3	11	Research skills		Final assignment
	12	Advanced subjects		
	13			
	14	Research themes, MSc proposal		
	15			
Block 4	16	Individual MSc research	MSc thesis	
	17			
	18			
	19			
	20			
	21			
	22			
	23			

Block 1: Principles of GIS/RS

Block 1 is the common core of all ITC educational programmes. It teaches the basic principles of Remote Sensing and GIS, and how these can be applied in various domains. This common core ensures a basic level of GIS and RS for all students, regardless of their background and experience. Block 1 also contains an introduction to the course as a whole and the teaching approach, and a student advisor is assigned to each student.

Block 2: Domain

Block 2 is specific for the different courses within ITC MSc programme (AES, GFM, GSIM, LA, NRM, UPM, WREM). In this block the basic principles of the domain and application of GIS and RS in it are taught and deepened. Please look at the course specific parts of this study guide to find out more about the content of Block 2 in your course. Students need to select an MSc thesis topic in this block and work this out in an MSc pre-proposal. An MSc day and MSc fair are organised to support this.

Block 3: Research profile

Block 3 prepares the student for his/her MSc research by offering learning opportunities on research skills, advanced research tools and methods, and deepening of research topics.

It starts with a module on research skills. The module is similar for all courses. The objectives are common, but examples and cases are used from the scientific domain of each course. Two MSc supervisors are assigned to each student.

The second part contains "advanced topics". These topics go in-depth in a certain research method or tool. These have a more generic nature and are supposed to attract students from different domains. Students have to make a choice from these advanced topics, which match to their envisaged MSc thesis topic. Because of the advanced level, entry requirements may be defined for the advanced topics.

The third part of this block is assigned to the ITC research themes. Students have to formulate their MSc thesis topic within one of ITC research themes. In the last two modules students will study state-of-the-art knowledge and research in these themes in a group research assignment. Parallel to this, the student will work on his/her final MSc thesis proposal. The student has to make a choice for a certain research theme, based on his envisaged MSc thesis topic.

Block 4: Individual MSc research

In Block 4 the student works individually on his/her MSc thesis. It is required to have an approved MSc research proposal before entering this block. During this block there is interaction with the staff, PhD and MSc students of the research theme, for example in *capita selecta*. Each student will be assigned 2 MSc supervisors. Formal assessment will be given at the mid-term presentation and of course the final MSc exam (see MSc regulations).

1.3 Academic Profile

The academic profile of the MSc programme puts strong emphasis on the scientific discipline, a scientific approach, basic intellectual skills, co-operation and communication and the temporal and social context of research. The emphasis on doing research and/or designing or developing new methods or techniques depends on the application domain.

Multi-disciplinary research is an important focus for the MSc programme because (applied) research in practice seldom concerns one discipline but is more likely to be multidisciplinary. Students have to be prepared for that. Starting with a sound basis in their own domain they will be brought into learning situations in which students from different domains work together. It should be noted that most if not all research at ITC is

already multidisciplinary in nature. This is evident in the wide scope of expertise within departments, and the common denominator to carry out applied research contributing towards development related issues as specified in ITC's mission.

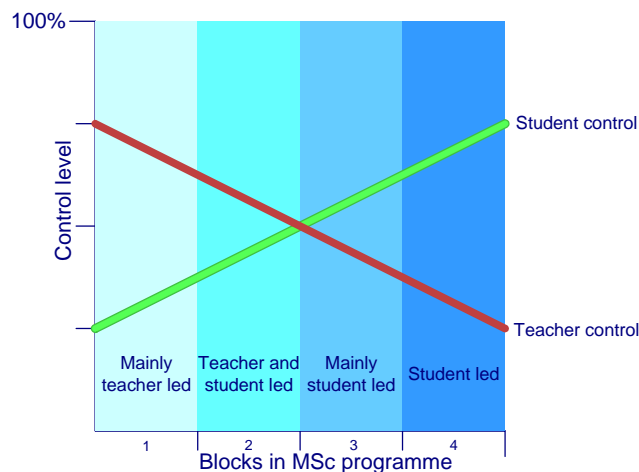
1.4 Teaching Approach

In their profession, the graduates have to apply knowledge and skills independently. The MSc programme is therefore focused at handing over the control of the learning process to the student. At the beginning of the programme, the teacher will have the main control and the programme will contain some choices, especially concerning preparation for the MSc research.

The choices should be motivated, fit to the envisaged research trajectory, and be accepted by the course director. During the programme the teacher role will develop towards the role of advisor. The student takes the lead in his/her own learning process by developing his/her own learning plan within the MSc framework and guidelines. The teacher supports this as a coach (while still passing on his/her experience).

Figure 3

Handing over control from the teacher to the student



Block 1: Mainly Teacher Led

In Block 1 the teacher takes the lead. He/she defines the content to be studied and learning tasks and exercises which have to be executed. Students can make limited choices between learning strategies and learning tasks. The number of contact hours between teacher and students is relatively large in this stage, mainly consisting of lectures and supervised practical exercises. Each student will be assigned a student advisor in Module 1 for advice on study related matters, especially the choice trajectory towards the MSc topic selection, but also for day-to-day problems, remedial self-study, etc. The student advisor is assigned for the whole MSc course.

Block 2: Teacher and Student Led

In Block 2 both the teacher and the student take the lead. The teacher defines the framework in which the student can make his/her own choices about study tasks. The amount of choice options varies across the different courses (or streams). The student has to start thinking about his/her MSc research topic and consult staff about its feasibility.

The number of contact hours between teacher and students is reduced in favour of group work and independent study and assignments.

Block 3: Mainly Student Led

In Block 3 the student takes control by choosing advanced subjects and a research theme which fit within his/her MSc thesis topic. The student works on the final version of MSc research proposal and consults his student advisor and other specialised staff about its feasibility and quality. The final version of the MSc research proposal has to be presented and defended by the student for the Thesis Admission Committee. The number of contact hours between teacher and student is further reduced to make room for independent study by the student. Two MSc supervisors (first and second) are assigned for MSc supervision at the beginning of Block 3.

Block 4: Student Led

In Block 4 the student works individually and independently on his/her MSc research project. This will be supported by meetings with the MSc supervisors and *capita selecta* meetings, organised by the research themes. The student is responsible for progress and quality of his/her own research project and its defence at the end.

The number of contact hours between teacher and students is reduced to a minimum in this period. It is therefore wise to look for peer support and peer review opportunities in this phase, which is offered in the research theme where staff, PhD and MSc students are together.

1.5 Roles within the Curriculum

Course Director

The course director is authorised by and accountable to the Head Education regarding development and implementation of all courses within a specific domain and their specialisations. The course director is responsible for execution of the courses, including logistic aspects, fieldwork, purchase of all materials, the administration of information regarding students and their study results, diplomas and course records, and course content archiving.

Course Secretary

The course secretary supports the execution of the course and the course director. She is the first point of contact for students requiring information regarding the course.

Module Coordinator

Each module is coordinated by a staff member. He or she is responsible for the organisation and execution of the entire module. The module coordinator can be contacted for information or questions regarding the module he/ she is responsible for.

Student Advisor

Each student is assigned a student advisor who can help him or her with study related problems and questions. In many courses, the course director has the role of student advisor.

Supervisor

Each MSc student will be assigned to a supervisor for the development of their research proposal and the execution of their thesis research.

Thesis Admission Committee

MSc students have to develop a research proposal for their thesis and defend this to the Thesis Admission Committee at the end of Module 10 of the MSc programme. The Thesis Admission Committee decides whether the research proposal is acceptable to ITC and complies with (inter)national standards. A positive decision of the Thesis Admission Committee grants the MSc student entrance to Block 4 of the MSc programme.

Thesis Assessment Board

The Thesis Assessment Board is responsible for the assessment of the MSc thesis at the end of the MSc degree programme.

Academic Board

The Academic Board, consisting of all professors of ITC, is amongst other tasks, responsible for the curriculum and quality assurance of education.

1.6 Study Load

The European Union has developed a European Credit Transfer System (ECTS) to allow easy comparison of study load of courses within Europe. ITC has adopted this system as a means of improving academic recognition for study abroad. In ECTS, 60 EC credits represent the workload of an academic year of study. These include lectures, practical work, seminars, tutorials, fieldwork, and self study. At ITC, each module of three-week duration has a study load of 5 EC. The MSc course consists of 23 modules and three additional weeks of remedial teaching, catch-up activities and graduation ceremonies, totalling 118 EC. The Postgraduate diploma course consists of 12 modules and 1 week of remedial teaching, and catch-up activities, totalling 61 EC.

1.7 Opening Hours of ITC Facilities

ITC building	
Monday-Thursday	07:30 - 22:30
Friday	07:30 - 21:00
Saturday	09:00 - 17:00

Bookshop (room 0-006)	
Monday-Friday	08:30 – 12:15 12:45 – 16:30

Library (room 3-038)	
Monday, Thursday, Friday	08:30 - 17:00
Tuesday, Wednesday	08:30 – 21:00

Audio-Visual centre (room 3-039)	
Monday, Thursday, Friday	08:30 - 17:00
Tuesday, Wednesday	08:30 – 21:00

Students' financial administration desk (room 1-130)	
Monday-Friday	10.30 – 13.30

Computer helpdesk (room 1-004)	
Monday-Friday	08:30 - 12:45 13:30 – 17:00

Restaurant (ground floor)	
Monday-Friday	
Coffee break free coffee/tea	10:15 – 10:45
Lunch	12:00 - 13:30
Tea break free coffee/tea	15:15 – 15:45

1.8 Starting dates of modules and holidays

Module number	2009 / 2010 / 2011
<i>Registration Master + MSc + PGD</i>	<i>Monday, September 14, 2009</i>
<i>Opening Academic Year</i>	<i>Thursday, September 24, 2009</i>
Module 1	September 28 through October 16
Module 2	October 19 through November 6
Module 3	November 9 through November 27
Module 4	November 30 through December 18 RS exam: Friday, 6 November 2009 GIS exam: Friday, 27 November 2009 re-sit exam RS: Wednesday, 9 December 2009 re-sit exam GIS: Wednesday, 16 December 2009
<i>Diēs Natalis ITC</i> <i>Christmas break</i>	<i>Thursday, December 17, 2009</i> <i>December 21, 2009 through January 3, 2010</i>
Module 5	January 4 through January 22, 2010
Module 6	January 25 through February 12
<i>MSc day</i>	<i>Wednesday, January 27, 2010</i>
Module 7	February 15 through March 5
Module 8	March 8 through March 26
<i>MSc research fair</i>	<i>Wednesday, March 10</i>
Module 9	March 29 through April 16
<i>Good Friday</i> <i>Easter Monday</i>	<i>April 2, 2010</i> <i>April 5, 2010</i>
Module 10	April 19 through May 7
<i>Queen's day</i> <i>Liberation day</i> <i>Ascension day</i>	<i>April 30, 2010</i> <i>May 5, 2010</i> <i>May 13, 2010 (+ May 14 ITC closed)</i>
<i>Catch-up week MSc & Master</i>	<i>May 10 through May 14</i>
Final Project PGD	May 10 through June 11
Module 11	May 17 through June 4
<i>Whitsun Monday</i>	<i>May 24, 2010</i>
Module 12	June 7 through June 25
<i>Closing week PGD</i> <i>PGD closing ceremony</i>	<i>June 14 through June 18, 2010</i> <i>Friday, June 18, 2010</i>
Module 13	June 28 through July 16
<i>Catch-up week MSc</i>	<i>July 19 through July 23</i>
Module 14	July 26 through August 13
Module 15 MSc proposal presentations + Master defences	August 16 through September 3 August 30 through September 3
<i>Closing week Master</i> <i>Master graduation</i>	<i>August 30 through September 3</i> <i>Friday, 3 September 2010</i>
MSc modules 16 through 23	September 6, 2010 through February 25, 2011
<i>MSc mid-term presentations</i> <i>Diēs Natalis ITC</i> <i>Christmas break</i> <i>MSc thesis submission</i> <i>MSc defences</i>	<i>November 1 through November 5, 2010</i> <i>Friday, 17 December 2010</i> <i>December 27, 2010 through January 3, 2011</i> <i>Monday, 21 February 2011</i> <i>February 28 through March 4, 2011</i>
<i>Closing week MSc</i>	<i>March 7 through March 11, 2011</i>
<i>MSc graduation</i>	<i>Thursday, March 10 and Friday, March 11, 2011</i>

Water Resources and Environmental Management

2. Water Resources and Environmental Management

2.1 Introduction

Security and sustainable development of our water resources is one of the key problems of the 21st century. Improved Water Management can make a significant contribution to achieve important Millennium Development Goals established by the UN General Assembly in 2000, in particular poverty, hunger, child and maternal mortality, and major diseases. During the World Summit on Sustainable Development in 2002, Water and Sanitation received great attention. It is identified that massive efforts in developing and application of science and technology are needed. In Water Resources Management and Hydrology important issues are sustainability of water resources, floods, droughts, water scarcity, water usage, water quality, water-ecosystem interactions and soil-water-climate interactions.

Current international initiatives, such as:

- the Integrated Global Observing Strategy– Partnership, the integrated Global Water Cycle Observations (IGOS-P IGWCO) theme;
- the Water Cycle Research Agenda undertaken by World Climate Research Programme, Global Energy and Water Cycle Experiment (WCRP GEWEX) and;
- the Water Targets in Global Earth Observation System of Systems 10-Year Implementation Plan (GEOSS);

have placed Earth Observation for Water Cycle Research as the key in helping to solve the world's water problems.

The availability of spatial information on water quantity and quality will enable closure of the water budget at river basin and continental scales to the point where effective water management is possible. The closure of the water budget is an important element in the EU Water Framework Directive (WFD) as well as national policies. Geo-information Science and Earth Observation will be vital in achieving a better understanding of the water cycle and better monitoring, assessment, prediction and management of the world's water resources.

The WREM-course (both MSc and PGD) exposes participants to the latest development in Geo-information Sciences and Earth Observation for assessment, monitoring and predictions in Water Resources, Hydrology and Environmental Management. Participants will obtain in-depth knowledge in Geo-information Science, Earth Observation and automated field data acquisition methods, as well as in public domain data and advanced hydrological models, all for the purpose of sustainable water resources and environmental management.

The WREM course is developed for those with a Bachelor of Science degree in fields such as (environmental) hydrology, geo-hydrology, civil engineering, agricultural engineering, agronomy, environment and geology. Most participants are having a profession in which 'water' plays an important role such as: lecturer-researcher at college and university level - executive officers, project planners, project designers at Water Board, Ministry of Water Resources, Provinces and NGO's dealing with water resources - researcher at international organizations (like IWMI, FAO) and agricultural engineers, agronomists working for irrigation boards. Most of our clients (applicants) have a background in Civil engineers or (Hydro-)geology.

Three WREM streams are offered at both Postgraduate Diploma level and Master of Science level:

- Groundwater Assessment and Modelling (GAM)
- Surface Hydrology (SH)
- Environmental Hydrology (EH)

The 9 months Postgraduate Diploma course (PGD) is for the first 10 modules similar to the MSc course. The last 2 modules (11 and 12) of the PGD course will be spent on some fieldwork near Enschede and with dedicated case-studies.

