ITC
Study guide
2008/2010

Applied Earth Sciences

APPLIED EARTH SCIENCES

Postgraduate Diploma & Master of Science Degree Course

Study Guide
2008 - 2010

Contents

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.

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 2008/2009 courses 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. The structure of the MSc courses was adjusted last year in order to strengthen the links between the courses and the research projects, implemented by ITC.

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 the ITC staff is originating from more than 30 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 ITC

One of humanity's greatest challenges is to achieve an appropriate balance between the development of natural resources and the maintenance of an optimal natural environment. To meet this challenge we need information on the earth's surface and sub-surface: spatially referenced information or *geo-information*.

Many different types of *earth observation* provide efficient ways of gathering geo-information. These types include conventional photographic and non-photographic imaging techniques, electro-optical sensing of the wider spectrum by multi-spectral, thermal infrared and radar scanning as well as geophysical and geochemical data-acquisition techniques. All these methods are used in mapping the earth's topography, monitoring the natural environment and exploring for natural resources and all are applied by specialist groups within the Institute.

ITC specializes in the collection, management and visualisation of geo-information and its integrated interpretation in support of resource management and policy development. In this way, scientific earth observation supports decision-making for sustainable development and the alleviation of poverty in the developing world.

The International Institute for Geo-Information Science and Earth Observation was established in 1950, and is usually referred to as ITC because of its original name: International Training Centre for Aerial Survey. It is the largest institute for international higher education in the Netherlands.

ITC is an autonomous organisation operating under the aegis of the University of Twente, and is funded by the Ministry of Education, Cultural Affairs and Science of the Netherlands. ITC is subject to the national quality assurance procedure for universities in the Netherlands. It is based in Enschede. ITC’s main activities are education, research and advisory services. These activities are carried out by six scientific Departments:

- Department of Earth Observation Science (EOS)
- Department of Earth Systems Analysis (ESA)
- Department of Geo-information Processing (GIP)
- Department of Urban and Regional Planning and Geo-information Management (PGM)
- Department of Natural Resources (NRS)
- Department of Water Resources (WRS)

They are supported by the education, research, consultancy and general support departments.

Education

ITC has a scientific staff of some 150 professionals of 31 nationalities. More than 19,000 students from over 150 countries have graduated from courses at the institute since 1952. ITC offers courses at different levels: PhD degree (conducted in collaboration with Netherlands universities), Master of Science degree, Master degree, postgraduate and undergraduate Diploma and Certificate courses.

The ITC degree programmes are nationally accredited and registered in the Central Register of Higher Education (CROHO) of The Netherlands.

Recently ITC embarked on a programme of decentralizing its education, through joint education programmes with partners in various countries throughout the world. ITC also offers a growing number of distance education courses.

Updating the knowledge and skills of ITC alumni is an important task, in addition to the institute's regular courses. Therefore, ITC organises refresher courses at ITC and abroad.

The language of instruction is English.

Research

ITC carries out multidisciplinary and problem-oriented research that focuses on strengthening organisations involved in survey, management and planning for sustainable development. To this end, a strategic multidisciplinary research programme with the following themes is established:

- Biodiversity in fragmenting landscape
- Carbon-cycle and climate change
- Stochastic methods for image mining and data quality
- Disaster management
- Earth systems science
- Food security and environmental sustainability
- Governance and Integrated Spatial Assessment
- Spatial data infrastructure technology
- Spatio-temporal data integration and visualization
- Informed multilevel governance of urban regions
- Land administration for informed governance
- Managing water scarcity
- Sustainable urban-regional dynamics
- Utilisation of sensor developments for efficient topographic mapping
- Water cycle climate

Advisory services

ITC's transfer of knowledge also encompasses advisory services, mainly in developing countries. Advisory services of ITC often act as a follow-up service to alumni and their organisations and institutes.
Approximately 1000 projects have now been completed and ITC is presently committed to a wide variety of assignments around the world. The majority of these are based in developing countries and are education-oriented.

Introduction to ITC's educational programmes

At degree level ITC offers PhD, MSc and Master degree courses. Also Diploma courses, and short courses (some through distance education) are offered as part of the regular education.

The MSc degree programme in Geo-Information Science and Earth Observation (lasting 18 months) consists of seven courses, each with a specific orientation:

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

The Master degree programme (lasting 12 months) consists of two courses:

- **Geoinformatics**
- **Natural Resources Management**

Postgraduate Diploma courses (lasting 9 months) are offered in:

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

<u>Programmes in cooperation with other institutes</u>
ITC cooperates with Universities in The Netherlands, Europe and throughout the world in full-time and part-time joint education programmes, leading to MSc and Master degrees and to Diplomas:

- In The Netherlands ITC cooperates with the universities of Utrecht, Delft and Wageningen in an MSc course, focusing on Geographic Information Management and Applications (GIMA). The course is offered through distance learning, with four periods of classroom learning.
- In Europe, ITC cooperates with the universities of Southampton, Lund and Warsaw in an MSc course on Geo-information Science and Earth Observation for Environmental Modelling (GEM). The course is taught in four countries: UK, Sweden, Poland and The Netherlands.
- ITC has entered into partnership with reputable education institutes for the purpose of providing joint courses in several countries throughout the world. At present, MSc and Master courses are or will be conducted in Bolivia, China, Ghana, India, Indonesia, Iran, Kenya, Mexico, Nigeria and Tanzania.

For more information on our joint courses, please consult the ITC website (http://www.itc.nl/education/jointcourses.aspx).

Master of Science degree, Master degree and Postgraduate Diploma

Master of Science degree

The 18 month Master of Science degree programme is intended for participants with a future task in research and development. In addition to 12 months regular coursework, the Master of Science participants learn by doing research and/or by developing new methods or techniques in a 6 months thesis period.

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

Master degree

The 12 month Master degree programme is more profession oriented and teaches more practical skills. It could be compared to taught masters in other countries.

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

Postgraduate diploma

The 9 month Postgraduate diploma programme 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.

The Postgraduate Diploma course leads to a Diploma with the title:
”Postgraduate Diploma in Geo-Information Science and Earth Observation’’

Course structure

The duration of the Master of Science courses is 18 months, of the Master courses 12 months and of the Postgraduate Diploma course 9 months.
All ITC courses are divided into 3 week periods (modules) or multiples of 3 weeks (blocks) in which one subject or related subjects are taught. All Master, Master of Science and Postgraduate Diploma courses start on the same date in September each year. The Postgraduate Degree programme is taught together with the MSc programme during the first nine months. The Master programme is taught separately.

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. Block 1 (modules 1-4) in all degree courses contains 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.

Master of Science and Postgraduate Diploma programme

The Master of Science programme is split up in 4 *blocks*. The PGD 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 courses

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

Figure 2

MSc and PGD course 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

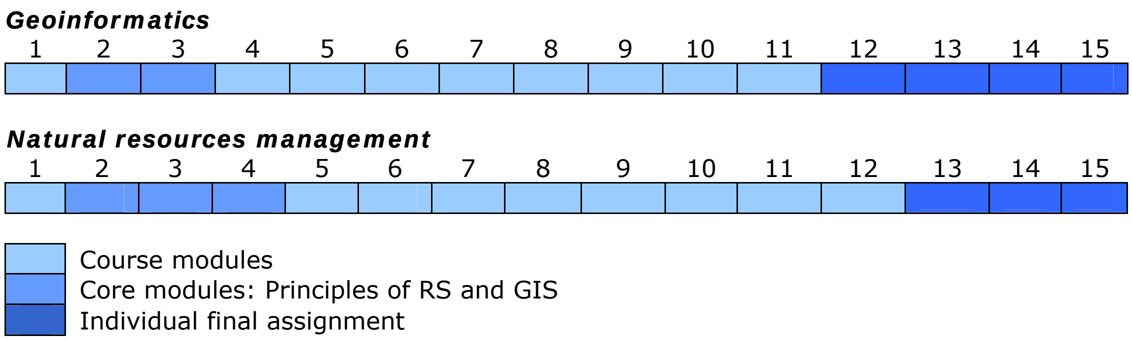
In Block 4 the student works individually on his/her MSc thesis. It is required to have an approved MSc research proposal before entering this block. During this block there is interaction with the staff, PhD and MSc students of the research theme, for example in *capita selecta*. Each student will be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

Master programme

The Master programme is made up of 15 modules, consisting of core modules about GIS and Remote Sensing, course modules, and an individual final assignment.

Figure 3

Structure of Master courses



Course modules

In the first module, the course domain and principles of databases are introduced. In module 5 and further the core modules are applied within this course domain.

Core modules

Modules 2 and 3 teach 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. The core modules are taught together in class with the MSc and PGD students.

Individual final assignment
The Master programme concludes with an individual final assignment in which the participant can work on a case and topic which is tailored to his or her particular situation and interest. Participants are encouraged to bring data and other material from their home country for this purpose, subject to approval.

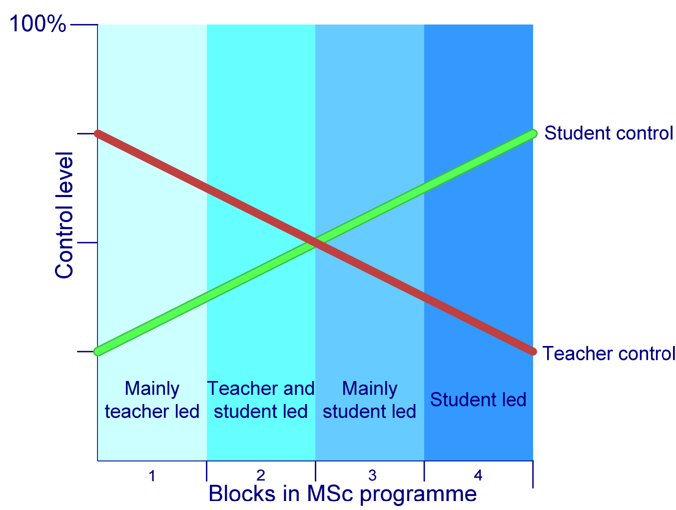
Academic Profile MSc
The academic profile of the MSc programme puts strong emphasis on the scientific discipline, a scientific approach, basic intellectual skills, co-operation and communication and the temporal and social context of research. The emphasis on doing research and/or designing or developing 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 al 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.

Teaching Approach MSc
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 4

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.

Study load of the ITC degree programmes

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 credits represent the workload of an academic year (9-10 months) 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 ECTS.
The MSc course consists of 23 modules and three additional weeks of remedial teaching, catch-up activities and graduation ceremonies, totalling 118 ECTS. The Master course consists of 15 modules and two weeks of remedial teaching, catch-up activities and graduation ceremonies, totalling 77 ECTS. The Postgraduate Diploma course consists of 12 modules and 1 week of remedial teaching, and catch-up activities, totalling 61 ECTS.

Opening hours of various 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 – 16:00

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

Starting dates modules and holidays

Module number	**2008 / 2009 / 2010**
Registration *Opening Academic year*	*Monday, September 15, 2008* *Thursday, September 25, 2008*
Module 1	September 29 through October 17
Module 2	October 20 through November 7 *RS core exam: November 7*
Module 3	November 10 through November 28 *GIS core exam: November 28*
Module 4	December 1 through December 19 *RS core re-sit exam: December 10*
DIES celebration	*GIS core re-sit exam: December 17: morning* *Wednesday, December 17: afternoon no classes*
X-mas	*December 25 through December 26*
New Year	*January 1, 2009*
X-mas break	*December 22, 2008 through January 2, 2009*
Module 5	January 5 through January 23, 2009
Module 6 *MSc day*	January 26 through February 13 *Wednesday, January 28, 2009*
Module 7	February 16 through March 6
Module 8 *MSc fair*	March 9 trough March 27 *Wednesday, March 11, 2009*
Module 9	March 30 through April 17
Good Friday	*April 10*
Easter Monday	*April 13*
Module 10	April 20 through May 8
Queen's day	*Thursday, April 30*
Liberation day	*Tuesday, May 5*
Catch-up week	*May 11 through May 15*
Module 11	May 18 through June 5
Ascension Day + compulsory ADV	*May 21 through May 22*
Whitsun Monday	*June 1*
Closing week PGD	*June 8 through June 12*
Closing PGD	*Friday, June 12*
Module 12	June 8 through June 26
Module 13	June 29 through July 17
Module 14	July 20 through August 7
Module 15	August 10 through August 28
Closing week Master - Catch-up week MSc	*August 31 through September 4*
Graduation Master	*Friday, September 4*
Module 16	September 7 through September 25
Module 17	September 28 through October 16
Module 18	October 19 through November 6
Module 19	November 9 through November 27

Module number	**2008 / 2009 / 2010**
Module 20	November 30 through December 18
X-Mas, New year break	*December 24, 2009 through January 1, 2010*
Module 21	December 21, 2009 through January 15, 2010
Module 22	January 18 through February 5
Module 23	February 8 through February 26
Closing week MSc	*March 1 through March 5, 2010*
Graduation MSc	*Friday, March 5, 2010*

Applied Earth Sciences

Introduction

In our daily life we are continuously confronted with things and situations that have a direct link to earth resources as well as with related processes that take place. The buildings in which we live and work are constructed with materials taken from the earth, the soil produces our daily food, and mineral resources provide fuel for our transport and cooking.
The other side of the coin is that the same processes that shape the environment in which we live, can be extremely destructive as well. Recent events, such as the tsunami in Southeast Asia and the earth quakes in Peru and Indonesia show that the forces in nature can have huge impact on the lives and livelihood of people.
We have developed a range of tools and techniques to make inventories of all the resources that are at our disposal and to plan and management their use in the best possible way, not only for our own current situation, but also for future generations. These tools and techniques make it possible for us to use those resources wisely, foresee risks and plan accordingly.

Natural disasters such as flooding, earthquakes and volcanic eruptions can occur all over the world. At the same time, many places on earth suffer from natural or man-induced land degradation, often with gradual but devastating effects, for example on food security. The assessment of how big the risks are and careful planning of precautionary measures are important issues to deal with. No place on this globe is 100% safe, and we have to come to grips with the vulnerability of the environment in which we live. This subject is central to the Applied Earth Sciences (AES) stream on **Geo-Hazards** (GH).

In addition, when we construct infrastructure, put buildings in place or in other ways influence the natural environment we need to be sure that the constructions will serve the purpose for which they are created. We also have to make sure that they are strong enough to survive catastrophic events and do not have a negative impact on the environment. Spatial information can be used in engineering practices but with a clear focus on environmental impact and environmental integrity in a planning context. This is the focus of the AES stream on **Geologic and Environmental Engineering** (GEE).

The utilisation of non-renewable earth resources such as oil and gas should leave future generations also the opportunity to develop and prosper in their own time. This means that the discovery of new earth resources is important. But also local expertise to discover and exploit these resources in a proper way that benefits society and does not harm the environment must be developed. This is the area of interest for the AES stream on **Earth Resources Exploration** (ERE).

We trust that the courses in Applied Earth Science will provide you as course participants with all relevant knowledge and skills that will help to meet the aims and objectives as described for them, and that they will enable you to apply them in an appropriate and creative way.

Tom Loran, Course Director

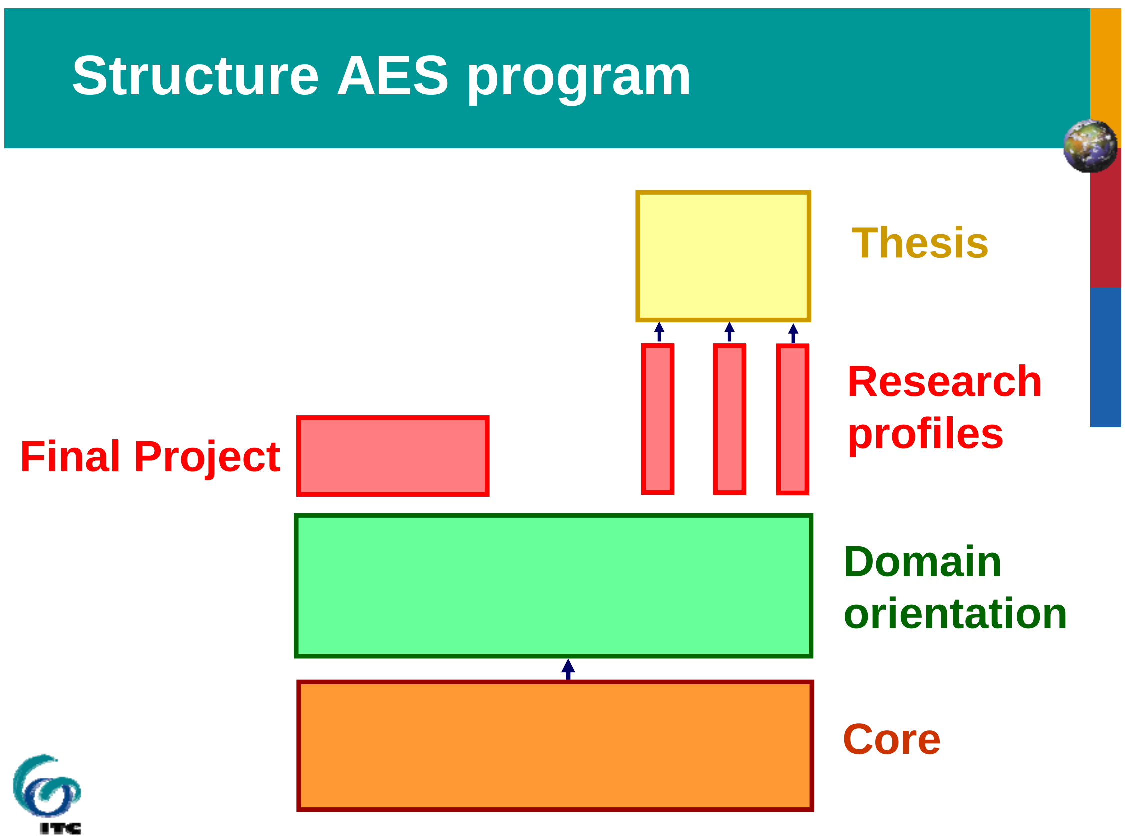
Applied Earth Sciences Courses, ITC
August 2008

The Applied Earth Sciences curriculum

The curriculum in Applied Earth Sciences (AES) courses in ITC aims at the application of Geo-Information Science and Earth Observation for problems in society that have an earth science nature. The emphasis in the AES courses is on dealing with development issues, ensuring that the participants develop a thorough appreciation of modern geoscience concepts and a good understanding of the management of spatial information. Emphasis will be on the use of remote sensing techniques and Geographic Information Systems; remote sensing methods will be used for the acquisition of all relevant datasets on earth resources, and GIS will be used for managing, modelling and analyzing these often large and complex data sets.

The Master of Science Degree (18 months) and Postgraduate Diploma (9 months)

Two courses are currently offered in Applied Earth Sciences: the 18-month Master of Science Degree (MSc) course and the 9-month Post Graduate Diploma (PGD) course. The course program is divided in a number of blocks of which the first two are common to both the MSc and the PGD course, as is shown in the figure below.



Course outline Applied Earth Sciences 2008 – 2010

Core Modules

The first block deals with the **core modules** of ITC and includes lectures and exercises on the principles of GIS and remote sensing. These subjects are common to all ITC programs and are followed by participants in all other courses as well. The ITC core modules deal with the theory, tools and techniques of the technology that are used to collect, store, manage analyze and process spatial data and information. The program includes a lot of practical work as well as a number of larger assignments, and is concluded with an Individual Practical Assignment (IPA).

Domain Modules

The second block is a block that deals with the thematic content (or **domain orientation**) that is relevant for the AES program, and includes issues that are important in solving problems in applied Earth Sciences. Use is made extensively of the tools and techniques that have been presented in the first block. Within the domain of Applied Earth Sciences it is possible to choose from three specializations or streams: Geo-Hazards, Earth Resources Exploration and Geologic and Environmental Engineering.

The second block includes a number of common subjects which will be attended by all AES students because they are considered relevant for all three specializations. Besides that there are lectures and practicals which are more specifically aimed at the specializations that are available.

The second block contains a number of projects that stretch out over several modules. The projects are scheduled in such a way that taught subjects that are necessary for carrying out the projects are presented at appropriate times. They provide the opportunity to develop practical skills and allow for actually applying what has been taught in the theoretical sessions. The projects encompass the entire scope of data acquisition, modelling, analysis, and reporting in a geo-information context, and are complemented by supporting lectures on programme-wide earth science and geo-information topics, as well as stream-specific topics. Participants will work in small teams for the projects,

Up to this point the program is the same for students that pursue the Post-Graduate Diploma and the Master of Science Degree. The third block is where the programs start to differ.

Post-Graduate Diploma – Individual final Assignment

The **Post Graduate Diploma course** goes into an **individual final project** that requires participants to bring together all theoretical and practical skills gained in the course up to that moment and carry out a real-world, practical assignment. The individual final project forms the last part of the course before graduation from the Post-Graduate Degree course. Focus is on the application of advanced survey techniques and data acquisition methods for the generation of stream relevant earth scientific information and understanding. The project also provides an opportunity for the development of 'life skills' (e.g. teamwork, project planning, problem-solving, presentation and communication).

Research Modules and Advanced Modules

The participants in the **Master of Science degree course** will start with their **research preparation** and ultimately will carry out their **thesis research**. The preparation for the research is done in block three, and the actual thesis research is carried out in block 4.