For the 18 months MSc course in module 11 Research Skills are developed needed to write a research proposal and execute MSc research. In module 12-13 the MSc course will focus on advanced topics. In module 14-15 participants will work on a project related to a specific research theme and parallel to that work on their research proposal. At the end of module 15 the research proposal should be defended. The teaching modules are followed by the execution of the MSc research: data collection, analyses, reporting and finally the thesis defence.

2.2 Objectives and competences

In this paragraph the objectives of the WREM course are described. The objectives are given related to the overall MSc programme of ITC, objectives specific for Earth Observation - GIS and WREM in general followed by stream-specific objectives.

Tasks of the WREM graduates

WREM-course graduates have a wide variety of tasks. MSc graduates work in a research and or water resource management setting where analytical and research skills are needed. Generally the tasks of a WREM graduate can be summarized as follows:

- studies and analyses physical aspects of the earth, focusing on the hydrosphere using Earth Observation information where applicable;
- studies, measures, and interprets hydrological and geographical data in relation to water resources assessment, modelling and management;
- compiles, analyses and evaluates data to prepare hydro(geo)logical maps and prepare environmental reports;
- Evaluates data in reference to project planning and project execution and management for projects such as flood and drought control, water supply, drainage, irrigation, environmental monitoring etc.
- Work in a multi-disciplinary environment and thus is able to communicate in an effective way outcome of research findings in scientific and non-scientific forums.
- Integrates the social context (water is not an isolated commodity) of water resource management with the scientific work.

Based on these tasks, competences which have to be acquired during the MSc study can be formulated (see paragraph 2.3.2 XXX check).

Course Objectives

The ITC MSc degree programme occupies a specific niche in the educational 'playing field'. ITC's MSc graduates get a degree in Geo-information Science and Earth Observation. Those who take the WREM course combine and apply knowledge in the above mentioned fields with WREM-specific course content.

At the end of the study the participants will be able to integrate data acquired from earth observation and in-situ observations in order manage, simulate, evaluate and validate water management problems.

It is possible to distinguish seven areas of competence that characterise a university graduate.

He or she:

1. is competent in one or more scientific disciplines
2. is competent in doing research
3. is competent in designing
4. has a scientific approach
5. possesses basic intellectual skills
6. is competent in co-operating and communicating
7. takes account of the temporal and the social context

The Master of Science programme at ITC aims at educating professionals who have predominantly tasks in the field of (applied) research. The exposure to new methods and concepts (area 1) development of critical understanding (area 4 and 5), and the development of research skills (area 2) are important.

The general MSc degree programme and specific WREM course objectives are given below:

Table 1: MSc program and specific WREM course objectives.

General MSc Degree in Geo-information Sciences and EO objectives	Specific WREM-related MSc objectives
Analyse a problem encountered in professional practice and develop an appropriate method to study and/or solve the problem.	Be able to analyse a problem related to too much, too little and/or too dirty water and develop an appropriate method to study the problem.
Apply appropriate methods for spatial data collection, verification and acquisition.	Be able to collect and verify relevant data on various hydrological cycle components from in-situ and EO techniques..
Use geo-information and earth observation to generate, integrate, analyse and display spatial data.	Be able to use geo-statistical, spatial and visualisation techniques to generate, structure and analyse hydrological data.
Evaluate and apply relevant and appropriate methods and models for data analysis and problem solving.	Evaluate and apply relevant and appropriate methods and models for data analysis and problem solving for specific WREM related problems.
Apply research skills to formulate and carry out an independent research project.	Apply research skills to formulate and carry out an independent research project.
Communicate and defend findings of research work.	Communicate and defend findings of research work.

The objectives can be translated in more specific competences. This is done in the following paragraph.

Competencies at Course Level

Generally speaking the participant who followed the WREM course will: 'have acquired up-to-date knowledge on appraisal, computational and management techniques used in WREM. Participant will be in the position to take-up research assignments, take initiatives and/or participate in establishing and managing Earth Observation and GIS activities for water resources related services'. The general objectives given in 2.2 can be made specific for WREM graduates as is done below.

1. Is competent in the scientific disciplines of GIS-EO in relation to WREM

- Be able to analyse a problem related to too much, too little or too dirty water and develop an appropriate method to study the problem.
- Be able to collect and interpreted relevant data on water cycle components from various in-situ observation methods and EO.
- Be able to quantify the components and processes of the water cycle at various scales with Earth Observation as data source.
- Master the concepts of hydrological modelling, its application and limitations.
- Know the concepts of Integrated Water Resources Management.
- Operate a GIS for spatial analysis and visualization tasks related to water resources and environmental issues.
- Apply appropriate EO data pre-processing techniques (geometric, atmospheric and radiometric corrections)
- Be able to select appropriate images and image processing operations in order to extract information from EO data required for the quantification of water cycle processes.
- Understand the details of the energy balance equation in its application to hydrology-related applications from remote sensing;
- Post-process the images to create hydrological relevant output

2. Is competent in doing research in the field of Water Resources and Environmental Management

- The WREM course participant should be aware of the main research questions which currently exist in the water sector and the role EO and Geo-information science can play to answer these questions.
- With this knowledge he/she should be able with supervision to produce and execute a research plan, defend the plan and its results.
- Where necessary knowledge and skills from related disciplines such as agricultural sciences, physics and geology should be draw upon.

3. Is competent in designing

The WREM graduate might develop a specific software or model-setup which should meet the requirements in terms of stability and transparency.

4. Has a scientific approach

The WREM course graduate:

- should be able to systematically work on a WREM-related problem and thus be able to justify the use of a certain (Earth) observation and/or hydrological process model if required for the analysis.
- has skills in, and affinity with the use, development and validation of hydrological process models; is able consciously to choose between modelling techniques.
- has insight in the purpose, methods, differences and similarities between scientific fields, nature of laws, theories, explanations, role of the experiment, objectivity
- has insight into the scientific practice such as publication system and the importance of integrity

- is able to document (proper referencing) and publish adequately (proper use of scientific English) the results of research.

5. Possesses basic intellectual skills

The WREM graduate should be competent in reasoning, reflecting, and forming a judgment specifically related to the water sector. He/ she should have:

- a critical yet constructive attitude towards analysing and solving simple problems in the field of EO-Geo-information science and hydrology
- basic numerical skills, and has an understanding of orders of magnitude and knows how to deal with incomplete or poor data sets
- logical reasoning and reflection skills.

6. Is competent in co-operating and communicating

The WREM graduate should be able to work with and for others. This requires not only adequate interaction, a sense of responsibility, and leadership, but also good communication with colleagues and non-colleagues. He or she is also able to participate in a scientific or public debate. In order to do so the graduate should:

- be able to communicate verbally and in writing about research and solutions to problems with colleagues, non-colleagues and other involved parties.
- be able to work within an interdisciplinary team involving civil engineers, agricultural-irrigation engineers and others and thus should be able to deal with team roles and dynamics.
- be able to perform project-based work: should be pragmatic and has a sense of responsibility; should be able to deal with limited sources; is able to deal with risks; is able to compromise.

7. Takes account of the temporal and the social context

WREM graduates do not work in isolation. Their work always has a temporal and social context. Beliefs and methods have their origins; decisions have social consequences in time. The WREM graduate is aware of this, and has the competence to integrate these insights into his or her scientific work. He/she is able to:

- analyse the consequences of scientific thinking and acting on the environment and sustainable development
- analyse and to discuss the social consequences (economical, social, cultural) of new developments in with colleagues and non-colleagues

Stream Specific Knowledge

In order to do research in one of the streams, specific knowledge is required. For each of the streams, additional specific objectives related are formulated below. Most of the objectives relate to the scientific discipline of the graduate.

Competencies related to the Groundwater Assessment and Modelling stream

- Master the collection of relevant data during a fieldwork campaigns using discharge measurements, hydrochemistry, hydrograph, pumping tests, and image interpretations
- Be able to make a hydro-geological interpretation of satellite images including well siting.
- Be able to interpret geophysical data, question its validity and applicability
- Be able to set up groundwater monitoring schema
- Estimate recharge using field and remote sensing data
- Execute and analyse pumping tests result
- Set-up, calibrate and run a regional groundwater model
- Develop groundwater management guidelines for sustainable groundwater exploration

Competencies related to the Environmental Hydrology stream

- Has a thorough mastery of parts of the methodology on pollutant inventories and water quality sampling
- Be able to quantify water quality parameters from appropriate EO data
- Be able to critically analyze and interpret hydro chemical and water quality data
- Be able to design water quality monitoring and assessment schemes
- Carry out environmental impact assessments related to water resources using earth observation and ground-based data
- Be able to develop, test and apply environmental systems approaches to water management
- Develop and apply water quality and environmental modelling tools in GIS environment

Competencies related to the Surface Hydrology stream

- Master the collection of relevant data during a fieldwork campaign in combination with EO techniques
- Analyse surface hydrological data of various timeframes (hours-years) and for various catchment sizes (50-several hundred-thousand km²)
- Develop and critically use techniques based on GIS and Earth Observation data for catchment parameterization
- Set-up, calibrate and validate rainfall-runoff models ranging from simple black box models to advanced physical based models with a strong GIS-component and EO-based input
- Be able to quantify surface hydrology relevant parameters (e.g. evapotranspiration) from appropriate EO data.

2.3 Curriculum of the Domain

Recent developments in the field of Earth Observation, GIS and data collection have led to different approaches to water resources and environmental research. Data acquired from Earth Observation and data analyses within a GIS environment can substantially contribute to obtain insight in the water resources processes on various scales (from sub-catchments to entire river basins). The WREM-course exposes participants to the latest development in Geo-information Sciences and Earth Observation for assessment, monitoring and predictions for Water Resources and Environmental Management.

The course addresses the use of quantitative earth observation techniques in combination with in-situ observations for gathering, analysing, modelling and interpreting geo-data within the context of water resources and environmental management. Management is defined as the management of hydrological processes. Starting point of this is the hydrological cycle, which integrates water processes and takes into account groundwater, surface water and water quality. Based on the assessment of the available resources and understanding of the processes management options can be analysed and reviewed. Where applicable, quantitative earth observation techniques will be integrated in the curriculum. The curriculum focuses on earth observation and geo-information techniques applied for water resources management. The course covers techniques and methods to observe aspects of the hydrological cycle and move from there to processing, data assimilation, modelling, dissemination and information to contribute to solve water and environmental issues. The issues can be categories as too much, too little and/or too dirty water.

Streams

Water Resources and Environmental Management is a very wide knowledge field, in order to cater for specific fields within the WREM domain three streams are developed within the WREM course:

- Groundwater Assessment and Modelling (GAM)
- Surface Hydrology (SH)
- Environmental Hydrology (EH)

Groundwater Assessment and Modelling (GAM)

The groundwater stream covers the use of earth observation for groundwater exploration, recharge assessment and the mapping of aquifer vulnerability. Attention will be paid to environmental monitoring, including automated data acquisition systems and data integration and modelling for purposes of assessing and managing groundwater, artificial recharge and irrigation.

Surface Hydrology (SH)

This stream focuses on how earth observation and GIS can be used to obtain relevant information for water resources assessment and rainfall-runoff modelling.

Environmental Hydrology (EH)

This stream deals with the environmental aspects of hydrology and water resources, including water quality assessment and management and the environmental impacts of water resource projects on water quality and environmental aspects related to water resources.

Research themes

The MSc course is strongly linked to ITC's research activities. In ITC's research activities two research themes are closely related to the WREM domain:

Water Cycle and Climate

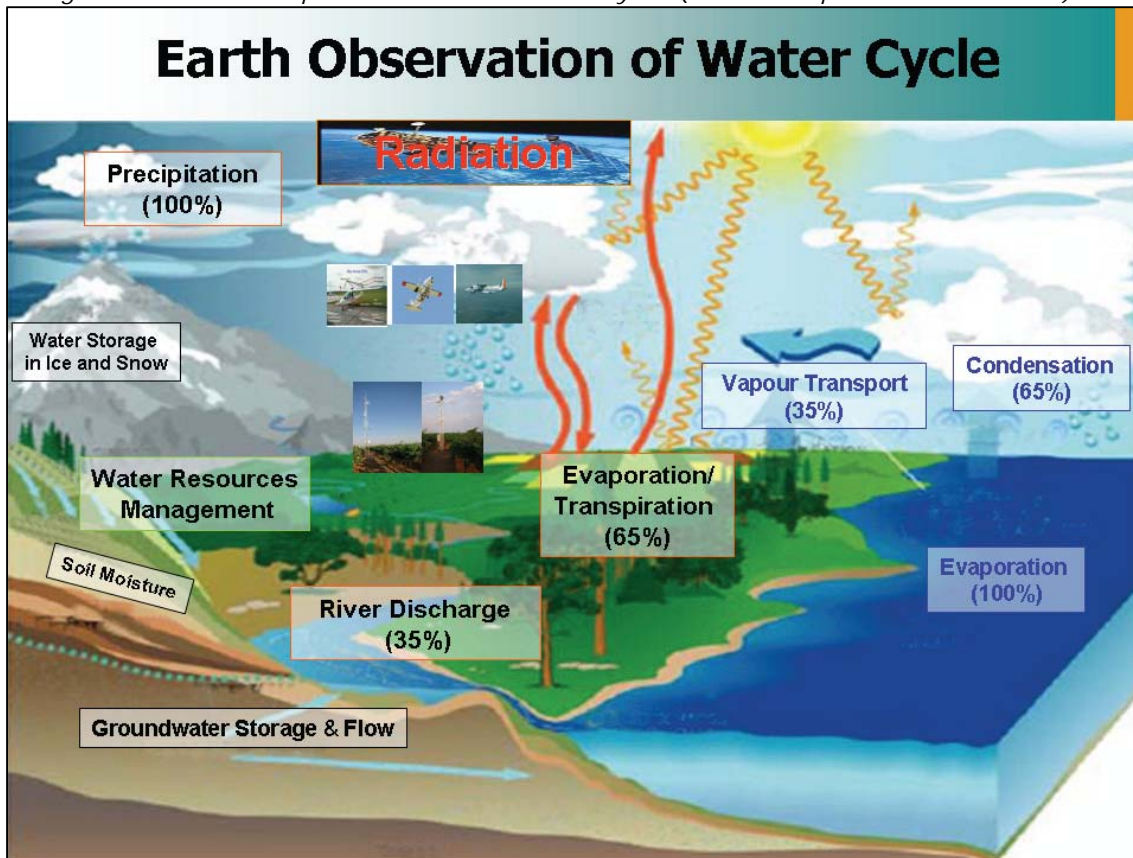
Research leader(s) : Prof. Z. (Bob) Su, Prof. W. Verhoef

Keywords : Water cycle, quantitative earth observation, field experiment, modelling and data assimilation, water management, ecosystem, climate

This research theme broadly addresses the following sub-themes or science and application profiles with the central aim of advancement of our understanding of the water and energy cycle and their interactions with climate, ecosystem and human activities:

- Water and climate: Land - atmosphere exchanges of water and energy (precipitation, evaporation/transpiration, discharge, soil moisture, as well as agricultural water uses, with.
- Application areas in droughts, food security and water use.
- Water and ecosystems: Water quality (lakes, wetlands, rivers, coastal areas) and integrated.
- Water and environment management.
- Water resources and security: Integrated watershed and aquifer management, rainfall-runoffs, floods, surface-groundwater interactions, Integrated Water Resources Management.

Figure 1: Schematic representation of the Water Cycle. (taken from presentation Prof. Su)



Managing Water Scarcity

Research leader(s) : Dr. M. Lubczynski

Keywords : Water allocation, river basin, irrigation, water use, groundwater, surface water, management, crop production, transpiration, hydrogeophysics

In water scarce basins, surface water resources are unreliable and highly dependent upon quantity and temporal distribution of rainfall. During the dry season, river flow reduces to base flow while small streams run dry. During this dry season, groundwater is a major source of water for ecosystems, irrigated agriculture and urban/industrial users.

Groundwater, however, cannot be analyzed in separation from surface water. Hence, a reliable parameterization of the entire basin and good understanding and definition of all hydrological fluxes involved in the water balance of the basin is needed to improve water management.

Water flows from one user to the next downstream user. Thus, the non-consumed part of the used water will be reused again. In the case of extreme water scarcity, this continues until drainage into the sea is zero. Under these conditions, all water that leaves one user system (e.g. leakage, spills, etc.) is reused by the next. Hence, increasing the efficiency of water use within one user system does not create "new" water for the next downstream user system.

Therefore the most important water management questions are the following:

- To which user subsystem should water be allocated?
- And which allocation criteria are to be used?

Using decision support systems (DSS) as a management tool is made to derive generic guidelines facilitating answers to those questions. To assess the allocation of water to (land) uses, these DSS should provide sufficiently accurate answers at a cost that meets the budget of managing organizations.

Set-up of PGD and MSc course

Both the PGD and MSc course consist of a series of several building blocks and comprises of theoretical lectures, workshops and practical assignments. A fieldwork assignment + cases studies including reporting completes the PGD course. Those in the MSc course get some additional training in research skills, proposal writing and advanced topics. The MSc course is concluded with a research project, which results in a thesis. An outline of the module names and sequence is given below.

	Stream	Modules	Title
Block 1 Core	All	1-2-3-4	Principles and Application of Geographic Information Systems and Remote Sensing in Water Resources and Environmental Management.
Block 2 Domain	All	5-6-7-8	EO and Quantification of Water Cycle Components
	GAM	9-10	Integrated EO and Modelling for WRM with Emphasis on Groundwater
	Surface Hydrology	9-10	Integrated EO and Modelling for WRM with Emphasis on Surface Hydrology
	Environmental Hydrology	9-10	Integrated EO and Modelling for WRM with Emphasis on Environmental Hydrology
GROUPWORK MODULE 11-12 FOR POSTGRADUATE DIPLOMA STUDENTS			
Block 3 Research Profile	All	11	Research Skills
		12-13	Various Advanced Topics
		14-15	Research Themes and Proposal Writing
Block 4 MSc Research	All	16-23	Individual MSc research

Block-1 (modules 1-4)

Block-1 (modules 1-4) deals with principles and applications of geographic information systems and EO to water resources and environmental management. Relevant applications to water resources and environmental management are added.

Block-2 (modules 5-10)

Block-2 (modules 5-10) is subdivided in two sub-blocks. The first, block-2a contains module 5 to 8 and forms a short course on EO and Quantification of Water Cycle Components. The second, block-2b contains modules 9 to 10 and forms an advance level on Integrated EO and Modeling for WRM.

On the one hand, block-2a focuses on quantitative remote sensing of the water cycle components coupled with basic understanding of the theory, processes and measurements of the hydrological cycle. On the other hand, block-2b focuses on the integrated application of earth observation and numerical process models for a better management of water resources.

Block-2a: EO and Quantification of Water Cycle Components

Block-2a consists of four modules 5 to 8. These modules are developed around one broad theme which can form a short course. The theme deals with all water cycle components that can be quantified using earth observation approach. For those components where EO can not contribute (or contribute to a limited extend), in-situ observations or traditional methods should be introduced as well. Block-2a is assessed through a combination of written exams, individual and group assignments.

Block-2b: Integrated EO and Modelling for WRM with Emphasis on specific stream

Block-2b consists of 2 modules. In these 2 modules students are exposed to the modelling principles and integration of EO in the assessment, modelling and management for the various specific aspects of the water cycle (groundwater, environmental aspects and surface hydrology). Where applicable lectures and exercises are combined. Block 2b is assessed through assignments, reports, presentations and written exams.

Final project Postgraduate diploma

The PGD course is finalised with a fieldwork project + case-study (module 11-12). They will write a small report, give a presentation on the work they have done. The course is finalized by an interview with 3 staff.

Block 3: MSc research profile

All MSc students receive a 3 weeks course in research skills in which research methodology, information skills and writing and communication skills are developed. These 3 weeks are followed by 6 weeks (2 modules) of advanced subjects which are directly relevant for MSc research in one of the MSc research themes and generic. In module 14-15 research theme leaders (per ITC Research Programme) devises / offers one project. Each project makes use of tools learned in modules 12-13. Each student carries out independent work/research in a project team environment. In this period the MSc research proposal is prepared and presented.

Block 4: Research

Depending on the proposal the research activities (data collection, methodology development, fieldwork etc) are executed. Finally the thesis is defended in front of a Thesis Assessment Board.

Teaching Method

Students arriving at ITC have a diverse cultural background with educational experiences and habits which might differ from our views on good teaching methods. According to our view on good teaching methods, students should work and learn independently from their teacher. ITC uses the term “student-centred learning” to describe this method of teaching. The following starting points for teaching methods are defined for the WREM curriculum:

- The students have to gradually adjust to become more independent in their learning so they will be able to conduct an MSc thesis research independently. This calls for more frontal teaching at the beginning of the course and more independent (group) work at the end.
- The group assignments in block-2a and the group project in block-2b prepare students for more independent learning and their MSc thesis research in block-4.

It is acknowledged that the amount of lectures should not be too big. However, each topic needs a certain amount of lectures for introduction of the topic and feedback to the students.

For teaching of the common topics in block -2a and -2b the following division is set: maximum of 50% for lecturing, 25% to work on assignments and exercises and 25% for self-study.

The overall programme offers an attractive and intensive educational package, including lectures and practicals, self-study, multi-disciplinary project work and hands-on case studies. Practicals may be in the form of discussion groups and assignments, image interpretation, computer assisted analysis and multi-media exercises. The programme is intended to deepen knowledge and skills in a practical problem-solving approach. Case studies and projects are designed to simulate realistic situations in your own organisation or country.

Assessment and certification

Degrees are awarded to participants who have fulfilled the conditions and passed the examination required in accordance with the official assessment rules of the Institute. Course records, that list the results for the specific modules and subjects, accompany the degree obtained

Lecture Timing

Lectures and practicals are given in four periods every day except Wednesday when only two periods are scheduled in the morning:

1 st period	08.40 till approx. 10.20
2 nd period	10.40 till approx. 12.20
3 rd period	13.40 till approx. 15.20
4 th period	15.40 till approx. 17.20

Module descriptions

3. Module descriptions

Principles and Application of Geographic Information Systems and Remote Sensing in Water Resources and Environmental Management			
Module: 1-4		Module coordinator: Dr. Z. Vekerdy	
Start:	28-09-2009		
End:	18-12-2009		
Level: MSc, PGD		ECTS: 20	U09-WREM-123

Introduction

This block forms the start of the Water Resources and Environmental Management (WREM) course. First the students are introduced to the WREM course curriculum. Then the principal concepts and techniques of Geographic Information Systems (GIS) and Remote Sensing (RS) in Water Resources and Environmental Management (WREM) are addressed. As such, the block consist of five interrelated parts:

- Introduction to the WREM program;
- A theoretical part which focuses on the main principles of GIS and (Quantitative) RS;
- A practical part that illustrates this theory using WREM specific exercises and industry standard software and tools;
- Basic introduction in atmospheric correction methods;
- An application oriented part in which participants learn how to individually design and carry out sequential data processing steps typical for the creation and use of basic GIS and RS methods that can be applied to create applications in WREM.

The concepts and techniques introduced in this block will be further enhanced during subsequent modules within the course.

Objectives

Main objective: to learn how to generate, store, analyze and present information about the Earth required for Water Resources and Environmental Management (WREM).

At the end of the block participants must be able to:

1. *Explain the principles and use the vocabulary of GIS and RS:*
 - Describe the nature of geographic phenomena and their representation in the context of geo-informatics;
 - Outline the principal data models for spatial and non-spatial data used in GIS databases;
 - Outline the main components of a GIS and their functions;
 - Explain the relationship between spatial data and coordinate systems;
 - Outline the main spatial data analysis functions;
 - Explain the role of RS in GIS;
 - Describe the physical background of remote sensing and compare the main platforms and sensor systems;
 - Understand and apply the main atmospheric correction techniques;
 - Explain the main digital image processing procedures;
 - Describe the common methods of image analysis;
 - Outline the principal rules for cartographic visualisation;
 - Describe aspects of data quality and how various stages of spatial data handling affect it.

2. *Carry out GIS and RS operations:*

- Independently search Internet Archives and download images and other resources from the Archive Internet Sites or Clearinghouses;
- Carry out data preparation, geo-referencing and data entry into a GIS;
- Perform manipulation, analysis and visualisation operations using a GIS;
- Perform image processing techniques;
- Carry out a visual interpretation of a satellite image;
- Apply data quality assessment procedures.

3. *Apply appropriate GIS and RS methods in applications:*

- Understand the capabilities, uses and limitations of GIS and RS in their field of application;
- Design and carry out basic sequential data processing steps that can be used when creating or using GIS and RS applications in WREM;
- Evaluate the results of data processing;
- Application of EO for Water Resources Management

Contents

The block covers the following topics:

- Geographic information and spatial data types;
- Spatial data entry and preparation;
- Spatial data analysis;
- The electromagnetic spectrum as required for RS analysis;
- Sensors and platforms;
- Geometric aspects of remotely sensed data;
- Image enhancement and visualisation;
- Image classification and interpretation;
- Spatial data visualisation;
- Quality assessment of spatial data;
- Field observations for satellite image interpretation
- Atmospheric correction in the visible part of the spectrum;
- EO contribution to Water Cycle studies

Prerequisites

Admission to WREM course or short course.

Recommended Knowledge

Computer skills (Windows OS, Office), physics/mathematics skills.

Compulsory textbook(s)

- O. Huisman and R.A. de By (ed.), 2009: Principles of Geographic Information Systems - An introductory textbook, 4th ed., ITC, ISBN 90-6164-269-5
- K. Tempfli, N. Kerle, L.L.F. Janssen and G.C. Huurneman (eds.), 2009: Principles of Remote Sensing - An introductory textbook, 4th ed., ITC, ISBN 90-6164-270-1

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
108	140	0	68	80	120	60

Time (in # of hours) allocated per major method:

- L lecture,
- SP supervised practical,
- UP unsupervised practical,
- GA group assignment (e.g. workshop, project),
- IA individual assignment (including Thesis, IFA),
- S self study,
- O overhead (e.g. QH, exam, opening)

Assessment

In the first module there will be no exam, and results in completed/fail.

For the other three modules three separate marks will be given:

- Two written closed book examinations on the theoretical part RS and GIS
- Assessment of the case studies.

Earth Observation and Quantification of Water Cycle Components			
Module: 5-8	Module coordinator: G.N. Parodi MSc.		
Start: 04-01-2010			
End: 26-03-2010			
Level: MSc, PGD	ECTS: 20	U10-WREM-104	

Introduction

In this block the theoretical background of the different water budget and water quality components are discussed including the EO methodologies to quantify each of the components. To assess the water balance component you need data. Data can be obtained from the ground and/or from satellite observations. Also applications of process modelling require reliable data related to water quantity & quality, climate, soils and vegetation. Today, using the newest sensor, ground and environmental technologies, a large number of these data can be acquired from space and can be integrated with in-situ and laboratory measurements.

Besides water quantity assessment also hydro-chemical data analysis and interpretation techniques are taught, along with an overview on biogeochemical cycles.

The final week of the block is reserved for finalizing the group assignment and final projects in which data integration for water cycle study is the main study-topic. Also time is reserved for capita selecta in which PhD students and special guests present their work in a theoretical and practical manner.

Objectives

Regarding processes, upon completion of this module students should have acquired knowledge of:

- Methods to quantify different components of the hydrological budget.
- The role EO can play in the quantification of the Water cycle

Through exercises students develop skills in:

- The quantification of components of the hydrological cycle
- The determination and monitoring of environmental indicators like water quality parameters, soil and climate data (meteorological and energy budget);
- The use of Earth Observation for the acquisition of hydrological, meteorological, soil and groundwater data;
- To obtain experience in working in groups, writing reports and present results.

Contents

This block consists of three components:

- The theory on and computational methods for water cycle quantification, water quality and ecosystems analysis. The following components will be discussed:
 - Precipitation
 - Rainfall/runoff processes
 - Evaporation /Transpiration
 - Soil water and groundwater
 - Hydrochemistry and Water quality
- The theory and methods for the use of Earth Observation for the quantification of Water Cycle components. Aspects of atmospheric correction and accuracy and resolutions will be discussed as a continuation from block 1.

- Methodology of data integration methods of water cycle components to assess closure of the water balance.

Prerequisites

Core module EO and GIS.

Recommended Knowledge

- Very good mathematical basis. Knowledge on physics is highly appreciated.
- Basic knowledge in hydrological sciences, soil science, chemistry.
- Basic knowledge in Excel and computer data processing.

Compulsory textbook(s)

Hydrology: An Introduction by Wilfried Brutsaert (2005) Cambridge University Press.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
164	120	0	60	80	120	32

Time (in # of hours) allocated per major method:

- L lecture,
- SP supervised practical,
- UP unsupervised practical,
- GA group assignment (e.g. workshop, project),
- IA individual assignment (including Thesis, IFA),
- S self study,
- O overhead (e.g. QH, exam, opening)

Assessment

The block is divided in 4 modules. For each module a mark will be given. Per written exam two modules will be assessed.

The first exam will cover:

- Module 5: Precipitation, and
- Module 6: Evaporation

The second exam will cover:

- Module 7: Soil Moisture-Groundwater, rainfall-runoff, and
- Module 8: Hydrochemistry and Water quality

Weight of the written exam is 70%. Per topic, assignments will be given, which have to be combined in the final project. Topic assignments will account for 30% of each module mark. Final group assignment will be have to be completed with a sufficient quality to finalize block2-a.

Both the written exam and topic assignments for each module should be with a mark of at least 50. Separate re-exam for written exam and assignment is possible.