For the MSc course, block three consists of 5 modules, of which the first one introduces participants to research skills, helps to develop a critical research attitude and provides pointers for developing the research proposal. This is followed by 2 modules (module 12 and 13) of advanced topics. These advanced topics are offered by the scientific departments in ITC and can be selected freely (under the condition that subjects are relevant for the selected research theme in which the thesis research will be done). The advanced modules are offered by the scientific departments in the Institute. They have a multi-disciplinary character, aiming at research skills and advanced research methods / tools which are useful for students from different courses. A list of modules that will be offered in the 2008-2010 course will be announced separately in the end of 2008.

All MSc research is done in the framework of one of the ongoing research projects in the Institute and all participants will select a research topic that fits within one of those themes. The themes present themselves during the MSc Fair. During the last two modules in this block (module 14 and 15) the participants will start orienting themselves towards the selected research theme. The program is organized and managed by the theme leaders of the various research themes in ITC. Participants will work together with research staff on subjects and issues that are relevant in the framework of the research theme that has been selected. The research proposal will be written in this period.

Block three ends with the presentation and defence of the research proposal. Upon successful completion of this block the participants will start the actual thesis research.

Note: A positive evaluation of the MSc. research proposal by the Thesis Admission Committee at the end of Module 15 is conditional before admittance to the remainder of the research period,

MSc Research

Block 4 of the MSc course is dedicated to the actual thesis research. A period of 8 modules is reserved for this in which the research has to be carried out and also the thesis has to be written and submitted. The MSc course ends with the defence of the thesis after which the MSc students will graduate.

A schematic overview of the PGS and MSc courses is shown in the table that is presented on the following page.

Schematic overview of the Post-Graduate Diploma and the Master of Science Degree course

<table>
<tr><th>Module</th><th>Dates</th><th colspan="2">Applied Earth Sciences 2008 – 2009 - 2010
MSc, PGD and short course schedule</th></tr>
<tr><td></td><td>15 September
25 September</td><td colspan="2">(PGD and MSc) Arrival, remedial teaching
Opening Academic Year</td></tr>
<tr><td>1</td><td>29 September</td><td colspan="2" rowspan="4"><u>BLOCK 1</u>, Intro and Core modules(PG and MSc):
"Principles and Applications of Remote Sensing and GIS for Applied Earth Sciences"</td></tr>
<tr><td>2</td><td>20 October</td></tr>
<tr><td>3</td><td>10 November</td></tr>
<tr><td>4</td><td>1 December</td></tr>
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<tr><td>11</td><td>18 May</td><td rowspan="2">Postgraduate (PGD) Final Project</td><td><u>BLOCK 3 (MSc) Module 11-15</u>
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</table>

Objectives of the course

The main aim of the course in Applied Earth Sciences is to equip participants with the necessary knowledge and skills to use spatial information, Geographic Information Systems and Remote Sensing techniques in the context of problems that are related to the field of earth sciences. Emphasis is put on the meaningful and creative use of these tools and techniques from an earth science background, but with an open eye for other disciplines and scientific fields.

A number of generic competencies and skills that will be obtained during the course are:

- Application oriented problem solving;
- Able to work in teams with specialists of other disciplines;
- Continuous critical learning attitude, flexible, pro-active, have a vision:
- Ability to respond to changing demands and opportunities (from society and discipline);
- Ability to respond to developing theory as well as improved techniques;
- Confident communicator, both to peers as well as to a general public;
- Ability to act in various cultural environments.

For the Post-Graduate Diploma course the above will be applied to key tasks from the professional field. Throughout the course participants will be exposed to new tools and techniques, and will be encouraged to develop a critical understanding of their application.

Specific objectives for the Post-Graduate Diploma course are:

- Acquire practical knowledge and skills in using technology for spatial information handling
- Apply practical skills for analysing and solving of relevant development problems
- Carry out projects and assignments (group-wise and individual)
- Carry out technical reporting on the results of an Individual Final Assignment
- Communicate and present the findings of work done

The Master of Science degree course aims at developing academic skills and will prepare participants to individually carry out scientific research. Specific objectives for the MSc course, in addition to those shared with the Postgraduate Diploma course, are:

- Acquire academic research skills in scientific reading, writing and reasoning;
- Apply research skills to formulate a research proposal;
- Carry out an individual research project;
- Apply up-to-date techniques in primary data acquisition and processing;
- Write an MSc thesis on the research projects and it's findings;
- Communicate and defend the findings of research work.

Three streams of specialisation

Within the Applied Earth Science course there are three streams or specializations. Each stream focuses on a certain area of the earth science domain. Streams that are currently offered as part of the course are:

- Geo-Hazards (GH)
- Geologic and Environmental Engineering (GEE)
- Earth Resources Exploration (ERE)

Specific objectives per stream

For each of the three streams a number of objectives can be identified which are briefly described below.

Geo-Hazards

Aim: This stream aims to strengthen capacity to apply spatial information and earth observation techniques in the identification, mapping and monitoring of geo-hazards and in the quantification of vulnerability and risk, in order to prevent and reduce damage done to people, their property and the physical resource base on which they depend.

Expected responsibilities: Study the occurrence and extent of natural disasters (volcanic eruptions, earthquakes, landslides, flooding and coastal hazards) as well as gradual degradation processes (erosion, desertification, salinization, land subsidence), including their distribution, frequency and intensity; Study susceptibility of society to the damage caused by these events and determine their environmental impact; Establish risk assessment methods, design hazard-warning systems and develop damage reduction scenarios. Develop spatially explicit land degradation control and restoration scenarios; **Communicate** with relevant stakeholders throughout the process of geo-hazard studies and communicate results effectively and efficiently

Geologic and Environmental Engineering

Aim: This stream aims to strengthen capacity to use spatial information and earth observation techniques in engineering practices but with a clear focus on environmental impact as well as awareness of environmental integrity in a planning context.

This is done through planning and selection of sites for engineered infrastructure (e.g. dams, roads, waste disposal sites) considering costs and function, risks of damage to the infrastructure (e.g. by earth quakes and slope instability) and impacts of the infrastructure on the environment at large. The program looks at the reality of engineering practice in the environment, considering the entire process from data acquisition, analysis, modelling and assessment, prediction and monitoring.

Expected responsibilities: Develop alternative scenarios (from an earth science perspective) for locating engineered infrastructure and apply decision support systems (DSS) to optimise site selection; Use spatial information to predict and assess the impact of engineered infrastructure on the environment, consider these impacts in planning, model and monitor developments, and develop alternative scenario's and remedial action; Make creative use of analysis and modelling techniques such as (3-D) GIS and DSS, EIA (environmental impact assessment)

Earth Resources Exploration

Aim: This stream aims to strengthen capacity to apply earth observation and geoinformation techniques to explore and prioritize areas for exploitation of earth resources (considering costs, benefits and potential impacts on the environment).

This is done through the investigation of mineral occurrences with exploration potential, making use of state-of-the-art techniques in GIS, remote sensing and modelling, with special attention for on-site and off-site environmental impact of extraction activities.

Expected responsibilities: Supply geological information to contribute within a multidisciplinary context including economic and environmental perspectives to prioritization of areas for mineral exploration. Define, collect, manage, process and analyse earth observation data as well as ground observations and geoinformation techniques to localize and quantify earth resources.

Organisation and Staff of the Applied Earth Sciences Course

Academic Board

The ITC Academic Board, of which all full-time and part-time professors are members, is responsible for policy development and quality assurance of both education and research.

1. In general terms the Academic Board is responsible for the following items:
2. Quality assurance of the MSc and Master Degree programs and Diploma courses of ITC, irrespective of location.
3. Policy of ITC's current degree programmes, both in Enschede and abroad, and in partnership with third parties.
4. Programme wide issues, like assessment regulations and core curriculum
5. Orientation, content, quality and development of the ITC research program
6. Quality assurance of the PhD programme.

Portfolio Holder

Members of the Academic Board will be appointed as *portfolio holders* for individual courses. These portfolio holders will:

- Be first point of contact for Course Directors with respect to course content and quality assurance.
- Monitor the course specific implementation of decisions of the Academic Board.

Course Director (CD)

The Course Director is responsible for implementation and day-to-day management of the courses in a domain. These tasks include approval of structure and contents of the modules of the AES course. Furthermore the Course Director deals with matters arising prior and during the course, such as pre-selection of candidates, administration and logistics of the course, and fieldwork. The Course Director also implements quality assurance measures, approves final project topics for the PGD and research topics for the MSc courses.

The Course Director will be assisted in all matters related to implementation of the course by block coordinators and student advisors.
The Course Director reports to the Educational Portfolio Holder of the Academic Board. The Course Director is authorized by and accountable to the Head Education.

Course Secretary (CS)

The Course Secretary gives administrative support to the Course Director, block and module coordinators and course lecturers for the execution of the courses.

Coordinator

A coordinator is responsible for implementation and day-to-day management of a course or part of a course. The coordinator coordinates the different education activities and the work of the involved staff members. In most cases this task is done under the authority of the Course Director. Within the AES block coordinators are assigned for block 1 and block 2. Module coordinators are assigned to most individual modules in the course.

Student Advisor

Lecturer who advises the individual student on study related issues during a substantial part of the course. The advisory task is not specifically related to a module or group of modules, but aims to support the students in all matters related to the course program. The student advisor is the first point of contact for the student. He/she can help with identifying and patching up of gaps in basic knowledge of students, and can provide clarification and support in making choices (i.e. for advanced subjects, research topics, etc).

Supervisor

The supervisor (e.g. thesis supervisor, IFA supervisor) helps students who work mainly independently. The supervisor may help with the process and with the content and therefore will always be an expert in the topic that the student works on.

Course Director

Tom Loran

Room 4-107
Phone 545

Module Coordinators and Student Advisors

Chris Hecker
MC 1-4:Block 1 Core modules

Room 5-042
Phone 356

Mark van der Meijde
MC 5-8 Block 2 Domain modules

Room 4-029
Phone 322

Freek van der Meer
MC Advanced Subjects Module 12-13

Room 5-007
Phone 353

David Rossiter
MC 11

Room 4-058
Phone 499

Victor Jetten
AES Portfolioholder for AB MC 14-15
Room 5-035
Phone 412

Mark van der Meijde
Student Advisor GEE stream

Room 4-029
Phone 322

Boudewijn de Smeth
MC 11-12 PGD Project Student Advisor ERE stream

Room 4-035
Phone 310

Dhruba Shrestha
Student Advisor GH stream

Room 4-048
Phone 264

Robert Voskuil
Student Advisor GH stream

Room 5-044
Phone 290

Supporting staff Applied Earth Sciences

Ms Anneke Nikijuluw – van der Horst Room 4-105 Phone 568		**Benno Masselink** (Technical Support) Room 4-126 Phone 246	
Ms. C. (Cecille) Plomp Room 4-129 Phone 208		**Job Duim** (Technical Support) Room 4-126 Phone 246	
Ms. L. (Linlin) Pei (Blackboard Coord.) Room 4-129 Phone 337			

Lecture Timing

Lectures and practicals are given in four periods every working day:
1st period 08.40 till 10.20
Coffee break
2nd period 10.40 till 12.20
Lunch break
3rd period 13.40 till 15.20
Tea break
4th period 15.40 till 17.20

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*Descriptions of these modules will be submitted later

AES Block 1: Core modules

Principles and Applications of Remote Sensing and GIS for Applied Earth Sciences			
Module: 1-4		Co-ordinating staff: C. Hecker	
Start:	29-09-2008		
End:	19-12-2009		
Level: MSc, PG			U08-AES-137

Introduction

These modules introduce the modern practices, processing techniques and applications of remote sensing (RS) and geographic information systems (GIS) to solve earth science related challenges. Participants learn how to independently design and carry out sequential data processing chains in the field of Earth Sciences.
Furthermore, these modules will offer participants an overview on state of the art in earth observation (EO) systems and geoinformation (GI) science for earth scientists. Focus is on the relation between earth processes and products and remote sensing systems and the embedding in geodata infrastructures. Aspects related to policy and decision making and relevant international frameworks in which EO/GI is embedded are discussed. Participants are also introduced to project-based learning and the tutor coaching system.
The knowledge on concepts and techniques introduced in these modules will be further developed during subsequent modules of the course.