Integrated EO and Modelling for WRM with emphasis on Groundwater		
Module: 9-10	Module coordinator: M.W. Lubczynski	
Start: 29-03-2010		
End: 07-05-2010		
Level: MSc, PGD	ECTS: 10	U10-WREM-105

Introduction

To exploit, protect and manage groundwater resources in a sound manner requires a thorough understanding of groundwater flow and transport processes and quantification of these processes in time and space. This is typically done by groundwater modelling. Groundwater modelling is nowadays indispensable for modern planning and management of groundwater resources in a sustainable manner.

For the reliable setup of a groundwater model, good understanding of the hydrogeological system and data describing its spatio-temporal characteristics are needed. This can be best achieved by data acquisition based on the combination of EO (Earth Observation), geophysical remote sensing techniques for spatial assessment as well as hydrological monitoring for temporal assessment. Various techniques of such data acquisition and data integration in groundwater models will be discussed. Afterwards, model calibration will be carried out using forward and inverse methods. The calibrated models will be finally used to show their applicability in groundwater management, such as for example determination of borehole safe yield, design of wellhead protection zones, remediation of contamination, etc.

Objectives

General objectives:

- Understand different hydrogeological modeling concepts and their limitations;
- Develop practical skills in setting-up, running and applying groundwater models in practice.

Specific objectives:

- Learn principles of hydrology of the unsaturated zone and recharge modeling
- Understand principles of flow system analysis and contaminant transport processes
- Learn to analyse hydrogeological data with emphasis on pumping test data for groundwater resource evaluation
- Learn to model the unsaturated zone with SWAP
- Learn principles of groundwater flow and transport modeling with MODFLOW and MT3DMS
- Learn how to carry out sensitivity analysis and how to evaluate model uncertainty
- Apply groundwater model in a groundwater management case study
- Compile a groundwater modeling report.

Contents

The course consists of a total of 6 weeks in which groundwater assessment, modelling, specific applications and the role of EO in groundwater modelling will be discussed. The 6 weeks will start with methods of groundwater resources assessment, then followed by principles of groundwater modelling, spatio-temporal data integration, transport modelling and finally groundwater management.

In the first 3 weeks of the course, lectures will be interacted with exercises to demonstrate various aspects of the groundwater system analysis and groundwater modelling such as: assessment of hydrogeological parameters with pumping tests, hydrology of unsaturated zone, assessment of recharge and discharge with SWAP, theory of groundwater flow, theory and practice of groundwater modelling with MODFLOW, theory and practice of advective transport modeling with PMPATH and theory and practice of advective-dispersive transport modeling with MT3DMS.

In the second half of the course i.e. in the last 3 weeks of the course, the individual groundwater modelling study cases will be carried out by students. They will involve: data processing, numerical model setup, spatio-temporal data integration, model calibration, model sensitivity and uncertainty analysis, prediction scenarios related to safe yield and contaminant transport modeling and finally project reporting. The overall program will be interacted by special lectures on: the role of remote sensing in groundwater modeling, role of hydrogeophysics in groundwater modelling, coupling of models etc.

Prerequisites

Module 1-8 of WREM course.

Recommended Knowledge

Module 1-8 of WREM course.

Compulsory textbook(s)

- Fetter C.W. Applied Hydrogeology
- Anderson M.P., Woessner W.W. Applied Groundwater Modelling – Simulation of flow and advective transport.
- Spitz K, Moreno J. A practical Guide to Groundwater and Solute transport modeling.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
74	52	0	0	70	80	12

Time (in # of hours) allocated per major method:

- L lecture,
- SP supervised practical,
- UP unsupervised practical,
- GA group assignment (e.g. workshop, project),
- IA individual assignment (including Thesis, IFA),
- S self study,
- O overhead (e.g. QH, exam, opening)

Assessment

This block will be assessed as follows:

- Written exam: pumping test and recharge/unsaturated zone hydrology 40%
- Modelling assignments (report and oral presentation) 60 %

Both assessments should be at least 50; separate re-exams for written exam and modelling assignment is possible.

Integrated EO and Modelling for WRM with emphasis on Environmental Hydrology		
Module: 9-10	Module coordinator: Dr. Ir. C.M.M. Mannaerts	
Start: 29-03-2010		
End: 07-05-2010		
Level: MSc, PGD	ECTS: 10	U10-WREM-107

Introduction

The course consists of a total of 6 weeks in which water security, using an integration of water quantity and quality assessment, modelling and the use of EO and in situ data for water monitoring, are being exposed. Assessment of human and climate impacts on water availability with focus on water quality is a central theme.

The course starts (3-weeks) with an introduction to hydrological and matter transport modelling theory together with a more (introduction given in block 2a) in-depth analysis of field water monitoring, sampling & analysis methods, including field experiments for acquisition of model data and parameters. Water quality modelling (theory and practicals) is given on diffuse source pollution, and numerical water quality process modelling (optional: watershed erosion - sediment transport). Computer modelling is combined with field experiments and lab work.

The second part (2-wks) of the module is used for EO for water quality of lakes and coastal waters. Retrieval of water quality parameters from space a/o airborne sensors, using atmospheric corrections and WQ algorithms is taught.

The last week (1-wk) is devoted to integration of EO and models in IWRM. Assignments are concluded by written exercises, workshops and presentations by students on how to apply EO data and modelling results in IWRM, with focus on environmental and water quality issues.

Objectives

General objectives:

- Understand different hydrologic modeling concepts and protocols, and develop practical skills in setting-up, running and evaluating watershed water quality hydrological models;
- Understand the physical and biogeochemical processes underlying water quality and water resources deterioration;
- Get familiar with concepts of IWRM including the role of Geo-information and Models;

Specific objectives:

- Understand the basic WQ and contaminant transport processes and apply watershed hydrologic and non-point source pollution model in GIS environment;
- Derive water quality information from EO sensor data using empirical and physical retrieval methods.

Contents

- Lectures and exercises to demonstrate the various aspects of the modelling process and good modelling practice
- Water Quality modelling using DMS 3.8.2 (DUFLOW): Advective, dispersive, reactive hydrologic transport phenomena; analytical solutions; numerical solutions of the 1-D

transport equation; application to surface water and soils; exercise(s) advection-dispersion, oxygen-, contaminant transport in a river networks.

- Water monitoring field experiments (flow, water quality assessment and model data acquisition) in Regge & Dinkel area, and GWS lab analysis
- Theory and case work on Watershed integrated modeling (erosion, sediment yield and water quality) using the SWAT2005, model (a/o other models, e.g. AgNPS5, etc.).
- Lectures on water quality remote sensing; spectral signatures of waters; inherent optical properties; radiative transfer; atmospheric & water interface corrections; algorithms; forward and inverse retrievals; EO sensors: MERIS, MODIS, SeaWiFS. Field excursions with practical in situ data collections for water quality modelling and remote sensing (in Regge & Dinkel area).

Prerequisites

Module 1-8 WREM.

Recommended Knowledge

Hydrochemistry, EO and GIS principles, Hydrological concepts.

Compulsory textbook(s)

- D.Chapman (2000): Water Quality Assessment and Monitoring
- SWAT2005, DMS/Duflow, WASI model documentations.
- S.C.Chapra (1997): Surface Water Quality Modeling.
- C.Mobley (2004): Light & Water: radiative transfer in water.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
40	52	0	0	78	98	0

Time (in # of hours) allocated per major method:

- L lecture,
- SP supervised practical,
- UP unsupervised practical,
- GA group assignment (e.g. workshop, project),
- IA individual assignment (including Thesis, IFA),
- S self study,
- O overhead (e.g. QH, exam, opening)

Assessment

This block will be assessed as follows:

- Oral exam: Measurement – Modelling – Management (theory) 30%
- Written group report: WQ Measurement – Modelling – Management assignments 20%
- Formative assessment: WQ Measurement – Modelling – Management Field experiments/lab 10%
- Oral exam: WQ Remote Sensing theory 20%
- Written group report: WQ Remote Sensing assignments 10%
- Formative assessment: WQ Remote Sensing field spectrometry/lab 10%

In case of marks below 60 separate assignment to cover the theoretical part could be given to improve the mark.

Integrated EO and Modelling for WRM with emphasis on Surface Hydrology		
Module: 9-10	Module coordinator: Ing. G.N. Parodi	
Start: 29-03-2010		
End: 07-05-2010		
Level: MSc, PGD	ECTS: 10	U10-WREM-106

Introduction

The course consists of a total of 6 weeks in which integrated monitoring, assessment and modelling of water resources as well as applications in floods, droughts and irrigation are introduced.

The 6 weeks start with a short introduction on modelling concepts. Different components of a modeling system will be addressed. Uncertainties in model processes, parameters and variables as well as model calibration and validation at different spatial and temporal scales will be addressed. Applications of the modeling approach to data poor area will be treated. Finally applications of the modeling approach in flood monitoring, drought assessment and land use will be worked out as case studies.

Special attentions are given to the integration of Earth Observation data of water cycle variables conventional hydrometric data, vegetation properties and catchment characteristics in a GIS based modelling framework.

Objectives

General objectives:

- Understand different hydrologic modeling concepts and their application potential and limitations;
- Develop practical skills in setting-up, running and evaluating specific hydrological models;
- Develop capability to use earth observation data in modeling context
- Specific objectives: Set-up, run and evaluate various hydrological models;
- Understand and apply optimization techniques,
- Understand and apply the use of specific software to evaluate irrigation water, drainage and salinization related aspects.

Contents

Lectures and exercises demonstrate the various aspects of the modelling process.

Prerequisites

Module 1-8 WREM.

Recommended Knowledge

- Basic mathematics and understanding of the concepts of numerical modelling
- Methods for field data collection and generalization
- GIS and EO techniques for hydrologic modelling
- Knowledge in water cycle variables.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
60	45	0	0	78	90	14

Time (in # of hours) allocated per major method:

L lecture,
 SP supervised practical,
 UP unsupervised practical,
 GA group assignment (e.g. workshop, project),
 IA individual assignment (including Thesis, IFA),
 S self study,
 O overhead (e.g. QH, exam, opening)

Assessment

This block will be assessed as follows: two separate marks, one for each module:

- Module 9: written exam 70%, assignments 30%, both sections should be at least 50, separate re-exams possible.
- Module 10: written exam 70%, assignments 30%, both sections should be at least 50, separate re-exams possible.

Final Project PGD			
Module: 11-12		Module coordinator: Drs. R. Becht	
Start:	10-05-2010		
End:	18-06-2010		
Level: PGD		ECTS: 10	U10-WREM-108

Introduction

Water Resources and Environmental Management can only be successful if management decisions are based on site specific field data investigations. The integration and verification of the remote sensing data with the field data in a GIS and models form the basis of the decision making process.

Objectives

Upon completion of these modules students should be able to:

- relate the hydrologic processes to the landscape;
- analyse time series of hydrologic data;
- execute water resources evaluation;
- solve hydrological problems.

Contents

The objective of these 2 modules is to give the students the opportunity to execute a small water resources and environmental management related project. The project can be based on own data or the study-case can be provided by the module coordinator. Students will have to make a preliminary water resources assessment based mainly on remote sensing data, hydrologic data and modelling and finally have to report on their activities. Case-study will be concluded with small presentation and discussion with senior staff members.

Prerequisites

All previous WREM programme and specialisation modules.

Recommended Knowledge

Knowledge gained during all previous modules is expected.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
0	0	0	120	120	0	0

Time (in # of hours) allocated per major method:

- L lecture,
- SP supervised practical,
- UP unsupervised practical,
- GA group assignment (e.g. workshop, project),
- IA individual assignment (including Thesis, IFA),
- S self study,
- O overhead (e.g. QH, exam, opening)

Assessment

Report, presentation and individual performance.

Research Skills		
Module: 11	Module coordinator: Dr. D.G. Rossiter	
Start:	17-05-2010	
End:	04-06-2010	
Level: MSc	ECTS: 5	P10-EDU-103

Introduction

The ITC MSc thesis research phase aims to strengthen your ability to execute scientific research. The success of your thesis research depends, apart from skills and conceptual background in your scientific discipline, also on the ability to adequately structure your research proposal and thesis. This module provides a set of research skills applicable to all MSc students at ITC to improve performance in the subsequent thesis research. It teaches you why research is structured as it is and challenges you to develop the ability to critically review scientific work of yourself and others. You will be trained to analyze the structure, logic and quality of research with examples from your own scientific field. Also you will develop skills to structure scientific research and write proper structured English. The module finally aims to create common understanding of what is expected of a research proposal and how it will be assessed, to allow you to comply with these expectations.

The module is structured as a series of common lectures, with per-course breakout sessions. In addition to the common lectures by Dr. D.G. Rossiter, overall coordinator module 11, delegate coordinators will organize and teach the per-course breakout sessions. Selected topics will be taught by other departmental staff and supporting staff (Library, RC, IT).

Objectives

Upon completion of the module, participants will be able to:

- understand why scientific research is structured as it is,
- recognize and critically assess research quality,
- recognize and follow ethical standards in research,
- find, evaluate, and summarize the most relevant and up-to-date scientific literature to support research, and
- structure an MSc thesis research proposal according to academic expectations.

Contents

- The scientific enterprise and the ITC MSc student's place in it
- Logic and structure of scientific research.
- Inference in various scientific disciplines.
- Literature search, citation and bibliography.
- Abstracting and reviewing scientific research.
- Structured scientific writing and argumentation.
- How to structure an MSc research proposal.
- Ethics and professionalism in research.

Follow-up lectures in the thesis-writing phase (not part of this module) will continue with related themes:

- Research quality and thesis assessment.
- Structuring results, discussion and conclusions
- Graphic presentation in an MSc thesis.

Prerequisites

Before entering module 11 participants have to submit their intended line of research (MSc pre-proposal), based on the available MSc projects presented at the MSc fair (March 11). This includes: choice of topic and rationale, choice of module 12, 13 and 14-15, available datasets, (optional) fieldwork planning and envisaged MSc supervisors.

At the start of module 11 participants must be able to:

- Present and discuss research in public (orally, supported by presentation slides);
- Communicate about technical subjects in written English;

Besides participants are expected to have:

- A background in at least one relevant scientific field;
- A critical/creative attitude.

Recommended Knowledge

Not applicable.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
31	4	0	0	0	98	11

Time (in # of hours) allocated per major method:

- L lecture,
- SP supervised practical,
- UP unsupervised practical,
- GA group assignment (e.g. workshop, project),
- IA individual assignment (including Thesis, IFA),
- S self study,
- O overhead (e.g. QH, exam, opening)

Assessment

- (1) Full participation in (group)discussions is expected;
- (2) Further, the mark is derived from three written assignments:
 1. Literature skills: (i) Finding relevant literature from specified information resources, (ii) entering references to these in a bibliographic database, (iii) organizing the main points into a coherent paragraph, and (iv) formatting a reference list from the bibliographic database;
 2. Summarizing and abstracting an important scientific paper in the research field of your course;
 3. Arguing a scientific position (importance of a research topic) in correct, compact and direct structured technical English.