Contents

The modules cover the following topics:

- Introduction to the AES course, its educational approach and student advisors.
- Introduction of participants' backgrounds in Participants Workshop.
- Overview of modern concepts in earth sciences and systems approaches and dynamic modeling.
- Overview of EO systems and GI structures relevant to modeling earth science processes.
- Introduction to earth science research activities at ITC.
- Excursion to EO/GIS-Institutions and Earth Systems in the Netherlands.
- Geographic information and spatial data types.
- Determining and mapping position.
- Spatial data entry and preparation.
- Spatial data analysis.
- The electromagnetic spectrum.
- Sensors and platforms.
- Thermal, hyperspectral and geophysical remote sensing methods.
- Geometric aspects of remotely sensed data.
- Image enhancement and visualisation.
- Image classification and interpretation.
- Spatial data visualization.
- Univariate, bi-variate and matrix statistics for EO/GI.
- Quality assessment of spatial data.
- Demonstrations of EO/GI laboratories and equipment at ITC.
- Information (Management) skills and use of library resources.

The modules include practical exercises, group projects, graded individual assignments and an excursion.

Objectives

Main objective: To learn how to generate information about the Earth from remote sensing and data stored in Geographic Information Systems for applications in the Earth Sciences.

At the end of Block 1 participants must be able to:

Explain the principles and use the vocabulary of RS and GIS.

- 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 in their field of application.
- Describe the physical background of remote sensing and compare the main platforms and sensor systems using examples for Applied Earth Sciences.
- Explain the main digital image processing procedures in Applied Earth Sciences.
- Describe the common methods of image analysis in Applied Earth Sciences.
- Outline the principal rules for cartographic visualisation.
- Describe aspects of data quality and how various stages of spatial data handling affect it.
- Outline state-of-the-art RS/GIS technology and techniques in Applied Earth Sciences.

Carry out basic RS/GIS operations

- Carry out basic data preparation, geo-referencing and data entry into a GIS.
- Perform basic manipulation, analysis and visualisation operations using a GIS.
- Perform basic image processing techniques in Applied Earth Sciences.
- Carry out a visual interpretation of an AP stereo pair and a satellite image in Applied Earth Sciences.
- Apply basic data quality assessment procedures.
- Communicate RS/GIS products to audiences with variable levels of expertise.
- Evaluate the influence of different scales and types of imagery on the resulting products.

Apply appropriate RS/GIS methods for problem solving

- Understand the capabilities, uses and limitations of GIS and RS in Applied Earth Sciences.
- Design and carry out sequential data processing steps for solving a typical earth science application problem.
- Evaluate the results of data processing.
- Be aware of organisational issues of GIS development and implementation.
- Identify and evaluate data archives relevant to their field of application.
- Resolve new tasks independently through consultation of library and online resources.
- Analyse GI/EO problems for Applied Earth Sciences in a systematic way, formulate questions and propose solutions, designing flow charts.

At the end of Block 1 participants are further expected to:

- Understand the AES course structure, get to know their study advisor and their course trajectory.
- Recognize their own responsibilities for the success of their learning process.

Prerequisites

Admission to AES course or short course.

Recommended Knowledge

Basic computer skills, stereo vision, basic Earth Science knowledge.

Staff involved

C. Hecker, msC, Prof.Dr. F.D. van der Meer, Prof.Dr. V.G. Jetten, Drs. N.C. Kingma, Ms. M. Koelen, Drs. M.C.J. Damen, Dr. E.J.M. Carranza, Ir. B. Krol, Drs. J.B. de Smeth, Dr. M. van der Meijde, Drs. R.P.G.A. Voskuil, Dr. F.J.A. van Ruitenbeek.

Hardware and Software Requirements

PC, Stereoscope, Field spectrometers, GPS, PDA, geophysical equipment, geochemical laboratory equipment.
GIS (ArcGIS) and Image Processing (ERDAS Imagine) software, standard office software.

Teaching Materials

Mandatory:

- R.A. de By (ed.), 2004: Principles of Geographic Information Systems - An introductory textbook, 3rd ed., ITC, 226 p. ISBN 90-6164-226-4
- N. Kerle, L.L.F. Janssen, G.C. Huurneman (eds.), 2004: Principles of Remote Sensing - An introductory textbook, 3rd ed., ITC, 250 p. ISBN 90-6164-227-2
- G.F. Bonham-Carter, 1994: Geographic Information Systems for Geoscientists: Modeling with GIS, Pergamon, 398 p. ISBN: 0-08-042420-1
- S.A. Drury, 2004: Image interpretation in Geology , 3rd ed., Routledge, 304 p. ISBN: 0748764992

Optional:

- T.M. Lillesand, R.W. Kiefer, J.W. Chipman, 2003: Remote Sensing and image interpretation, 5th ed., Wiley, 784 p. ISBN: 0471152277

Printed handouts and digital lecture notes

Edunet/Blackboard environment

Recommended book for participants with little knowledge of geology and natural hazards (resp.):

- C.W. Montgommery, W.C. Brown (Publishers), 1997: Fundamentals of Geology, ISBN 0-697-32986-0
- K. Smith, 2001, Assessing Risks and Reducing Disaster, 3rd ed., Routledge, Physical Environment Series, ISBN: 0-114-22463-2(hbk) and -22464-0 (paperback).

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
65	73		92	55	57	17

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

- Written closed book exam on the ITC GIS textbook (theory)
- Written closed book exam on the ITC RS textbook (theory)
- Graded assignment on AES specific topics in GIS and Remote Sensing
- Graded Individual Practical Assignment

Note(s)

- Module 1 will be assessed based on participation and will receive the notification completed or fail.
- The modules 2, 3 and 4 will each receive an assessment on the basis of the assignments and examinations listed above.
- Module 2 will receive the grade obtained for the exam on the ITC RS textbook;
- Module 3 will receive the grade obtained for the exam on the ITC GIS textbook; Module 4 will receive a grade that is based on the average of the two graded assignments done during the modules.

AES Block 2: Domain modules

Common Topic: Image Interpretation and Geodatabases			
Module: 5-10		Co-ordinating staff: Dr. T. Woldai	
Start:	05-01-2009		
End:	23-01-2009		
Level: MSc, PG			M09-AES-106

Introduction

The interpretation of aerial photographs and satellite images is a cost effective and efficient way of extracting information on the earth's surface and subsurface for use in many aspects of earth resources and geo-environmental management. Such information is normally stored in geodatabases in which earth science data from various sources can be stored, searched, and retrieved rapidly and accurately according to user requests.
This module introduces the basic concepts and techniques for extracting spatial information from remotely sensed data and introduces techniques to organize and store spatial information (and related attributes) in spatial databases.

Contents

- Selection and preparation of imagery for interpretations purposes
- Use of various types of remotely sensed data at different scales
- Image characteristics and their relation to spatial information and processes in applied earth science
- Interpretation of imagery and extraction of spatial data and information within an applied earth science context (i.e. Geology, geomorphology)
- Organization and storage of data in structured data catalogues and spatial databases

Keywords

Image interpretation, Geology, Geomorphology, Terrain analysis, data standards, database design and implementation

Objectives

The subject of image interpretation and geo-databases aims to introduce participants to the principles and practice of interpreting remotely sensed data. This is done in the context of applied earth science applications and puts the interpretation in a context of geology, geomorphology and terrain, and soils. The subject will help participants to recognize relevant spatial information and will help to relate this to the structure of and processes at the earth surface.
The subject aims to introduce participants to the principles and practice of organizing extracted information in existing spatial databases (i.e. making use of data structures, documentation procedures, etc).

Prerequisites

- Principles and Applications of Remote Sensing and GIS (ITC core modules or equivalent)
- Background in Earth Sciences
- Good stereoscopic vision

Recommended Knowledge

Non-earth scientists attending the course are recommended to read up on basic geology and geomorphology.

Staff involved

Dr. T. Woldai, Drs. R. Voskuil, Ir. B. Krol

Hardware and Software Requirements

Hardware:

- Mirror stereoscope and pocket stereoscope
- Screen stereoscopes
- Drawing pens/pencils/ruler (50 cm long)
- Digitising tablets
- PC

Software:

- ERDAS Imagine
- ArcGIS 9 (or maybe ArcView9).
- Relational database software (such as MS Access, ESRI geodatabase)
- Systems analysis tools (entity-relation diagrams/UML, XML, metadata generators)

Teaching Materials

- Lecture notes on geological image interpretation
- Lecture notes on geomorphological image interpretation
- Lecture notes on databases
- Overhead sheets
- Assignment handouts
- Aerial photographs, satellite images and maps

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
8	18				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

Assignment is based on the results of the practical exercises and assignments

Note(s)

-

Common Topic: Geostatistics & Statistical Modelling			
Module: 5-7		Co-ordinating staff: Dr. D.G. Rossiter	
Start:	05-01-2009		
End:	23-01-2009		
Level: MSc, PG			M09-AES-107

Introduction

Almost all data in earth science studies is spatially-explicit, that is, from known locations on, in, or over the earth's surface. These data must be assumed to have a spatial structure; that is, the data values can not be considered independent of their relative location. This provides opportunities to use the data to examine this structure and to map by trend surfaces or local interpolation (e.g. kriging), but also requires specialised methods to avoid incorrect inferences. It also opens the possibility to understand earth science processes by statistical inference. Statistics is an important component of models – mathematical models – where the real world is described in terms of equations, functions or statistics. Different approaches to mathematical modelling will be explained and demonstrated in short exercises with emphasis on the reach and limits of the applicability of each approach.