Advanced Topics		
Module: 12-13	Module coordinator: Dr. M.J.C. Weir	
Start:	07-06-2010	
End:	16-07-2010	
Level: MSc	ECTS: 10	P10-EDU-104/105

Introduction

Modules 12 and 13 form the backbone of the third Block of the MSc programme. Following module 11 on research skills and before working together in research themes during modules 14-15, students follow two advanced subjects to equip them with specific research tools, methods and applications that are important for their envisaged MSc research. In selecting these two topics, participants therefore have to make a logical choice that fits to the envisaged MSc research to be carried out during Block 4 (MSc research phase; modules 16-23). The choice is made, and explained, in the MSc pre-proposal that has to be submitted after the MSc fair (March 10th 2010) and before the start of module 11 (exact date and format to be specified).

The final list of choices for the 2009/10 courses will be made available no later than January 2010, after evaluation of the 2008/09 courses and following final approval by the Academic Board. The offered subjects may be updated or revised, and new subjects may be added and some may be dropped.

In this generic study guide description the 28 advanced subjects of the 2008/09 course are mentioned to show the range of subjects on offer. Descriptions of these modules can be found in the "Search module descriptions" option on internet:

<http://www.itc.nl/education/courses/modules.aspx>, select study guide = 2008-2009, level = MSc and module = 12, respectively 13.

Objectives

Specified per advanced subject.

Contents

Module 12:	Title:
M09-EOS-100	Advanced image analysis
M09-EOS-101	Geostatistics
M09-EOS-103	Laser scanning and InSAR
M09-ESA-100	Essentials of physical process modelling
M09-ESA-101	Hyperspectral Remote Sensing
M09-ESA-102	Geophysics and 3D geo-visualization of the subsurface
M09-GIP-100	Design and Implementation of Spatial Databases
M09-GIP-101	Time series
M09-NRS-100	SAR Remote Sensing
M09-PGM-100	Managing geoinformation systems in the public sector
M09-PGM-102	Spatial planning support systems and scenario development
M09-PGM-103	Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA) applying Spatial Decision Support tools
M09-WRS-101	Quantitative retrieval of geo(bio)physical parameters from remote sensing data
M09-WRS-102	Use of GEONETCast environmental data streams for climate, water and environmental studies

Module 13:	Title:
M09-ESA-103	Multihazard Risk Assessment
M09-ESA-104	Data analysis in earth, water and natural resources studies
M09-ESA-105	Soil and Water conservation
M09-EOS-104	3D Geoinformation from imagery
M09-EOS-105	Advanced statistics
M09-GIP-102	Design and implementation of Geoinformation Services for SDI
M09-GIP-103	Use, users and usability
M09-NRS-101	Spatial modelling of biological Ecosystem Properties
M09-PGM-101	Spatial change and spatial interaction modelling
M09-PGM-104	Applying research methods for public sector geoinformation management
M09-PGM-105	Participatory GIS – principles and applications
M09-PGM-106	Scenario analysis and collaborative decision support
M09-WRS-100	Large scale process modeling and data assimilation
M09-WRS-103	Climate change impacts and adaption – Analysis and monitoring techniques of climate change

Prerequisites

MSc modules 1-11 (and other specifications as given per subject).

Recommended Knowledge

Specified per advanced subject.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
32	40	0	60	60	80	16

Time (in # of hours) allocated per major method:

L	lecture,
SP	supervised practical,
UP	unsupervised practical,
GA	group assignment (e.g. workshop, project),
IA	individual assignment (including Thesis, IFA),
S	self study,
O	overhead (e.g. QH, exam, opening)

Important:

The numbers above are calculated for two modules.

Assessment

Specified per advanced module. Note that the assessments of Modules 12 and 13 must both result in a mark.

Research Themes/MSc Qualifier		
Module: 14-15	Module coordinator: Dr. M.J.C. Weir	
Start: 19-07-2010	<ul style="list-style-type: none"> ▪ Research project coordinators appointed per research theme ▪ 2 MSc supervisors appointed beforehand for each participant 	
End: 27-08-2010		
Level: MSc	ECTS: 10	P10-EDU-106

Introduction

Modules 14 and 15 form the last part of Block 3 of the MSc programme. While Modules 11 to 13 have provided the students with research methods and tools, the last two modules focus on the research themes of ITC. These themes form the subject framework and organizational structure in which MSc students conduct their individual MSc research in Block 4 of the MSc programme (modules 16-23). At the end of Module 15, a Thesis Admission Committee decides whether or not a student is admitted to Block 4.

Each ITC research theme offers one or more projects for Module 14 and 15, where possible together with one or more other themes. The general structure is the same; the content will be theme specific, and, where possible, inter-disciplinary. Research themes are free to fill this in within the boundaries described in this module description.

The purpose of Modules 14 and 15 is to deepen the knowledge and skills of students within the research theme and to help students to define their own MSc research proposal.

The student has to make a choice for a certain research theme, based on his/her envisaged MSc thesis topic. The choice is made, and explained, in the MSc pre-proposal that has to be submitted after the MSc fair (March 10th 2010) and before the start of module 11 (exact date and format to be specified). The following 15 themes are available:

Education Unit 14/15:	Title Research theme	Research theme leader
U09-NRS-101	Biodiversity in fragmenting landscape	Prof. A.K. Skidmore
U09-NRS-102	Carbon-cycle and climate change	Dr. Y. Hussin
U09-ESA-100	Disaster management	Prof. V.G. Jetten
U09-ESA-101	Earth systems science	Prof. F.D. van der Meer
U09-NRS-103	Food security and environmental sustainability	Prof. E.M.A. Smaling
U09-PGM-100	Governance and Integrated Spatial Assessment	Prof. A. van der Veen
U09-PGM-101	Informed multilevel governance of urban regions	Prof. Y. Georgiadou
U09-PGM-102	Land administration for informed governance	Prof. J. Zevenbergen, Prof. P. van der Molen
U09-WRS-100	Managing water scarcity	Dr. M. Lubczynski
U09-GIP-100	Spatial data infrastructure technology	Dr. R.A. de By
U09-GIP-101	Spatio-temporal data integration and visualization	Prof. M.J. Kraak
U09-PGM-103	Sustainable urban-regional dynamics	Prof. F.A.M. van Maarseveen
U09-EOS-100	Stochastic methods for image mining and data quality	Prof. A. Stein
U09-EOS-101	Utilisation of sensor developments for efficient topographic mapping	Prof. M.G. Vosselman
U09-WRS-101	Water cycle climate	Prof. Z. Su, Prof. W. Verhoef

For more information about the content and scope of the ITC research themes, please visit: <http://www.itc.nl/research/themes.asp>

Objectives

Upon completion of these modules students will be able to:

1. Write an MSc research proposal.
2. Define ways how to tackle a scientific problem and structure research.
3. Place research projects in a wider scientific and societal context.
4. Structure scientific research to the specifications of the scientific discipline.
5. Meet quality standards and excellence in research.
6. Present scientific information in written English at a standard acceptable to the scientific community.

Contents

Two main activities run parallel in Modules 14 and 15:

1. A group research project,
2. Finalizing the research proposal for the individual MSc thesis.

1. Group research project

The purpose of the group project is:

- To let the student place his/her own MSc research project and research interests in a wider scientific context.
- To give the student an opportunity to practise – under supervision of a tutor - conducting a research project before starting to work on his/her individual MSc research project.
- To give the student an opportunity to practise undertaking research in a team.
- To give student the opportunity to share their knowledge in a multi-disciplinary context.

These activities are considered an important preparation for conducting the individual MSc research in Block 4, as well as for the student's future professional academic working practice in which projects are often conducted in multi-disciplinary groups.

Research projects can be defined by one or several research themes. The projects are defined with a view to catering for a variety of research approaches and interests, as well as the relevance of these to society. Projects are described with a title, a problem definition, and, if appropriate, the available dataset. The student group, consisting normally of a maximum of five students, is responsible for working this out into various activities according to an agreed plan. The student group has the freedom to make its own choices, supported by a tutor. The available projects will be made known early in 2010 in order to give the participants the opportunity to select a project that matches their research interest. The choice has to be submitted before the start of module 11 (exact date to be specified) and should be justified within the MSc pre-proposal.

In a plenary session at the start of module 14, the Principal Investigator of the research group will introduce the various MSc subjects and their interrelation in the framework of the research of his/her group, and introduce the research assignments. A tutor will be appointed during module 14-15 to guide each student group. The tutors will convene plenary sessions (in principle per research group) to monitor the progress of all participating students and to exchange experiences in a discussion forum.

2. Finalizing the research proposal

The MSc research proposal is finalized by the student in mutual agreement with his/her MSc supervisors, appointed in Module 11. The research proposal should be a logical and ordered exposition of the envisaged research (as introduced in Module 11), including data availability, (fieldwork) methods, a flowchart, and time planning. In the last week of Module 15, the research proposal is presented before a Thesis Admission Committee (see MSc assessment regulations paragraph 5.1.1). When presenting the proposal, the student must also satisfy the Thesis Admission Committee that all the required data is available or, if not, that steps (including fieldwork if appropriate) will be taken to acquire these data in time. Likewise, requirements for hardware and/or software should be specified to ensure that these can be made available as required. Acceptance of the proposal is a prerequisite for the start of the individual research (Modules 16-23). The MSc student will draft a supervision plan with the two appointed MSc supervisors.

Prerequisites

Successful completion of Modules 1 to 13 of the MSc curriculum.

Because the research themes will be taught at advanced level, it is necessary to have a basic level of knowledge in the chosen research theme. Consequently, students who want to choose a research theme which differs from their choice in Blocks 1 and 2, have to provide satisfactory evidence that they have the right background.

Recommended Knowledge

To be specified per research theme.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
10	0	0	70	(120)	16 (+32)	(40)

Time (in # of hours) allocated per major method:

- L lecture,
- SP supervised practical,
- UP unsupervised practical,
- GA group assignment (e.g. workshop, project),
- IA individual assignment (including Thesis, IFA),
- S self study,
- O overhead (e.g. QH, exam, opening)

Important:

The numbers above are calculated for two modules: 96 hrs (= 2 weeks) are allocated for the group research project, and 192 hrs (= 4 weeks) are reserved for the MSc proposal (=numbers between brackets).

Assessment

- Group report of the research project.
- Individual written reflection report on the group research project.
- Individual MSc research proposal (written and oral presentation).

MSc Research and Thesis Writing		
Module: 16-23	Module coordinator: Dr. M.J.C. Weir	
Start: 06-09-2010	<ul style="list-style-type: none"> ▪ Course directors of all MSc courses ▪ 2 MSc supervisors per student 	
End: 25-02-2011		
Level: MSc	ECTS: 40	U10-EDU-107

Introduction

The final stage of the MSc course is dedicated to the execution of an individual research project. Each student works independently on an approved research topic (see module 15) connected to one of the 15 research themes of ITC. In this project, the students further develop their research skills, interact with their fellow students, PhD's and staff members and, finally, demonstrate that they have achieved the course objectives for the Master of Science degree by research, on a satisfactory academic level.

Objectives

The student must be able to:

- Define, plan and execute a research project dealing with a problem related to the application of geo-information and earth observation in a domain that suits his/her background and course followed.
- Write a concise, logical and well structured thesis describing the key elements of the research process, the findings and recommendations.
- Orally present and defend the work done before the Thesis Assessment Board.

Contents

Based on the pre-proposal handed in before module 11, and the final accepted research proposal prepared in module 15, the student will carry out the planned activities. The students will be provided with guidelines for the thesis early in the course (specifically in module 11). Regular individual progress meetings with the supervisors will be held to monitor the progress on the research and thesis writing, and records of the progress will be kept. The supervisors keep the course director informed about the progress.

The activities normally include:

- Describe and define a problem statement and research topic and its research margins.
- In-depth literature review, including assessment of the usability of literature and previous research.
- Collection of relevant on-line and archived data.
- If appropriate, preparation and execution of fieldwork to collect primary data required for the research.
- Data processing and analysis and, if deemed necessary, adjustment of the research plan in consultation with the supervisors (based on sound arguments).
- Active participation in Institute seminars and *capita selecta* of the research theme under which the MSc research resorts.
- Mid-term presentation (first week of November).
- Preparation of the final manuscript of the MSc thesis (=hardcopy thesis and CD-ROM with thesis, appendices and full dataset including the original data and results).
- A critical review of the quality, use and usefulness of the data and results, as well as the learning process.
- Oral presentation and defence of the MSc thesis before the Thesis Assessment Board, all in accordance with the relevant paragraphs of the MSc regulations.

Prerequisites

Successful completion of MSc modules 1-15, and proven ability to undertake independent research (ref. to par. 5.3.1. of the MSc regulations).

Recommended Knowledge

During the research phase, the students can specialise further in their own field of expertise.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
0	0	0	0	1136	0	16

Time (in # of hours) allocated per major method:

L	lecture,
SP	supervised practical,
UP	unsupervised practical,
GA	group assignment (e.g. workshop, project),
IA	individual assignment (including Thesis, IFA),
S	self study,
O	overhead (e.g. QH, exam, opening)

Assessment

A Thesis Assessment Board (TAB) will assess the individual assessment based on the written thesis and a presentation plus oral defence. The assessed aspects are:

- Research skills;
- Contribution to the development of the scientific field;
- Ability to work independently;
- Critical and professional thinking;
- Scientific writing;
- Presentation and defence.

For further details on the regulations and thesis assessment, see:

- ITC Regulations for courses leading to an ITC Master of Science (MSc.) Degree (September 2009);
- Instructions for Thesis Assessment Board.

Assessment Regulations

EA/4330

**ITC REGULATIONS FOR COURSES LEADING TO AN
ITC MASTER OF SCIENCE (MSc.) DEGREE
OR
ITC POSTGRADUATE DIPLOMA**

– September 2009 –

1. **Range of application**
2. **Management, structure and organization of the MSc. and Postgraduate Diploma course**
3. **Admission to the course and exemptions**
4. **Assessment of modules (excluding research period and final assignment)**
 - 4.1 **Organization of module assessment**
 - 4.2 **Feedback to participants and re-sits**
5. **Research orientation and research period (MSc. course)**
 - 5.1 **Research orientation (block 3)**
 - 5.2 **The individual research period and thesis (block 4)**
 - 5.3 **Supervision of the proposal phase and the research work**
 - 5.4 **Admission to the research period**
 - 5.5 **Submission of the thesis**
 - 5.6 **Thesis examination**
 - 5.7 **Access to the thesis**
6. **Final Assignment (Postgraduate diploma course)**
 - 6.1 **The Final Assignment and result**
 - 6.2 **Supervision of the Final Assignment**
 - 6.3 **Submission of the Final Assignment result**
 - 6.4 **Assessment of the Final Assignment**
7. **Assessment of MSc. degree and Postgraduate diploma**
8. **Awards and certification**
9. **Early termination of the course**
10. **Student appeal procedures**

Appendix:

Bodies and persons involved in management and quality assurance of the MSc. course and the Postgraduate diploma course

These ITC Regulations for the Master of Science (MSc.) degree and Postgraduate diploma courses were approved by the Rector and the Academic Board on 17 September 2008. These regulations apply to all courses commencing September 2009 onwards and replace all former ITC Regulations for Master of Science degree Courses and Regulations for Postgraduate diploma courses.