Contents

- Geographic vs. feature spaces
- Theory of spatial dependence (spatially-correlated processes)
- Concepts of spatial sampling: support, independence
- Modelling regional trends by regression on coordinates
- Discovering and modelling spatial dependence; the experimental and fittede variogram and correlogram
- Mapping by trends and local interpolation (kriging)
- Non-parametric methods for thresholds and extreme values
- Directional statistics: anisotropy
- Introduction to modelling / modelling approaches

Keywords

Spatial dependence, trend surfaces, kriging, feature and geographic space, interpolation, anisotropy, statistics

Objectives

At the end of this topic, the student should be able to:

- explain the difference between geographic vs. feature spaces, and when analysis in each is appropriate to earth science problems;
- compute regional trends by regression analysis and map using trend surfaces;
- compute local structure by variogram analysis and map using ordinary kriging;
- prepare a probability-of-exceedence map by indicator kriging;
- determine anisotropy in local structures.

Prerequisites

- Core Module – basics of GIS including statistics of image analysis
- Background in Earth Sciences
- First university-level courses in mathematics (introductory linear algebra, vectors and matrices) and (non-spatial) descriptive and inferential statistics (probability, distributions, correlation, regression)

Recommended Knowledge

Not applicable

Staff involved

Dr. D.G. Rossiter

Hardware and Software Requirements

Hardware:
- networked PC

Software:
- R environment for statistical computing; gstat package
- ArcGIS geostatistical analyst

Teaching Materials

- Text (to be determined), e.g. Davis, J. C. (2002). *Statistics and data analysis in geology, 3rd edition*. New York: John Wiley & Sons
- Internet sites on (geo-)statistics
- R manuals and contributed documentation
- Lecture notes on principles of modelling
- Extensive presentation sheets
- Assignment handouts
- Data

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
8	14				10	

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

Written (2nd week of module 7), and oral (end of module 7)

Note(s)

-

Common Topic: Life Skills			
Module: 5-10		Co-ordinating staff: Dr. D.G. Rossiter	
Start:	28-01-2009		
End:	06-03-2009		
Level: MSc, PG			U09-AES-114

Introduction

All scientific workers are responsible for communication in two directions: from others (as represented by the scientific literature) to themselves, and from themselves to other scientists, research sponsors, and the general public. This set of three lectures/exercises is intended to raise awareness of the importance of scientific communication skills, and to give the students a chance to practice them.

Contents

- Extracting information from scientific literature: finding relevant literature and summarizing its key points.
- Presenting the results of a research work to scientific peers and the general public.
- Reporting the results of a research work to scientific peers and the general public.

Keywords

Communication, literature search, reporting, presentation

Objectives

At the end of this topic, the student should be able to:

- find scientific literature relevant to a given topic, using resources of the ITC library;
- summarize the key points of a research paper: what were the objectives, methods, and key findings;
- present the key points of a research work to the general public or research sponsors;
- prepare a written summary of a research work for the general public or research sponsors.

Prerequisites

None.

Recommended Knowledge

Not applicable.

Staff involved

Dr. D.G. Rossiter, Dr. C.J. van Westen, Prof.Dr. V.G. Jetten, Drs. R. Voskuil, Dr. M. van der Meijde

Hardware and Software Requirements

Hardware:

- networked PC

Software:

- standard office programs (word processor, presentation)

Teaching Materials

- Lecture notes
- Library resources

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
8	8				8	

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

Through grading of assignments.

Note(s)

-

Common Topic: Active Methods in Remote Sensing			
Module: 8-10		Co-ordinating staff: Dr. M. van der Meijde	
Start:	10-03-2009		
End:	28-03-2009		
Level: MSc, PG			M09-AES-108

Introduction

Active remote sensing technologies have the potential to provide accurate information about the land surface and subsurface by imaging (geo) physical properties in 2D and 3D. A combination of surface and subsurface information is essential while studying natural hazards, geo-engineering problems or finding natural resources.
Shallow geophysical non-destructive methods can give insight in physical parameters of the sub-surface that will go undetected with other methods. Information can be obtained about on layering, stability of various layers, seismic velocities, conductivity/resistivity, etc. The use of geophysical techniques gives a possibility for obtaining detailed information in a non-destructive and environmentally friendly way.
Radar and Lidar provide very detailed information on surface topography and earth motions visible at the surface with a very high accuracy. They are often used in geo-engineering, environmental and hazard studies

Contents

This introductory lecture series will deal with the basic theory of most widely applied geophysical techniques in various fields of earth sciences, radar (Insar) and Lidar. In case studies we will discuss the potential and applicability of the various methods for different application fields such as natural hazards, geo-engineering and natural resource exploration. Data management and integration of data with respect to other data sources is also an important aspect of the lecture series.

Keywords

Resistivity imaging, refraction seismics, ground penetrating radar, Radar, Insar, Lidar, data integration, multi-disciplinary investigations, and potential field methods

Objectives

At the end of this topic, the student should be able to:

- understand the basic theory of the aforementioned active methods in remote sensing;
- determine the applicability of the various methods for their field of interest;
- recognize the importance of integrating geophysical data with other data sources;
- understand the basics of geophysical interpretations.

Prerequisites

- Background in Earth Sciences
- Basic knowledge of mathematics and physics

Recommended Knowledge

Not applicable

Staff involved

Dr. M. van der Meijde, Dr. T. Woldai, Dr. M.W. Straatsma

Hardware and Software Requirements

Hardware:

- networked PC

Software:

- to be determined

Teaching Materials

- Lecture notes
- Hand-outs
- Assignments (both individual as in groups)
- ITC library
- Internet resources

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
10	20				10	

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

Written (2nd week of module 10), and oral (end of module 10)

Note(s)

-

ERE topic: Geology and Mineral Deposits			
Module: 5-10		Co-ordinating staff: Dr. E.J.M. Carranza	
Start:	05-01-2009		
End:	06-03-2009		
Level: MSc, PG			U09-AES-115

Introduction

Identifying and finding mineral resources for development is a complex undertaking in our challenged environment and one that relies heavy on conceptual deposit and exploration models and the application of modern technologies. In the case of deposit and exploration models, economic geology and structural geology are very closely related. In general, mineral deposit occurrences are structurally- and geochemically-controlled. Therefore, an area's potential for certain types of mineral deposits can be described in terms of geological setting, structural control and geo chemical (alteration) environment.

Contents

The lecture series covers the mode of formation, structural control and geochemical signatures of mineral deposits. The occurrences of certain types of mineral deposits will be discussed in terms of geological setting, structural control and geochemical environment.

The emphasis of the lectures will be on recognition of geological, geophysical and/or geochemical signatures that can be used for prospecting and assessing the potential of an area for a certain type of mineral commodity.

The lectures will be integrated into the two major projects and several smaller case studies.

Keywords

Mineral deposit models, economic geology, structural geology, hydrothermal alteration, mineral deposits, industrial minerals

Objectives

At the end of this topic, the student should:
- have gained knowledge of geologic controls on occurrence of certain types of mineral deposits and signatures of mineralized ground in geological, geophysical and geochemical datasets;
- be able to identify appropriate key criteria that can be used in predictive GIS modelling of prospectivity for certain types of mineral deposits (e.g. structural features, geophysical responses, geochemical assemblages, stratigraphic/sedimentary features);
- be able to assess the prospectivity of a given area with regards to the main classes of ore deposits (e.g. magmatic, hydrothermal, and sedimentary).

Prerequisites

- Background in Earth Sciences
- Basic knowledge of mathematics and physics

Recommended Knowledge

Not applicable.

Hardware and Software Requirements

Hardware:
- networked PC

Software:
- to be determined

Staff involved
Dr. E.J.M. Carranza, Dr. P.M. van Dijk, Dr. T. Woldai

Teaching Materials
- ITC reader on earth resource exploration methods
- Lecture notes
- ITC library
- Internet resources

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
28	14				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
Written (2nd week of module 7), and oral (end of module 7)

Note(s)
-

ERE topic: Airborne Geophysics			
Module: 5-7		Co-ordinating staff: Dr. S.D. Barrit	
Start:	05-01-2009		
End:	23-02-2009		
Level: MSc, PG			U09-AES-116

Introduction

Identifying earth resources for development is a complex undertaking in our challenged environment and one that relies on conceptual models and the application of modern technologies. Economic conditions, environmental consequences and societal constraints further influence decision making about their actual development. Non-destructive geophysical investigative methods play a crucial role in modern exploration for natural resources. The application of airborne and ground based geophysical methods is of importance in practically every phase of the exploration process: From the large scale airborne regional reconnaissance to ground based follow-up studies. The focus of the lectures will be on potential field methods and radiometrics. All lectures will be linked and integrated into the two major projects and several smaller case studies.

Contents

This lecture series will focus on potential field methods (magnetics and gravity) and radiometrics (gamma-ray spectrometry). Topics that will be discussed include:

- Introduction to basic physical principals.
- Summary of data acquisition and processing.
- Qualitative analysis
- Estimating geological parameters from data analysis using data-driven or knowledge driven approaches.

Keywords

Geophysics, potential field methods, radiometrics, physics, processing, qualitative analysis, data integration.

Objectives

At the end of this lecture series, the student should be able to:

- understand the mathematical and physical background of the various potential field methods and radiometrics;
- know the applicability of the various methods for detection and monitoring of various targets;
- apply the various geophysical methods in a useful way;
- analyse and interpret the results of the geophysical methods in a multi-disciplinary approach.

Prerequisites

- Background in Earth Sciences
- Basic knowledge of mathematics and physics

Recommended Knowledge

Not applicable

Hardware and Software Requirements

<u>Hardware:</u>

- networked PC

<u>Software:</u>

- ArcGIS
- OASIS

Staff involved

Dr. S.D. Barrit, Dr. M. van der Meijde

Teaching Materials

- ITC reader on earth resource exploration methods
- Lecture notes
- ITC library
- Internet resources

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
12	24				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

Written (2nd week of module 7), and oral (end of module 7)

Note(s)

-

ERE topic: Exploration and Environmental Geochemistry			
Module: 5-10		Co-ordinating staff: Drs. J.B. de Smeth	
Start:	09-03-2009		
End:	17-04-2009		
Level: MSc, PG			U09-AES-118

Introduction

The use of geochemistry in the field of mineral exploration and environmental studies is widely spread. Environmental and exploration geochemistry uses the chemical concentration of major, minor and trace elements in the earth materials in order to delineate distribution patterns in relation mainly to geological, ore forming- and environmental processes. In all these fields similar sampling and analytical concepts and techniques are used to make spatial element distribution patterns visible. These patterns or combined patterns are related to element concentrations which in combination with mineralogy, geology, hydrogeology and geomorphology can provide insight on the location and extent of hidden ore deposits, sources of pollution or the extend to which the environment has been disturbed and/or is at risk.
All lectures will be highly linked and integrated into the two major projects and several smaller case studies within module 5-10.

Contents

The lecture series will cover the principal geochemical methods. Topics that will be discussed are among others:

- Elements, minerals, their natural abundance and chemical behaviour and dispersion processes in the near surface environment in rocks, soils, sediment and water, anomalous element concentrations;
- Geochemistry of rocks and soils, hydro and drainage geochemistry as well as sampling methods, quality control measures and demonstration of sample analysis in ITC's geochemical laboratory using UV-Vis, AAS and ICP-AES instrumentation.
- Choices in sampling and analytical laboratory procedures.
- Data interpretation- and modelling techniques to assess for example the mineral potential of a surveyed area.
- Newest developments in geochemistry.

Keywords

Exploration geochemistry, environmental geochemistry, inorganic elements, chemical analysis, geochemical sampling of rocks, soils, drainage systems, water, organic material and gas, analytic procedures, spatial modelling

Objectives

At the end of this topic, the student should be able to:

- understand the principles of natural and anomalous element abundance and dispersion;
- apply the various geochemical sampling techniques for different environments;
- chose appropriate analytical methods on geochemical samples and data sets;
- interpret the results of the various sampling and analysis techniques in a multi-disciplinary approach.

Prerequisites

Background in Earth Sciences

Recommended Knowledge

Basic knowledge of inorganic chemistry and univariate statistics.

Staff involved

Drs. J.B. de Smeth, Dr. F.J.A. van Ruitenbeek

Hardware and Software Requirements

Hardware:

- networked PC

Software:

- EXCEL, Grapher and Surfer, Blackboard

Teaching Materials

- ITC reader on earth resource exploration methods
- Lecture notes
- ITC library
- Internet resources

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
14	28				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

Written (2nd week of module 10), and oral (end of module 10)

Note(s)

-

<table>
<tr><th colspan="3">ERE topic: Multi- and Hyperspectral Remote Sensing</th></tr>
<tr><td>Module: 5-10
Start: 26-02-2009
End: 06-03-2009</td><td colspan="2">Co-ordinating staff:
Dr. F.J.A. van Ruitenbeek</td></tr>
<tr><td>Level: MSc, PG</td><td></td><td>U09-AES-117</td></tr>
</table>

Introduction

Remote sensing, also called earth observation, refers in a general sense to the instrumentation, techniques and methods used to observe, or sense, the surface of the earth, usually by the formation of an image in a position, stationary or mobile, at a certain distance remote from that surface.
In spectral remote sensing energy reflected from an object, is being measured and translated into information about the object or into processes related to the object. Reflectance spectra have been used for many years to obtain compositional information of the Earth surface. Spectral reflectance in visible and near-infrared offers a rapid and inexpensive technique for determining the mineralogy of samples and obtaining information on chemical composition. Recent developments in this field are fast and this lecture series will introduce state-of-the-art techniques in multi- and hyperspectral processing and interpretation.
All lectures will be highly linked and integrated into the two major projects and several smaller case studies.

Contents

The lecture series will provide a comprehensive overview of spectral remote sensing in Earth Science. Topics that will be discussed include:

- reflectance properties of earth materials;
- acquisition and pre-processing of remote sensing imagery;
- image enhancement and analysis techniques such as rationing, classification, spectrum matching, sub-pixel classifiers and spectral processing including the spatial domain;
- estimating physical and chemical parameters from spectral data sets.

Keywords

Multi- and hyperspectral remote sensing, sensors, data processing, spectral parameters, image analysis, advanced techniques.

Objectives

At the end of this topic, the student should be able to:

- understand the principles of multi- and hyperspectral remote sensing;
- determine the applicability of the various detection and analysis techniques for their field of interest;
- apply the various processing and analysis techniques in a useful way;
- interpret the results of the various processing and analysis techniques in a multi-disciplinary approach.

Prerequisites

- Background in Earth Sciences
- Basic knowledge of mathematics and physics

Recommended Knowledge

Not applicable

Staff involved

Dr. F.J.A. van Ruitenbeek, Prof. D.R. van der Meer

Hardware and Software Requirements

Hardware:

- networked PC

Software:

- ENVI
- Further software to be determined

Teaching Materials

- ITC reader on earth resource exploration methods
- Lecture notes
- ITC library
- Internet resources

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
12	18				18	

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

Written (2nd week of module 10), and oral (end of module 10)

Note(s)

-

ERE topic: Mineral Prospectivity Mapping			
Module: 5-7		Co-ordinating staff: Dr. E.J.M. Carranza	
Start:	05-01-2009		
End:	06-03-2009		
Level: MSc, PG			U08-AES-138

Introduction

Despite our considerable knowledge about the Earth, it remains difficult to predict where to find mineral deposits. The basic problem is that ore-forming processes evolve at widely different spatial and temporal scales. Mineral exploration and mineral prospectivity mapping are (therefore) multi-disciplinary fields: they involve geology, geophysics and geochemistry. This module (MINPROS) is concerned with analysis and integration of various types and sets of relevant spatial (geological, geophysical, geochemical) evidence of occurrence of mineral deposits of the type sought. The evidential data sets are input to GIS-based predictive mapping of prospective land for mineral deposits of the type sought.

Contents

The lecture and practical exercise series covers GIS-based map representations of prospectivity recognition criteria based on conceptual mineral deposit models, methods for knowledge-drive assignment and data-driven calculation of weights of spatial evidence of mineral prospectivity and method for evaluating performance of a mineral prospectivity map.

Keywords

Mineral deposit models, economic geology, structural geology, hydrothermal alteration, mineral deposits, industrial minerals.

Objectives

On completion of this module, students should have acquired basic understanding and skills of applying GIS-based methods for:

- Knowledge-driven modeling of mineral prospectivity
- Data-driven modeling of mineral prospectivity
- Cross-validation of mineral prospectivity models

Prerequisites

- Background in mineral deposit geology
- Basic knowledge of mathematics and statistics

Recommended Knowledge

GIS operations

Staff involved

Dr. E.J.M. Carranza

Hardware and Software Requirements

Hardware:

- networked PC

Software:

- ILWIS

Teaching Materials

- Lecture notes
- Practical exercise instructions
- Real data sets
- ITC library
- Internet resources

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
4	8				4	

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

Written (2nd week of module 7), and oral (end of module 7)

Note(s)

-

ERE Project 1: Regional Mineral Exploration			
Module: 5-7		Co-ordinating staff: Dr. F.J.A. van Ruitenbeek	
Start:	26-01-2009		
End:	06-03-2009		
Level: MSc, PG			U09-AES-119

Introduction

In regional exploration studies various techniques are used to obtain geological information that is relevant to finding mineralization of interest. The type of deposit and the scale of investigation determine suitability of the various methods. On regional reconnaissance scale methods are used that can quickly provide geological information of large areas. Airborne geophysical data, such as magnetics and gamma-ray spectrometry, and spectral remote sensing, such as Landsat TM and ASTER, are very suitable to obtain geological information over large areas. Integrated analyses of these data sets provide a geological framework that is necessary for investigation of mineral potential. Exploration criteria or exploration guides that are obtained from conceptual deposit models of the mineral of interest are used to further analyse remote sensing and other geological data sets for finding mineralization itself. Proper management of data sets and their derived products, such as interpretations or classifications, is an essential part of the regional exploration study.

Contents

In this project two regional exploration case studies are presented. The first case study is about geologic mapping and exploration in an Archean granite greenstone terrain in Western Australia, the Pilbara. The area hosts numerous mineral occurrences of various commodities. It is relatively undeformed and well exposed. Therefore it is very suitable for exercising remote sensing based method in mineral exploration. The second case study is on geologic mapping and mineral exploration in the Tete Province of Mozambique. This area is geologically more complex and is host to many different types of deposits. The project consists of two parts. First a regional geologic interpretation with remote sensing data will be made. After that conceptual models of various commodities will be used together with mineral occurrences data and multi-source data sets to determine mineral prospectivity of the area. Results will be presented by oral presentation and a report.

Keywords

Economic geology, regional geophysics, remote sensing, GIS, data handling and integration, mineral potential.

Objectives

At the end of this topic, the student should be able to:

- understand the principles and techniques in regional exploration studies;
- determine the suitability of various methods for exploring a target of interest;
- make a geological interpretation on various scales with multi-source remote sensing data;
- determine exploration criteria from conceptual deposit models;
- extract the necessary geological information from geological, geophysical, and remote sensing data sets for determining mineral potential.

Prerequisites

- Background in Earth Sciences
- Basic knowledge of mathematics and physics
- Core module ITC

Recommended Knowledge

Knowledge of GIS and remote sensing, geology

Staff involved

Dr. F.J.A. van Ruitenbeek, Dr. T. Woldai, Dr. S. Barrit, Dr. E.J.M. Carranza

Hardware and Software Requirements

Hardware:

- Networked PC

Software:

- ArcGIS
- ENVI
- Oasis

Teaching Materials

- ITC reader on earth resource exploration methods
- Lecture notes
- ITC library
- Internet resources

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
4			84			8

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

Final report and presentation in the last week module 7

Note(s)

-

ERE Project 2: Follow-up Exploration Techniques			
Module: 8-10		Co-ordinating staff: Dr. F.J.A. van Ruitenbeek	
Start:	30-03-2009		
End:	17-04-2009		
Level: MSc, PG			U09-AES-120

Introduction

In follow-up exploration studies various techniques are used to obtain geological information that is relevant to finding mineralization of interest. Suitability of the various techniques depends on the type of deposit and the scale of investigation. In local-scale exploration campaigns, methods are used that can provide detailed geological information on relatively small areas and methods that can directly or indirectly detect mineralized zones. Hyperspectral remote sensing, geochemical methods, and ground based geophysics, such as gamma-ray spectrometry and potential field methods, are suitable to obtain geological information in high spatial resolution and for delineation of potentially mineralized zones. Integrated analyses of these data sets provide the information that is necessary for investigation of mineral potential. Exploration criteria that are obtained from conceptual deposit models are used to further analyse remote sensing and other geological data sets for finding mineralization itself. Proper management of data sets and their derived products, such as interpretations or classifications, is an essential part of the local exploration study.

Contents

In this project a follow-up exploration case study is presented. Area of interest is the Cabo de Gata volcanic province in south-eastern Spain where various types of epithermal mineralization are related to extensive hydrothermal alteration events. The area hosts high sulfidation and low sulfidation precious metal and base metal deposits that contain Au, Ag, Pb, Zn and Cu. Several industrial mineral deposits such as bentonite, alunite and gypsum occur in the area. Lithology is well exposed since vegetation is sparse and weathering is limited and therefore the area is very suitable for studying geology and rock alteration patterns.

The project consists of several parts. First a regional geologic interpretation will be carried out using remote sensing data upon which map areas with high exploration potential will be selected for further investigation with hyperspectral, geophysical and geochemical techniques. This includes validation of remote sensing based interpretation with ground data using field spectrometers. Finally, potentially mineralized zones, which are of interest for further investigation, such as soil sampling or reconnaissance drilling, will be delineated by integration of the various available data layers. Results will be presented by oral presentation and a report.