1. Range of application

- 1.1. These assessment regulations apply to all courses leading to an ITC Master of Science (MSc.) degree or a Postgraduate diploma (PGD) starting from September 2009 onwards and replace all previous ITC Regulations for Master of Science degree Courses and ITC Regulations for Postgraduate diploma courses.
- 1.2. The MSc. and Postgraduate diploma course can be an ITC course only (fully taught at ITC) or a joint course (partly taught by one or more of ITC's partners and partly by ITC). The course can be taught fully face-to-face or be a combination of face-to-face and distance components. In all cases, ITC monitors and assures the quality of the whole course.
- 1.3. In most cases where the MSc. / Postgraduate diploma course is taught in conjunction with a partner, the two institutes will agree upon new procedures which may take precedence over these 'ITC regulations for courses leading to an ITC Master of Science degree or ITC Postgraduate diploma'. The Course Director of the course concerned will inform the participants which assessment regulations and procedures apply.
- 1.4. Per 1 January 2010 ITC will be integrated in and will become a Faculty with special status of the University of Twente. This integration might have consequences for the assessment regulations and might lead to changes in these assessment regulations during the course.
- 1.5. In all cases that are not dealt with in these rules, the Course Director of the course concerned will decide upon an appropriate course of action. Disputes about the interpretation of these regulations shall be referred to the Rector of ITC, who will determine the interpretation and action that should be taken.
- 1.6. In exceptional circumstances, the Academic Board, Degree Assessment Board, Head Education, and/or Course Director may deviate from these regulations, but only with the approval of the Rector.

2. Management, structure and organization of the MSc. and Postgraduate diploma course

- 2.1. The MSc. course is organized into four blocks with a total of 23 modules and one or two starting weeks for introductory and remedial activities.

Block 1: modules 1-4

Block 2: modules 5-10

Block 3: modules 11-15

Block 4: modules 16-23

The first year of three blocks and 15 modules consists of coursework. The last 6 months (block 4; 8 modules) focus on individual research.

The Postgraduate diploma course consists of the first two blocks (10 modules) of the MSc. course, one or two starting weeks and a Final Assignment of four weeks duration.

- 2.2. The duration of the MSc. course is 18 months fulltime. The duration of the Postgraduate diploma course is nine months fulltime. Participants in both courses may spread the modules over a maximum of three and a half years.
- 2.3. The formal curriculum of the MSc. course and the Postgraduate diploma course has been approved by the Academic Board. Responsibility for detailed development and implementation of the approved course rests with Head Education, who delegates this responsibility to the Course Director. Responsibility for quality assurance of the course rests with the Academic Board.
The Degree Assessment Board decides on the eligibility of the MSc. participant to receive the MSc. degree. The Academic Board decides on whether the participant in the Postgraduate diploma course will receive the Postgraduate diploma.
(See also the appendix 'Bodies and persons involved in management and quality assurance of the MSc. course and the Postgraduate diploma course').
- 2.4. During and at the end of the course, a participant's competence in the field of study will be assessed through tests, examinations and/or assignments (in written, oral and/or practical form) and/or based on participation. Assessments will be used to:
- Provide feedback to participants so that they may improve their performance (formative assessment), or,
 - Grade participants' work with a mark or quality description on a scale which indicates their competence in the field of study (summative assessment).
- Before any assessment, participants shall be told which of the above two functions applies.
These regulations describe the conditions and procedures concerning summative assessments.
- 2.5. At the beginning of the MSc. and Postgraduate diploma course each participant shall receive a study guide that contains:
- Descriptions of the content of the course and modules
 - A copy of these regulations
 - The name of the MSc. degree / Postgraduate diploma to be received on successful completion of the course
 - The course-specific conditions relating to that MSc. degree / Postgraduate diploma
 - Which module assessments will result in a mark and which modules in 'completed/fail'.
- 2.6. The relationship between mark ranges, 'completed / fail' and grades is as follows:
- | Mark: | Grade: |
|--------------|----------------|
| 90 100 | Excellent |
| 80 89 | Very good |
| 70 79 | Good |
| 60 69 | Pass |
| 00 59 | Fail |
|
 | |
| 'completed' | Pass or higher |
| 'fail' | Fail |

3. Admission to the course and exemptions

- 3.1. Applicants who meet the entry requirements for the MSc. / Postgraduate diploma course, as stipulated in the current course brochure, may be registered for the MSc. / Postgraduate diploma course at the discretion of the Course Director.
- 3.2. Participants in the Postgraduate diploma course who wish to take the whole MSc. course have to re-apply for the (second part of the) MSc. course. In such cases the maximum time between the starting date of the Postgraduate diploma course and the graduation date of the MSc. course is three and a half years (see rule 3.4).
- 3.3. Participants may be given exemption for a module of the course when they have shown they have already mastered the content of the module. An exemption for a module may lead to direct admission to the next module or to exchange of the module for a module in another course. Exemptions are subject to the approval of the Degree Assessment Board (MSc. course) or the Academic Board (PGD course) and, in case of exchange for a module in another course, approval of the Course Director of that course.
- 3.4. Exemption for a module will be given when this module was successfully completed by the participant:
 - (1) As part of another course in the same ITC domain as the MSc. / Postgraduate diploma course and
 - (2) No longer ago than three and a half years before the participant is expected to complete the MSc. / Postgraduate diploma course.At least 50% of the MSc. / Postgraduate diploma course has to be taken to be eligible for the MSc. degree / Postgraduate diploma. Therefore, exemption can be given for a maximum of 11 modules of the MSc. course and for a maximum of five modules of the Postgraduate diploma course.

Requests for exemption that do not meet these conditions will be considered on an individual basis, at the discretion of the Degree Assessment Board (MSc. course) or the Academic Board (PGD course). In such cases, exemption can be given for a maximum of eight modules in the MSc. course and four modules in the Postgraduate diploma course.

Exemption can never be given for (part of) the research work or Final Assignment.
- 3.5. In exceptional cases, a participant may also exchange a module of which the content has not been mastered for a module given in another course, provided that the Course Director of that course approves. Such an exchange is up to a maximum of two modules and subject to the approval of the Degree Assessment Board (MSc. course) or Academic Board (PGD course).
- 3.6. Rules 3.2, 3.3 and 3.4 concerning exemptions do not apply to joint courses and other cases where ITC has an agreement with a partner institute that participants who have successfully completed a specific curriculum in the partner institute can be given direct admission to a later part of the MSc. or Postgraduate diploma course.

4. Assessment of modules (excluding research period and final assignment)

4.1. Organization of module assessment

- 4.1.1. Each module will be assessed by means of a test, examination, assignment and/or based on participation. More than one assessment per module is allowed but must result in a single module mark (0 - 100) or 'completed / fail'. For combined modules (e.g. core modules, thesis), one overall assessment is allowed.

Up to three of the first 11 modules in the MSc. course may be assessed by 'completed / fail'. The other module assessments must result in a mark.

The assessment of modules 12 and 13 may not be based on participation only and must result in a mark.

- 4.1.2. For admission to the research part (see rule 5.3.1) and for the calculation of the average of all modules (see rule 7.2), the result obtained for combined modules will be given to each separate module.
- 4.1.3. Participants shall be informed of the date, subject, objectives and form of the assessment (practical, written, oral or computer-based, open or closed book), at least one week before an assessment.
- 4.1.4. The maximum duration of each assessment shall be as follows:
- | | |
|------------------------------------|-----------------------------------|
| Written theoretical exam | 3 hours |
| Computer-based theoretical exam | 2 hours |
| Practical assignment | determined by the Course Director |
| Oral theoretical or practical exam | 45 minutes |

Participants shall be informed at the start of each assessment of:

- the duration of the assessment;
- if there is a choice, the number of questions to be answered;
- the weight of each question;
- whether books and/or notes may be used.

Two staff members must be present at an oral assessment.

4.2. Feedback to participants and re-sits

- 4.2.1. Participants shall be informed, individually, of the results of an assessment by the staff responsible for the assessment or by the Course Secretary, normally within two weeks of an assessment. The marks awarded for each question or assignment shall be made known to each participant.
- 4.2.2. Marked scripts shall be shown to participants so that they may know the strengths and weaknesses of their answers. Answers to questions and results of assignments shall be reviewed in a class session, through the distribution of answer sheets or through comments on scripts. Staff responsible for the assessment is required to give an explanation of the marks awarded.

Scripts will be retained for at least one year after the results are officially recorded.

- 4.2.3. The following rules apply to re-sits:
- (1) Only those participants who fail an assessment at the first attempt (i.e. who achieve a mark less than 60 or 'fail') may re-sit that assessment. Only one re-sit per assessment is allowed.
 - (2) Participants who re-sit an assessment may obtain only a maximum mark of 69 (or PASS grade) or 'completed'.
 - (3) The previous mark or 'fail' will only be superseded when participants achieve a higher mark or 'completed' in the re-sit.
 - (4) Only the final grade will be shown on the Course Record or Certificate, without any indication whether the final grade was obtained through a re-sit or not.
 - (5) Participants who have failed due to serious circumstances (at the discretion of the Course Director) can apply for a new assessment, provided they have reported their circumstances in writing to the module coordinator or staff member responsible for the assessment before the scheduled assessment time.
- 4.2.4. In the case of practical assignments of long duration (practical exercises, a case study with fieldwork) the possibility of repetition can be considered only in exceptional circumstances and subject to approval by the Course Director.
- 4.2.5. A participant not attending a scheduled assessment, not completing an assignment or not presenting the required work within the specified time, will be considered as having failed. The participant will be given a 'fail' or a mark of 40 (or the lowest mark, if lower than 40, scored by the other participants on this assessment). If an acceptable reason (at the discretion of the Course Director) can be offered, the participant can apply in writing for a new assessment or extension of the deadline for submission of the assignment.
- 4.2.6. In case of plagiarism or other types of fraud, the participant(s) concerned will be considered to have failed and a mark 0 (zero) will be given (see also rule 9.5).
- 4.2.7. The grade sheets managed by the Course Secretary are the official record of the results of assessments. In case of discrepancies between this official record and marks and grades presented to participants in other ways, the marks and grades in the official record apply.

5. Research orientation and research period (MSc. course)

5.1. Research orientation (block 3)

- 5.1.1. At a specified date before the start of Module 11 participants must submit:
- (1) The research theme they will join,
 - (2) A motivated choice of modules 12 and 13, and
 - (3) The preliminary title of the individual MSc. research topic and its main thrust.

The choices will be assessed by the Course Director and the research theme leader concerned (or delegate).

Approval of these choices leads to admission to the research theme and two MSc. supervisors will be appointed (see rule 5.3.1).

- 5.1.2. The final MSc. research proposal (approximately 8 pages) must be presented in module 15.
- 5.1.3. Participants have freedom to choose from the advanced subjects on offer in modules 12 and 13, with the limitation that modules will only be given when sufficient participants will participate.

5.2. The individual research period and thesis (block 4)

- 5.2.1. The MSc. research period focuses on individual research. The research requires that the MSc. participant carries out the research and reports on progress to the supervisors according to an agreed schedule for the research and preparation of the thesis.
- 5.2.2. The research work will be assessed on three occasions:
- (1) The detailed research proposal and presentation, leading to admission / no admission to the research period (end of module 15).
 - (2) The mid-term presentation. No mark is given. The participant receives feedback from the supervisors. In the case of weak performance, the participant will receive a written warning from the Course Director (see rule 9.1).
 - (3) The assessment and oral examination of the thesis.
- In addition to these formal assessments, the participant will receive feedback on his/her performance from the supervisors throughout the research period.
- 5.2.3. A participant not presenting the (draft) research proposal, not making the mid-term presentation, not submitting the thesis or not attending the final oral examination within the specified time, will be considered to have failed. Only in exceptional cases, and for reasons beyond the control of the participant (at the discretion of the Course Director), the participant may apply in writing for a new opportunity to meet the above requirements.

- 5.2.4. The thesis, approximately 50 pages of text (approximately 350 words per page and presented in the standard ITC format for theses), excluding appendices, shall constitute an ordered, logical and critical description of the research and should afford evidence of reasoning power, critical attitude, competence in the scientific discipline (application and/or development of knowledge and skills), and knowledge of relevant literature.
- 5.2.5. The thesis may describe work done in conjunction with a supervisor or any other person, but the extent of the participant's personal contribution must be certified by the supervisor concerned.
- 5.2.6. With the explicit approval of the supervisor, a participant may be permitted to incorporate in his/her thesis a limited amount of unpublished work undertaken by the participant prior to the start of the research. A participant may not incorporate in his/her thesis material which has been submitted for achieving the award of a degree from any other educational institution.
- 5.2.7. The source of any photograph, map, or other illustration shall be indicated, as shall the source, published or unpublished, of any material not resulting from the participant's own work.
If material from other work is incorporated verbatim, without proper acknowledgement of the source (plagiarism), the Thesis Assessment Board will decide not to assess the thesis. This means that the MSc. degree cannot be awarded (see also rule 9.3 and 9.5).
- 5.3. Supervision of the proposal phase and the research work
 - 5.3.1. In module 11, in consultation with the research theme leader and the MSc. participant, the Course Director shall recommend a primary and secondary supervisor to the supervisor's department(s). PhD students and AiO's may be involved in the supervision as advisor and support the work of the supervisors. Supervisors and advisors are appointed by the management team of the department.
 - 5.3.2. The two supervisors and, if applicable, the advisor shall divide the supervision tasks and make a supervision plan and meeting schedule with the participant.
 - 5.3.3. Supervisor(s) shall:
 - (1) Guide the MSc. participant in the formulation of a detailed research proposal.
 - (2) Establish a schedule of regular supervisory meetings with the MSc. participant (on an average once per fortnight). Additional meetings may be arranged by agreement.
 - (3) Provide general advice and guidance on the execution of the research.
 - (4) Provide feedback on draft written work, normally within 10 days of receipt.
 - (5) Where appropriate, forward any comments on the performance of the participant to the Course Director.

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- (6) Inform the Course Director when the progress of a participant gives cause for concern so that action can be taken in accordance with these regulations (see rules 9.1 and 9.2).
- 5.3.4. If a MSc. participant considers that he/she is not receiving the quality of supervision required in the regulations, the participant should report this to the Course Director.
 - 5.3.5. Replacement of a supervisor may be considered if the research is found to be outside a supervisor's area of expertise, or at the request of the supervisor and/or of the participant.
- 5.4. Admission to the research period
 - 5.4.1. For admission to the research part of the course, at least all but two of the previous modules (see rule 7.2 to see which modules are to be included) must have been successfully completed and no mark below 50 is allowed. The second requirement for admission to the research part, which is as important as the marks obtained in previous modules, is the ability to undertake independent research. This ability will be developed and assessed during the first 15 modules and finally assessed on the basis of the detailed, written and orally presented, research proposal (end of module 15).
 - 5.4.2. The Course Director will nominate, and the Degree Assessment Board will approve, a Thesis Admission Committee. This Committee will assess the proposal and the presentation by the participant. The Thesis Admission Committee is accountable to the Course Director.
 - 5.4.3. Each Thesis Admission Committee has 3 members: the research theme leader or delegate (chair), the first supervisor and the second supervisor (or delegate). The Course Director and involved PhD students or AiO's (see 5.3.1) may be present as advisors.
 - 5.4.4. The research proposal will be assessed based on the written proposal, a presentation and oral defence. The presentation and oral defence have a duration of a half hour. The participant will receive the result and remarks in writing.
 - 5.4.5. The oral defence of the research proposal is open and will be announced as such.

In exceptional cases the Course Director can decide to have the oral defence of individual participants closed to observers other than ITC staff.
 - 5.4.6. When the Thesis Admission Committee is of the opinion that the research proposal is not of a level required for the start of the individual research period, the participant will receive feedback and will have a second opportunity to defend a revised proposal within two weeks. In case the second proposal presentation is not satisfactory, the candidate will not be admitted to the individual research period.

- 5.4.7. A participant who is not eligible for admission to the individual research period of the course but has completed modules 1 to 14 of the MSc. course successfully (see rule 8.1) will receive a Postgraduate diploma.
- 5.5. Submission of the thesis
- 5.5.1. The participant must submit a well-organized copy of all digital files associated with the research work on DVD, and a hard-copy of graphic output, at least two weeks before the examination date or as specified by the Course Director.
- 5.5.2. ITC will produce sufficient printed copies of the thesis, including two for the participant. The participant must bring one of his/her copies of the thesis to the oral examination.
- 5.5.3. One copy of the thesis will be sent to each member of the Thesis Assessment Board. The Institute will retain two bound copies if a degree is awarded, one of the copies being lodged with the Institute Librarian and the second copy in the course archive.
- 5.5.4. Where work submitted has been done in cooperation with others, the supervisor must submit a written statement to the Thesis Assessment Board indicating the extent of the participant's share of the work.
- 5.6. Thesis examination
- 5.6.1. For the thesis examination, the Course Director nominates and the Degree Assessment Board approves a separate Thesis Assessment Board for each participant. The Thesis Assessment Board is accountable to the Course Director.
- Each Thesis Assessment Board has 3 to 5 members: one or both supervisor(s), an ITC professor or associate professor in a relevant discipline, an external examiner and, if necessary, other staff members of the ITC. The involved AiO or PhD student (see 5.4.1) and the Course Director may be present as advisors.
- In many cases, the external member comes from outside ITC, preferably being an academic staff member of a university. In the remaining cases, the external member comes from an ITC department that does not play a major role in the course and research theme.
- The Thesis Assessment Board is chaired by the ITC (associate) professor. In exceptional cases one of the other members, but not the first supervisor, can be the chair.
- 5.6.2. The thesis examination consists of the assessment of the thesis and the oral examination that includes a presentation and defence. The oral examination has a duration of one hour.
- 5.6.3. The Course Director assigns a date for an oral examination and informs the participant at least one month in advance of this date.

- 5.6.4. All members of the Thesis Assessment Board shall read and assess the quality of the thesis as an ordered, logical and critical exposition of research work in the approved field.

A minimum of three members of the Thesis Assessment Board must be present at the oral examination. (In case the ITC (associate) professor cannot attend, Head Education will appoint another ITC (associate) professor to replace him or her.) These members of the Thesis Assessment Board will assess the participant's reasoning power, critical attitude, competence in the scientific discipline, and knowledge of the relevant literature, will raise questions concerning the thesis and will decide on the mark.

- 5.6.5. The oral examination is open and will be announced as such. In exceptional cases the Course Director can decide to have the defence of individual participants closed to observers other than ITC staff.
- 5.6.6. On the basis of the assessment of the participant the Thesis Assessment Board shall take one of the following decisions:
- (1) The thesis is satisfactory. One single mark is given.
 - (2) Subject to minor corrections (that can be implemented within three working days and implemented before the official end of the course) in the thesis, the thesis is satisfactory. One single mark is given, subject to the corrections in the thesis being made.
 - (3) The thesis is not satisfactory and is given the FAIL grade.
- 5.6.7. No changes may be made in the thesis after submission for the thesis examination, only an errata list may be added. If the Thesis Assessment Board requires minor corrections to the thesis, these, and only these, corrections must be made and must be checked and approved by one of the supervisors. In all other cases changes can only be made when the thesis is to be re-examined by the Thesis Assessment Board.
- 5.6.8. Extensions to the research period can be given before the thesis is submitted and/or as result of the thesis examination. In case the participant does the research work at a distance, extension can only be given before the thesis is submitted.
Extensions will be given only when:
- (1) Funding for the extension is available,
 - (2) The main cause of the unsatisfactory level of the thesis has been beyond the control of the participant (at the discretion of the Course Director),
 - (3) The extension could lead to an acceptable thesis and re-examination (at the discretion of the Thesis Assessment Board)
- The participant will take the initiative and apply in writing for extension. If the Course Director is of the opinion that the second and third conditions are met, he/she will forward the request to Head Education for decision.
- 5.6.9. The maximum total duration of extensions to the research period is three months. Extensions are allowed only when the participant stays at ITC or, in the case of a joint course, at the institute of the partner.

This does not apply to participants who study part-time. They are allowed to work on the thesis in the home organization and since the MSc. course may be spread over a period of maximum three and a half years (see rule 2.2) they may work on the thesis until about a month before the end of the three and a half year period. In such cases, no extensions are possible.

5.7. Access to the thesis

5.7.1. The primary function of the Institute is the development and dissemination of knowledge. Theses are lodged with the Institute Librarian and shall be made available for consultation, inter-library loan and photocopying.

Theses that meet the following criteria will also be made available in digital format at the ITC website:

- (1) Have been awarded a mark of 75 or more
- (2) Contain no material of which the copyright rests with third parties
- (3) Contain no confidential data or information.

5.7.2. Any staff member who publishes results from MSc. research work or the related thesis is obliged to make a proper reference to the MSc. participant's work.

6. Final Assignment (Postgraduate diploma course)

6.1. The Final Assignment and result

6.1.1. The Final Assignment period focuses on the application of knowledge, methods and techniques in the subject of the course to the task performed or to the topic investigated. Depending on the course, the Final Assignment will be done individually or in small groups.

- (1) At the start of the Final Assignment period, participants will receive terms of reference from supervising and coordinating staff.
- (2) Subsequently, participants will have to plan and carry out the assignment according to the terms of reference.
- (3) Part of the output of the assignment will be a final report and a documented database.
- (4) The output of the assignment will be presented and discussed in public.

6.1.2. A participant or group not completing the Final Assignment within the specified time, will be considered to have failed. Only in exceptional cases and for reasons beyond the control of the participant/group (at the discretion of the Course Director), the participant/group may apply in writing for a new opportunity to meet the above requirements.

6.1.3. A participant or group may not incorporate material that has been submitted for achieving certification from any other educational institution, in the Final Assignment result.

6.1.4. The source of any photograph, map, or other illustration shall be indicated, as shall the source, published or unpublished, of any material not resulting from the participant/group's own work.

If material from other work is incorporated verbatim, without proper acknowledgement of the source (plagiarism), the Course Director may decide that the Final Assignment will not be assessed. This means that the Diploma cannot be awarded.

6.2. Supervision of the Final Assignment

6.2.1. The coordinator of the Final Assignment period, in consultation with the Course Director, will set up a scheme indicating which staff is available for consultation and supervision throughout the Final Assignment period. The supervising staff have to be appointed by the management team of their department.

6.2.2. The supervising staff shall:

- (1) Provide the participant/group with clear terms of reference.
- (2) Establish a schedule of supervisory meetings with the participant/group.
- (3) Provide general advice and guidance on the execution of the Final Assignment.
- (4) Provide feedback on work, normally within three days of submission.
- (5) Forward, where appropriate, any comments on the performance of the participant(s) to the Course Director.
- (6) Advise the Course Director when the progress of a participant gives cause for concern so that action can be taken in accordance with these regulations (see 9.1 and 9.2).

6.2.3. If a participant/group considers that he/she is not receiving the quality of supervision required in the regulations, the participant/group should seek action from the Course Director.

6.3. Submission of the Final Assignment result

6.3.1. The participant/group must submit a well-organized copy of all digital files associated with the Final Assignment work on DVD, and copies of hard-copy graphic output, to the supervising staff on the date of the Final Assignment assessment or as specified by the coordinator of the Final Assignment period in consultation with the Course Director.

6.3.2. Where the Final Assignment has been executed in groups or where individual Final Assignment work submitted has been executed in cooperation with others, the supervisor(s) must provide a written statement, indicating the extent of the share of the work that each participant has done.

6.4. Assessment of the Final Assignment

6.4.1. Participants will be assessed individually based on the output of and the presentation of the Final Assignment.

6.4.2. The Course Director assigns a date for the Final Assignment assessment and informs the participant/group of this date at least two weeks in advance.

- 6.4.3. Criteria for the assessment of the Final Assignment will be provided at the start of the Final Assignment period, i.e. at the time of providing the participants with the terms of reference for the final assignment.
- 6.4.4. The Final Assignment result will be assessed by two or three staff members: at least one (associate) professor in a relevant discipline and at least one staff member who has been involved in the supervision during the execution of the Final Assignment.
- 6.4.5. The presentation of the Final Assignment is open and will be announced as such. In exceptional cases the Course Director can decide to have the presentation of individual participants closed to observers other than ITC staff.
- 6.4.6. On the basis of the assessment of the participant(s) the assessing staff shall take one of the following decisions:
- (1) That the Final Assignment is satisfactory. One single mark is given.
 - (2) That subject to minor corrections (that can be implemented within three working days and implemented before the official end of the course) in the Final Assignment result, the Final Assignment is satisfactory. One single mark is given, subject to the corrections in the Final Assignment result being made.
 - (3) The Final Assignment is not satisfactory and is given the FAIL grade.
- 6.4.7. In exceptional cases extension may be given for the Final Assignment work, but only before the Final Assignment assessment and only when:
- (1) Funding for the extension is available, and
 - (2) The main cause of the unsatisfactory level of the Final Assignment has been beyond the control of the participant/group, at the discretion of the Course Director.
- The participant will take the initiative and apply in writing for extension. If the Course Director is of the opinion that condition 2 is met he/she will forward the request to Head Education for decision.
- 6.4.8. Extensions have a maximum duration of 50% of the standard duration of the Final Assignment. Extensions are only allowed when the participant/group stays at ITC.

This rule does not apply to participants who study part-time. They are allowed to work on the Final Assignment in the home organization until the end of the period of three and a half years counting from the official starting date of the course (see rule 2.2). In such cases, no extensions are possible.

7. Assessment of MSc. degree and Postgraduate diploma

- 7.1. On the basis of the assessment results of the participant, the Degree Assessment Board decides whether the participant will be awarded the MSc. degree.

On the basis of the assessment results of the participant, the Academic Board decides whether the participant will be awarded the Postgraduate diploma.

In case the Degree Assessment Board (MSc. course) or Academic Board (PGD course) decides that the MSc. degree or Postgraduate diploma will not be awarded, the Course Director will decide whether the participant will be awarded a Certificate or Certificate of Attendance.

- 7.2. For the award of a MSc. degree the average of all module marks (including the thesis that counts for 8 module marks) must be at least 60, no more than 2 modules may have a mark below 60 and no module mark below 50 is allowed. This implies that the thesis must have a mark of at least 60.

The criteria for the award of a Postgraduate diploma are:

- (1) The average of all final module marks must be at least 60. When a module is assessed with 'completed' or 'fail': a 'completed' will not be included in the average, a 'fail' will be counted as a mark of 50. In case of one overall assessment for combined modules, the overall mark will be given to each separate module, before calculation of the average.
- (2) No more than two of the modules may have a mark below 60. No final module mark below 50 is allowed.
- (3) The final assignment must have a mark of at least 60.

Only results of modules that are part of the formal curriculum of the MSc. or Postgraduate diploma course are included in the calculation of the average and counted for the number of marks below 60 and below 50. Therefore results of a module that is taken in addition to the formal curriculum or in exchange for a module of the formal curriculum for which exemption was given, will not be included. However, a module that was taken in exchange because of a reason other than exemption (see rule 3.4), is (only for the application of this rule 7.2) considered as part of the formal curriculum.

When a module is assessed with 'completed', this will not be included in the average. When a module is assessed with 'fail', this will be counted as a mark of 50.

If results of modules were obtained more than three and a half years before the end of the course, then the validity of these modules must be confirmed by the Degree Assessment Board (MSc. course) or Academic Board (PGD course). (See rule 3.4.)

- 7.3. To be entitled to receive a MSc. degree or Postgraduate diploma with distinction the average of all module assessments (see rule 7.2 which modules are to be included) must be 80 or above. The thesis or Final assignment must have a mark of 80 or above. No marks below 70 or 'fails' are allowed.

Participants who have made changes in the formal curriculum of their MSc. or Postgraduate diploma course (exemptions or exchanged modules) that affect more than four (MSc. course) or two (PGD course) modules are not entitled to receive a MSc. degree or Postgraduate diploma 'with distinction'.

- 7.4. The Degree Assessment Board (MSc. course) / Academic Board (PGD course) shall take one of the following decisions:
- (1) That the thesis / final assignment and overall course performance of the participant are satisfactory. The degree of MSc. / Postgraduate diploma shall be awarded.
 - (2) That the thesis / final assignment and overall course performance of the participant are such that the MSc. degree / Postgraduate diploma shall be awarded "with distinction".
 - (3) That subject to minor corrections in the thesis / final assignment, the thesis/ final assignment and overall course performance are satisfactory. The degree of MSc. / Postgraduate diploma shall be awarded subject to the corrections in the thesis / Final Assignment result being made before the official end of the course.
 - (4) For MSc. candidates: That the research work / final assignment and/or overall course performance are not satisfactory. The degree of MSc. shall not be awarded. The participant will receive a Postgraduate diploma.

For Postgraduate diploma course participants: That the final assignment and/or overall course performance are not satisfactory. The Postgraduate diploma shall not be awarded. The participant will receive a Certificate.

8. Awards and certification

- 8.1. A "**Master of Science degree**" will be awarded to a participant who has been officially admitted to a MSc. course (as approved by the Academic Board) and has fulfilled the assessment requirements of that course.

A "**Postgraduate diploma**" will be awarded to a participant who has been officially admitted to a PGD course (as approved by the Academic Board) and has fulfilled the assessment requirements of that course.

A "Postgraduate diploma" ('with distinction' will not be possible in this case) will also be awarded to a participant who (1) has been officially admitted to a MSc. course, (2) has not been admitted to the research period or has failed the thesis, and (3) has completed modules 1 to 14 of the MSc. course successfully (average of all module marks is at least 60, not more than two marks between 50 and 60 and no marks below 50).

A "**Certificate**" will be awarded to a participant who (1) has been officially admitted to a MSc. course or Postgraduate diploma course but has not fulfilled all assessment requirements for that course, and (2) who has fulfilled the assessment requirements of at least one summatively assessed module of that MSc. or Postgraduate diploma course.