Keywords

Economic geology, (hyper)spectral remote sensing, geochemistry, geophysics, GIS, data handling, data integration, multi-disciplinary investigations, infra red mineral analysis

Objectives

At the end of this topic, the student should be able to:

- understand the principles and techniques in follow-up exploration studies;
- determine the suitability of various methods for exploring a target of interest in the follow-up stage;
- make an interpretation of the area on various scales in terms of geology and mineralized zones with multi-source remote sensing and ground data;
- determine exploration criteria from conceptual deposit models.

Extract the necessary geological information from geological, geophysical, geochemical and remote sensing data sets for finding mineralization.

Prerequisites
- Background in Earth Sciences
- Basic knowledge of mathematics and physics
- Core modules ITC
- ERE project 1: Regional Mineral Exploration

Recommended Knowledge
Not applicable.

Staff involved
Dr. F.J.A. van Ruitenbeek, Dr. H.M.A. van der Werff, Dr. E.J.M. Carranza, Drs. J.B. de Smeth, Prof.Dr. F.M. van der Meer, C. Hecker, Dr. M. van der Meijde

Hardware and Software Requirements
Hardware:
- networked PC
- PIMA and / or ASD infrared field spectrometers for mineral analysis
- Gamma ray Spectrometer

Software:
- ArcGIS
- ENVI

Teaching Materials
- ITC reader on earth resource exploration methods
- Lecture notes
- ITC library
- Internet resources

Allocated Time per Teaching Learning Method
L	SP	UP	GA	IA	S	O
4			88			8

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
Final report and presentation in the last week module 10, possible mid-term presentation.

Note(s)
-

<table>
<tr><th colspan="4">GEE topic: Site Investigations and Engineering Mapping</th></tr>
<tr><td colspan="2">Module: 5-10</td><td colspan="2" rowspan="3">Co-ordinating staff:
Dr. H.R.G.K. Hack</td></tr>
<tr><td>Start:</td><td>05-01-2009</td></tr>
<tr><td>End:</td><td>23-01-2009</td></tr>
<tr><td colspan="2">Level: MSc, PG</td><td></td><td>U09-AES-122</td></tr>
</table>

Introduction
Site investigation is a complex process. It involves the acquisition of geological, geotechnical, and other relevant information which might affect the construction or performance of a civil engineering or building project. Adequate site investigations are vital to the success of any construction project. If no or inadequate site investigations are done, it can lead to very large construction cost overruns. If site investigation is to be effective it must be carried out in a systematic way, using techniques that are relevant, reliable and cost-effective.

Contents
- Objectives of site investigations
- Importance of site investigations
- General procedure and stages
- Techniques for acquiring and interpreting data
- Description and classification of soil and rock
- Subsurface exploration techniques
- In-situ testing techniques
- Laboratory and field tests

Keywords
Site investigations, RQD, light percussion boring, rotary core drilling, CPT, DCPT, SPT, Geophysics, Field vane, Window sampler, Split sampler, Falling/rising head test, Lugeon test, Packer test, Pressure meter test, Plate bearing test, etc.

Objectives
Upon completion of the topic, the participant should be able to:
- understand the relevance of site investigations;
- know the standards for describing rock and soil;
- know the various stages of site investigations;
- know the various site investigations techniques and understand in which situations they can and should be used.

Prerequisites
Not applicable.

Recommended Knowledge
Not applicable.

Staff involved
Dr. H.R.G.K. Hack

Hardware and Software Requirements
Not applicable

Teaching Materials
- BS 5930 1999-Code of practice for site investigations
- Site Investigation. Second Edition. C. R. I. Clayton, M. C. Matthews and N. E. Simons, Department of Civil Engineering, University of Surrey

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
2	2				2	

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

Written examination.

Note(s)

-

<table>
<tr><th colspan="4">GEE topic: Soil Mechanics</th></tr>
<tr><td colspan="2">Module: 5-10</td><td colspan="2" rowspan="3">Co-ordinating staff:
Dr. H.R.G.K. Hack</td></tr>
<tr><td>Start:</td><td>05-01-2009</td></tr>
<tr><td>End:</td><td>13-02-2009</td></tr>
<tr><td colspan="2">Level: MSc, PG</td><td></td><td>U09-AES-123</td></tr>
</table>

Introduction

During lectures the main topics of the subject will be discussed, and some examples may be shown. Major parts are applied in Stream specific Projects.

Contents

Classification of soils; groundwater; phreatic level; heads; coefficient of permeability; vertical flow of ground water; difference between phreatic level and piezometric level; vertical effective stresses in hydrostatic and non-hydrostatic conditions; shear strength; triaxial test; UCS test; ultimate horizontal effective stresses; stress-strain behaviour; settlements according to Terzaghi, oedometer test; pre-consolidation stress; consolidation theory; drainage length; hydrodynamic period for one or more layers; secondary settlement; Anglo-Saxon formula; stability of slopes in soil; slip circle calculations (Bishop); influence of pore water pressures; overview of available in-situ and laboratory testing methods; the planning of a site investigation in more or less known soil conditions for different projects, using the most appropriate field and laboratory tests; monitoring methods to be used during construction.

Keywords

Classification, groundwater, effective stress, shear strength, settlements, consolidation theory, slope stability, site investigations.

Objectives

Upon completion of the topic, the student should be able to:

- understand of the behaviour of different types of soil, including the determination of the major soil parameters, and the execution of basic calculations;
- understand the changes of the vertical effective stresses due to surcharges and changes of the ground water levels;
- have a "feeling" for the order of magnitude of the major soil parameters;
- determine with approximate methods settlements for the short and the long term, including the consolidation behaviour;
- understand by which factors the stability of a slope will be influenced in favourable or unfavourable way;
- make a plan for a site investigation, if required with laboratory tests, and with monitoring during the execution, that will give all the parameter values, that may be important for a certain project in more or less known circumstances.

Prerequisites

Not applicable.

Recommended Knowledge

Stress; strain; logarithms; trigonometric functions.

Staff involved

Dr. H.R.G.K. Hack

Hardware and Software Requirements

Not applicable.

Teaching Materials

- Lecture notes Soil Mechanics I
- Lecture notes Soil Mechanics II, Booklet with Formulas, tables and graphs, Questions and Exercises.
- Booklet with Formulas, tables and graphs, Questions and Exercises.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
11				4	3	

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

Written examination. It is allowed to use the booklet with Formulas, tables and graphs.

Note(s)

-

GEE topic: Rock Mechanics			
Module: 5-10		Co-ordinating staff: Dr. H.R.G.K. Hack	
Start:	05-01-2009		
End:	23-01-2009		
Level: MSc, PG			M09-AES-110

Introduction

The mechanics of discontinuous rock masses are elementary for the safe design of tunnels, dams, foundations and slopes in discontinuous rock masses.

During lectures the main topics of the subject will be discussed, and examples will be shown.

Contents

Intact rock versus rock mass. Characterization and properties of discontinuities in rock. Characterization and properties of discontinuous rock masses. Mechanical and physical behaviour of discontinuous rock masses. Weathering of discontinuous rock masses. Characterization and properties of weathered rock masses. Mechanics of weak rock(s) mass(es) and cemented soils. Principles of flow through discontinuities and discontinuous rock masses. Methods and influence of excavation methods. Influence of blasting and other vibrations. Influence of stress and stress changes. Classification of discontinuous rock masses. Possibilities for analytical and numerical modelling of discontinuous rock masses. Large and small scale testing and monitoring of discontinuities and discontinuous rock masses. Principles of tunnel and dam design. Interaction between discontinuous rock masses and engineering structures, such as tunnels, dams and foundations. Case histories.

Keywords

Rock, mechanics, mass, discontinuties, strength, deformation, excavation, blasting, testing, monitoring, tunnels, dams, foundations, slopes.

Objectives

Upon completion of the topic, the participant should be able to:

- understand the mechanical and physical behaviour of discontinuous rock masses;
- understand the interaction between civil engineering structures and discontinuous rock masses;
- understand the specific issues concerning tunnels, dams and foundations in or on discontinuous rock masses.

Prerequisites

Not applicable.

Recommended Knowledge

Basic knowledge of physics, mechanics, rocks and minerals, and geology

Staff involved

Dr. H.R.G.K. Hack

Hardware and Software Requirements

Not applicable

Teaching Materials

- Introduction to rock mechanics (except chapters on slope stability) by R. Goodman
- Lecture notes:
  - Discontinuous rock mechanics
  - Dams

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
11				6	3	

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

Written examination.

Note(s)

-

GEE topic: Laboratory Testing			
Module: 5-10		Co-ordinating staff: Dr. H.R.G.K. Hack	
Start:	05-01-2009		
End:	23-01-2009		
Level: MSc, PG			M09-AES-109

Introduction
Many material and mass properties can be determined in the fields during site investigations or with in-situ testing methods. However, mostly rock and soil samples also have to be tested in a laboratory in order to assess its variability and in order to obtain parameters for particular geotechnical calculations. The rock and soil samples are generally obtained during the site investigations. In order to obtain the proper samples and to acquire the right design properties, it is essential to know and understand the various rock and soil tests that can be carried out.

Contents
- Laboratory tests on rock and aggregates
- Laboratory tests on soil samples

Keywords
Laboratory testing, UCS, Triaxial test, Point load test, Brazilian tensile strength, abrasivity, durability, Schmidt hammer, roughness, Methylene blue adsorption test, Grain size distribution, Plastic limit, Liquid limit, Density, Specific gravity, Compaction tests, Permeability, Vane test, etc.

Objectives
Upon completion of the topic, the participant should be able to:
- know about different rock and soil laboratory tests;
- understand the different material and mass properties that can be determined;
- know the limitations and complications of the various tests and understand sampling requirements.

Prerequisites
- Site investigations
- Rock mechanics
- Soil mechanics

Recommended Knowledge
Rock and soil mechanics

Staff involved
Dr. H.R.G.K. Hack, W. Verwaal / A. Mulder (TU Delft)

Hardware and Software Requirements
Laboratory testing equipment available at rock and soil mechanics laboratory at the TU Delft

Teaching Materials
- Rock and aggregate test procedures. Verwaal and Mulder, TU Delft
- ISRM: "Rock Characterization, Testing and Monitoring", ISRM Suggested Methods, Editor E.T. Brown. Pergamon press 1981
- ASTM: "1985 and 2000 Annual Book of ASTM Standards", Volume 04.08: Soil and Rock; Building Stones. Published by ASTM in 1986.
- BS: 812: Published by British Standards Institution

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
3				6		

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

Written examination, assigment

Note(s)

-

GEE topic: 3-D GIS and Modelling			
Module: 5-10		Co-ordinating staff: Dr. H.R.G.K. Hack	
Start:	26-01-2009		
End:	06-03-2009		
Level: MSc, PG			U09-AES-124

Introduction

Numerical modelling and constitutive models of soil and rock masses are often required for the safe design of engineering constructions in or on the soil or rock mass.
During lectures the main topics of the subject will be discussed, and examples will be shown. Practical exercises will be given to give the participants hands-on experience with numerical modeling.