The Certificate will mention that the participant 'has followed a course in Geo-information Science and Earth Observation' and the study load. Only the modules that have been completed and the modules in which the participant has participated for at least 80%, will be included in the study load.

A “**Certificate of Attendance**” will be given to participants who have been officially admitted to a MSc. course or Postgraduate diploma course, but have not fulfilled the assessment requirements of any summatively assessed module. The Certificate of Attendance will mention that the participant ‘has attended a course in Geo-information Science and Earth Observation’ and the study load. Only the modules in which the participant has participated for at least 80% will be included in the study load.

No qualification other than “with distinction” will be indicated on any MSc. degree or Postgraduate diploma.

- 8.2. MSc. degrees and Postgraduate diplomas are issued under the responsibility of the Rector. Certificates and Certificates of Attendance are issued under the responsibility of the Course Director.
- 8.3. MSc. degrees and Postgraduate diplomas are signed by the Rector of the ITC and Head Education. Certificates and Certificates of Attendance are signed by the Course Director.
- 8.4. MSc. degrees are accompanied by a Diploma Supplement. The Diploma Supplement describes the nature, level, context, content and status of the MSc. degree and the MSc. course. The Course Record (see 8.4) is included in the Diploma Supplement.
- 8.5. MSc. degrees, Postgraduate diplomas and Certificates are accompanied by a Course Record, signed by the Course Director. The Course Record will show the period of study, the study load, the titles of and marks or grades obtained for the modules that have been finished successfully or that the participant has participated in for at least 80% but not finished successfully. The assessments ‘completed’ or ‘fail’ will appear as such in the Course Record.
- 8.6. Only the names and marks and/or grades of the modules that are taken are mentioned on the Course Record. In case of exemption the number and not the name of the module will be mentioned (e.g. “Modules 1-3: exemption”). In case a new module was taken in exchange of a module for which exemption was given, the name of the new module will be mentioned also (e.g. “Module 3: exemption. Extra module: Database design”). In case of exchange of a module for another reason than exemption only the name of the new module will be mentioned (e.g. “Module 3: Database design”).

The names of modules (and the results obtained) that are taken in addition to the formal curriculum of the course are also listed on the Course Record (e.g. “Extra module: Database design”).

9. Early termination of the course

- 9.1. Where a Course Director and/or Head Education are/is of the opinion that a participant's progress gives cause for concern the participant shall be informed of the situation by the Course Director. Where a participant's performance is such that she/he is unlikely to obtain a MSc. Degree / Postgraduate diploma without a significant improvement in performance, the participant shall be advised in writing by the Course Director of the situation and the implications.
(Oral or written advice by the Course Director may not be given when the concern arises after the mid-term presentation of the thesis or after the approval of the Final Assignment plan.
- 9.2. In cases of obvious non-performance, a Course Director and/or Head Education may decide at any time that a participant must discontinue his/her course. Such a decision will not be taken without consulting the Degree Assessment Board (MSc. course) or Academic Board (PGD course) and the participant having received one written warning and being given time to improve performance.
- 9.3. In case of fraud during an exam or in assignments, the participant(s) concerned will be considered to have failed and a mark 0 (zero) will be given.

In case of plagiarism in the submitted thesis, the Thesis Assessment Board will decide not to assess the thesis. Extensions of the thesis period are then not possible. This means that the MSc. degree cannot be awarded. The participant will get a Postgraduate diploma.

In case of plagiarism in the submitted final assignment of the Postgraduate diploma course, the Course Director may decide that the final assignment will not be assessed. This will mean that the Diploma cannot be awarded, the participant will get a Certificate.

- 9.4. In case of other types of misbehaviour, the Course Director will consider expulsion from the course.
- 9.5. In case of severe or repeated fraud, plagiarism or other types of misbehaviour, the Course Director, in consultation with the Academic Board, will decide that the participant is expelled from the course.
Expulsion from the course means that the participant will not receive any certification.
- 9.6. ITC will use plagiarism detection software or other tools to detect fraud.

In submitting a text, the participant implicitly consents to the text being entered in the database of the detection software concerned.

10. Student appeal procedures

- 10.1. In case of problems of a general or structural nature in the course, the Student Association Board (SAB) may be consulted.
- 10.2. In the event that a participant disagrees with decisions taken by a staff member or Thesis Assessment Board, he/she may present this decision for reconsideration to the Course Director.
Where a participant finds that he/she is not receiving the quality of thesis / final assignment supervision required in the regulations, the participant should also seek action from the Course Director.
- Only in the event that a MSc. participant disagrees with decisions taken by the Degree Assessment Board he/she may present this decision for reconsideration to Head Education directly (see rule 10.3).
- 10.3. If not satisfied with the decision of the Course Director, the participant can seek action from Head Education. If Head Education rejects the complaint of the participant he/she will respond in writing describing the reasons.
- 10.4. If still not satisfied, participants have a final right of appeal with the Student Appeals Board. An appeal will only be accepted if:
- The formal methods of dealing with complaints (see rules 10.2 and 10.3) have not led to agreement;
 - The appeal concerns the implementation of these 'ITC Regulations for Master of Science (MSc.) degree and Postgraduate diploma courses' or the assessment of the thesis / Final assignment and
 - The appeal has been made before the official end of the course. Appeals concerning the assessment of the thesis can be made later up to a maximum of four weeks after the mark was received.
- Appeals should be addressed in writing to the Chairman of the Student Appeals Board, through the Rector, and be accompanied by the argued written response to the appeal by Head Education.
- 10.5. Where unequal treatment of participants is claimed, copies of all relevant scripts shall be made available for review by those investigating the appeal.
- 10.6. The Student Appeals Board consists of three staff members to be appointed by the Rector. These staff members should not have been involved in the situation leading to the appeal. For appeals concerning the assessment of the thesis, staff members representing fields related to the subject of research will be invited to sit on the Student Appeals Board.
- 10.7. After having heard all parties involved (including the Course Director) for relevant information, the Student Appeals Board will take a final decision on the appeal. The decision on an appeal will be passed on to the Rector only if the Appeals Board cannot reach consensus. No further appeal will be possible.
- 10.8. The Student Appeals Board can reject the appeal or support it. In the latter case, the Student Appeals Board shall suggest remedial actions, which may include extension of the fellowship.

- 10.9. The Student Appeals Board should deal with the case within two weeks of receipt of the appeal. If necessary the fellowship will be extended for the duration of the appeal procedure. In case of an appeal concerning the assessment of the thesis, the fellowship may only be extended when the appeal is made before the official end of the course.
- 10.10. Support to a request for reconsideration or appeal concerning the assessment of the thesis cannot lead to overruling the assessment of the thesis by a Thesis Assessment Board that is composed according to these regulations. Acceptable remedial actions do include a re-sit for the oral part of the thesis examination (only when a reason beyond the control of the participant has caused underperformance in the oral part) or an extension to the research period (only when the main cause of unsatisfactory level of the thesis has been beyond the control of the participant) in combination with a full re-examination.

Support to a request for reconsideration or appeal concerning the assessment of the final assignment in the Postgraduate diploma course cannot lead to overruling the assessment of the final assignment, carried by (a) supervisor(s) according to these regulations. Acceptable remedial actions do include a re-examination (only when a reason beyond the control of the participant has caused underperformance in the oral part) by the supervisor(s) or two other ITC staff members with sufficient expertise in the subject of the Final Assignment.

Bodies and persons involved in management and quality assurance of the MSc. course and the Postgraduate diploma course

The mentioned tasks and responsibilities must be carried out in accordance with these 'ITC Regulations for the Master of Science (MSc.) degree and Postgraduate diploma courses'.

Rector

The Rector has the overall responsibility for all tasks of ITC. The Rector has delegated the academic, quality and policy aspects of the educational programmes and courses to the Academic Board and the implementation of the programmes and courses to Head Education.

The Rector appoints the Head Education, Course Director, Director Graduate Programme and Student Appeals Board.

Scientific Council

The Scientific Council advises the Rector and Academic Board on the quality of education and research of the ITC. This responsibility includes:

- Advice on degrees offered by the ITC
- Advice on course curricula, including admission and thesis examination criteria.
- Advice on ITC's quality assurance system
- Advice on degree and assessment regulations, including these 'ITC Regulations for the Master of Science (MSc.) degree and Postgraduate diploma courses'

The Scientific Council is a mainly external body; two third of the members are professors of Dutch universities.

Academic Board (AB)

The Academic Board is responsible for the quality of ITC's courses and for development of policy on education. This responsibility includes:

- Advice on the degrees offered by the ITC
- Approval of the curricula of MSc. and Postgraduate diploma courses
- Approval of ITC's quality assurance system and monitoring of the implementation
- Advice on course-specific elements of the quality assurance system
- Approval of policy on education
- Approval of degree and assessment regulations, including these 'ITC Regulations for the Master of Science (MSc.) degree and Postgraduate diploma courses'
- Acting as Degree Assessment Board
- Decision on deviation of the formal curriculum by individual participants in the Postgraduate diploma course.
- Decision on award of the Diploma to individual participants in the Postgraduate diploma course.

The Academic Board consists of the Rector (chair) and all full and visiting professors of ITC.

Research theme leader

The Research Theme leader is responsible for all research carried out by the scientific staff and participants connected to that theme. This responsibility includes:

- Admission of the participant to the research theme
- Monitoring of the quality of the research supervision given to MSc. participants under the theme

Research theme leaders are ITC (associate) professors.

Head Education

Head Education is responsible for:

- Monitoring of the implementation of the MSc. course and Postgraduate diploma course, ITC's quality assurance system and ITC's educational policy as approved by the Academic Board and the Rector. Head Education delegates the actual implementation to the Course Director
- Coordination and implementation of supra-course aspects. Head Education delegates the coordination of supra-course aspects of block 3 and block 4 of all MSc. courses to the Director Graduate Programme

Course Director (CD)

The Course Director is responsible for:

- Implementation of the MSc. course and Postgraduate diploma course, ITC's quality assurance system and ITC's educational policy, as delegated by Head Education
- Implementation of decisions taken by Head Education
- Day-to-day co-ordination and execution of the course
- Counselling of participants in matters concerning their studies

Director Graduate Programme

The Director Graduate Programme is responsible for:

- Coordination of the development and implementation of supra-course aspects of block 3 (research orientation) and block 4 (individual research period) of the MSc. course

Degree Assessment Board

The Degree Assessment Board assures that participants who are awarded the MSc. degree have the required level.

This responsibility includes:

- Decision on deviation of the formal curriculum by individual participants
- Appointment of the Thesis Admission Committee
- Appointment of the Thesis Assessment Boards
- Decision on award of the degree to individual participants

The Academic Board acts as Degree Assessment Board.

Thesis Admission Committee

The thesis Admission Committee is responsible for assessment of the thesis proposal and admission to the research part of the MSc. course.

Thesis Assessment Board

Responsible for assessment of the thesis and oral examination of the participant on completion of the research.

Student Appeals Board

The Student Appeals Board is a semi-permanent committee, which will be appointed by the Rector when an appeal from a participant is received.

EA/4334

**Additional rules for
short courses and individual study programmes leading to an
ITC CERTIFICATE1
- September 2009 -**

Short courses and individual study programmes consist of modules of an ITC (Postgraduate) Diploma, Master and/or Master of Science (MSc.) course. The regulations that apply to the latter courses apply to the parts as well. Only the rules described below take precedence over the Diploma, Master and MSc. regulations.

1. These additional rules apply to all courses and individual study programmes leading to an ITC Certificate starting from September 2009 onwards². These courses consist of one or more modules of a Diploma, Master and/or Master of Science course.

Short courses have specific course objectives. These courses may start and/or finish with a few days for introductory respectively rounding-off activities. The individual study programmes consist of one or more separate modules chosen by the participant.

2. **Management of the course**
The curriculum of short courses has been approved by the Academic Board. Individually chosen combinations of separate modules need the approval of the Course Director. In case the individual study programme consists of modules of block 3 of the MSc. course only or of a combination of modules from more than one domain, approval of Head Education is needed.
Individual changes made in the course curriculum of the short course lead to the course being seen as an individual study programme.

Responsibility for implementation of the approved short course or individual study programme rests with Head Education, who delegates this responsibility to the Course Director(s) or, in the case of elective modules, to Module Coordinators.

Responsibility for quality assurance rests with the Academic Board.

3. **Assessment**
Courses leading to a Certificate are summatively assessed.
The right to re-sit for an examination exists only when the date of the re-sit falls within the official study period of the participant.

¹ *These rules were approved by the Rector and by the Academic Board on 17 September 2008; they apply to all courses commencing September 2009 onwards.*

² *Per 1 January 2010 ITC will be integrated in and will become a Faculty with special status of the University of Twente. This integration might have consequences for the assessment regulations and might lead to changes in these assessment regulations during the course.*

4. **Certification**

A "Certificate", mentioning that the participant has followed the course, will be awarded to a participant in a short course who has fulfilled all assessment requirements for that course. For short courses of 4 or more modules one module mark between 50 and 60 is allowed.

A "Certificate", mentioning that the participant 'has followed an individual study programme in Geo-information Science and Earth Observation', will be awarded to

- A participant in a short course who has fulfilled the assessment requirements of one module but has not fulfilled all assessment requirements of that short course and to
- A participant in an individual study programme who has fulfilled the assessment requirements of at least one module.

A "Certificate of Attendance", mentioning that the participant 'has attended an individual study programme in Geo-information Science and Earth Observation', will be awarded to all other participants who have participated for at least 80% in one or more modules. The titles of these modules will be mentioned on the Certificate of Attendance.

Certificates and Certificates of Attendance mention the study load. Only the study load of the modules that have been completed and the study load of the modules that the participant has participated in for at least 80%, are included in the study load.

Certificates are accompanied by a Course Record mentioning the period of study, the study load and the titles of the modules that the participant has completed or participated in for at least 80%.

Certificates, Certificates of Attendance and accompanying Course Records are signed by the Course Director or, in case the short course or individual study programme consists of modules 14 and 15 of the MSc. course only or of a combination of modules from more than one domain, by Head Education. Certificates and Certificates of Attendance of distance courses are signed by the Course Coordinator and by the Course Director or, in case of new distance courses, by Head Education.

5. **Building blocks for Diploma or Degree**

Successfully completed modules of short courses and individual study programmes can be used as building blocks for obtaining an ITC (Postgraduate) Diploma, Master degree or MSc. degree, provided the participant has been formally admitted to the (Postgraduate) Diploma, Master or Master of Science course.

Participants have three and a half years to meet all requirements of the (Postgraduate) Diploma, Master or MSc. course. If results of modules were obtained more than three and a half years before the end of the course, then the validity of these modules must be confirmed by the Degree Assessment Board (MSc. and Master courses) or Academic Board (Diploma courses).

Appendix:

- ITC Regulations for courses leading to an ITC Master of Science (MSc.) degree or ITC Postgraduate diploma (September 2009),
- ITC Regulations for courses leading to an ITC Master degree (September 2009) or ITC Regulations for courses leading to an ITC Diploma (September 2009).