Contents

Introduction to numerical modelling for soil and rock:

- Finite Element Modelling (FEM)
- Distinct Element Modelling (DEM)

Constitutive models:

- Linear-elastic
- Mohr-Coulomb
- Soft soil
- Soft soil creep
- Hardening soil
- Cam-Clay

Keywords

Constitutive models, numerical modeling, finite element modeling, distinct element modeling, Mohr-Coulomb.

Objectives

Upon completion of the topic, the student should be able to:

- use numerical modelling and to choose constitutive model to model the stability of foundations, slopes and tunnels in or on a soil or rock mass.

Prerequisites

- Rock mechanics
- Soil mechanics

Recommended Knowledge

Soil and rock mechanics

Staff involved

Dr. H.R.G.K. Hack, Guestlecture

Hardware and Software Requirements

Software:

- Plaxis 8.0, Slope/W, Flac, Udec

Teaching Materials

Handouts

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
6				3	6	

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

Written examination; assignment.

Note(s)

-

GEE topic: Engineering Spectroscopy			
Module: 5-10		Co-ordinating staff: Dr. H.M.A. van der Werff	
Start:	26-01-2009		
End:	06-03-2009		
Level: MSc, PG			U09-AES-125

Introduction

Remote sensing, also called earth observation, refers in a general sense to the instrumentation, techniques and methods used to observe, or sense, the surface of the earth, usually by the formation of an image in a position, stationary or mobile, at a certain distance remote from that surface. In spectral remote sensing energy reflected from an object, is being measured and translated into information about the object or into processes related to the object. Reflectance spectra have been used for many years to obtain compositional information of the Earth surface. Spectral reflectance in visible and near-infrared offers a rapid and inexpensive technique for determining the chemical composition of samples and from that deriving engineering properties. Recent developments in this field are fast and this lecture series will introduce state-of-the-art techniques in multi- and hyperspectral processing and interpretation.

Contents

The lecture series will provide a comprehensive overview of spectral remote sensing in Earth Science. Topics that will be discussed include:

- Reflectance properties of earth materials and vegetation.
- Hyperspectral image enhancement and analysis techniques and spectral processing including the spatial domain.
- Estimating physical and chemical parameters from spectral data sets.

Keywords

Multi- and hyperspectral remote sensing, spectral processing, physical and chemical parameter estimation, image analysis, advanced techniques, hydrocarbon pollution, acid mine drainage, soil engineering.

Objectives

At the end of this topic, the student should be able to:

- understand the principles of multi- and hyperspectral remote sensing;
- determine the applicability of the various detection and analysis techniques for their field of interest;
- apply the various processing and analysis techniques in a useful way;
- interpret the results of the various processing and analysis techniques in a multi-disciplinary geo-environmental approach.

Prerequisites

- Background in Earth Sciences
- Basic knowledge of mathematics and physics

Recommended Knowledge

Multi-spectral remote sensing

Staff involved

Dr. H.M.A. van der Werff
Dr. M. van der Meijde

Hardware and Software Requirements

Hardware:

- networked PC

Software:

- ENVI/IDL

Further software to be determined

Teaching Materials

- Handouts
- Book (chapters)

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
6				3	6	

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

Written examination

Note(s)

-

GEE topic: Environmental Geochemistry			
Module: 5-10		Co-ordinating staff: Drs. J.B. de Smeth	
Start:	09-03-2009		
End:	17-04-2009		
Level: MSc, PG			U09-AES-126

Introduction

During this lecture series the environmental aspects of Geo-Environmental Engineering will be discussed. The lecture series is a mix of what is pollution, the geochemistry of pollution, how to sample different types of pollution and how it can be transported in the subsurface. The lecture series will give a basis for application of engineering principles to reduce and mitigate subsurface pollution.

Contents

- What is pollution
- Behaviour of chemical components in the near surface environment
- Analytical methods for determining pollution in solids
- Water quality analysis
- Soil leaching of chemical compounds
- Contaminant transport in shallow aquifer
- Assessment procedures for contaminated land

Keywords

Pollution, chemical components, analytical methods, quality, transport, assessment of pollution

Objectives

Upon completion of the topic, the student should be able to:

- understand the problems related to near surface or subsurface pollution;
- be capable of doing some types of measurements and analysis;
- understand transport mechanisms for pollution.

Prerequisites

- Basic chemistry and mineralogy

Recommended Knowledge

Chemistry (especially inorganic), groundwater modelling

Hardware and Software Requirements

Laboratory and field facilities

Staff involved

Drs. J.B. de Smeth, Dr. C.M.M. Mannaerts

Teaching Materials

- Handouts
- Books
- Laboratory and field exercises
- Excursion

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
6				3	6	

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

Written examination; assignment.

Note(s)

-

GEE topic: Environmental Impact Assessment			
Module: 5-10		Co-ordinating staff: Dr. M. van der Meijde	
Start:	09-03-2009		
End:	17-04-2009		
Level: MSc, PG			U09-AES-128

Introduction

During this lecture series various aspects of Environmental Impact Assessment (EIA) will be discussed, especially from a geo-environmental engineering point of view. The lecture series will start with a technical lecture on EIA, the different legislation and how to deal with it. The remaining lectures will be focussed on the implementation of EIA by various organizations. Different organizations involved in EIA will be visited and case studies on how one can deal with pollution problems taking into account the limitations but also possibilities of environmental legislation will be presented and discussed. An important part of the discussion should deal with the implementation of Geo-environmental Engineering techniques for detection, analysis and mitigation of pollution in EIA.

Contents

- What is EIA
- Different legislation EIA
- Various visits to organizations involved in EIA
- Case studies on EIA problems
- Implementation of Geo-environmental Engineering techniques for detection, analysis and mitigation of pollution in EIA.

Keywords

Environmental Impact Assessment (EIA), detection, analysis and mitigation of pollution, industry examples.

Objectives

Upon completion of the topic, the student should be able to:

- understand the problems and challenges in EIA;
- implement EIA in Geo-environmental Engineering practices;
- have an overview of application of EIA in industry.

Prerequisites

- Environmental Geochemistry

Recommended Knowledge

EIA

Staff involved

Dr. M. van der Meijde

Ms. Drs. J.M. Looijen

Guestlecturers

Hardware and Software Requirements

Not applicable

Teaching Materials

- Handouts
- Books (chapters)

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
6				3	6	

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

t.b.d.

Note(s)

-

GEE topic: Geo-Environmental Engineering and Geo-Hazards			
Module: 9		Co-ordinating staff: Dr. M. van der Meijde	
Start:	30-03-2009		
End:	17-04-2009		
Level: MSc, PG			M09-AES-111

Introduction

The study of geo-hazards is a strongly multidisciplinary research field that focuses on the development of innovative and integrated solutions to enhance the resilience of infrastructure against extreme events (earthquakes, landslides, flooding, fires, etc.). Such events often have an engineering and/or environmental components related to the direct or indirect effects of the disaster. This lecture series will focus pre-dominantly on earthquakes and landslides.
Earthquakes are one of the most devastating of all natural hazards. In order to do a site-specific hazard assessment or hazard zonation, it is essential to understand the local ground conditions. This forms the basis of earthquake engineering and micro- and macro-zonation.
The stability of existing or new to be made slopes in soil or rock is elementary for the safety of constructions such as roads or buildings, underneath a slope.
During lectures the main topics of the subject will be discussed, and examples will be shown.

Contents

Earthquakes:

- Concepts of seismic ground amplification, topographic amplification and liquefaction.
- Liquefaction analysis
- Using surface and subsurface information to create large scale hazard zonation maps, which will form the basis for a risk assessment.
- Different examples of micro- and macro hazard zonation approaches and concepts

Landslides

- Types of slope instability (e.g. wedge failure, sliding, rotational, rock fall, toppling, buckling) in soil and rock masses
- Analytical slope stability analysis
- Numerical slope stability analysis
- Slope stability classification
- Weathering
- Triggering mechanism (earthquakes, rainfall)

Keywords

Ground response, amplification, liquefaction, micro- and macro hazard zonation, slope stability analysis, classification systems, SSPC, weathering, rock, soil

Objectives

Upon completion of the topic, the student should be able to:

- Understand the main issues in earthquake engineering and seismic micro- and macro zonation
- Understand how soil and buildings react to earthquake tremors
- assess an existing slope on stability

Prerequisites

- Core Module
- Basic knowledge of soil mechanics and dynamics

Recommended Knowledge

Soil mechanics, dynamics, civil engineering, geotechnical engineering, GIS

Staff involved
Dr. M. van der Meijde

Hardware and Software Requirements
<u>Software:</u>
- Edushake

Teaching Materials
- Kramer, Earthquake Engineering
- Articles, Handouts, Powerpoint presentation

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
3				3	3	

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
Written examination; assignment.

Note(s)
-

GEE Project 1: Engineering Feasibility Study for Various Construction Projects in the Baix-Camp Area			
Module: 5-10		Co-ordinating staff: Dr. H.R.G.K. Hack	
Start:	26-01-2009		
End:	06-03-2009		
Level: MSc, PG			U09-AES-130

Introduction

Based on a large-scale multi-purpose engineering geological map, a large-scale (1:5,000) GIS database and an engineering geological mapping report that contains all the relevant engineering parameters, an engineering feasibility study has to be carried out. What are given for the project are the terms of reference to the design of a high-speed railway line that runs through the project area. The study may involve the preliminary design of tunnels, portals, bridges, embankments and slopes. The aim of this project is to carry out a feasibility study, given the terms of reference and the available data. The delivery of this project is a feasibility report, which should serve as a basis for a tender document and/or a site-investigation project.

Contents

- Rock mechanics
- Soil mechanics
- 3D modelling
- Numerical modelling
- (GIS) Database design and data handling
- Technical report writing

Keywords

Feasibility study, engineering design, engineering geological mapping, 3D modelling

Objectives

Upon completion of the topic, the student should be able to:

- carry out a feasibility study for any engineering work;
- make a preliminary design for e.g. tunnel, bridge, foundation, etc;
- understand engineering geological maps, geotechnical reports;
- write a professional technical report.

Prerequisites

- Core Module
- Rock mechanics
- Soil mechanics
- Numerical modelling

Recommended Knowledge

GIS, Rock mechanics, Numerical modelling, Engineering Geological mapping, Data extraction from imagery

Staff involved

Dr. H.R.G.K. Hack, Ms. W. Tegtmeier

Hardware and Software Requirements

<u>Software:</u>

- Plaxis, Flac, Udec
- GIS: Ilwis, ArcGIS
- Excel, Word
- (Rockworks)

Teaching Materials

See topics: Rock mechanics, Engineering Geological mapping, Information extraction from Imagery, Numerical modelling.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O

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

Delivery: Feasibility report, presentation, oral examination

Note(s)

-

GEE Project 2: Assessment of Hydrocarbon Pollution			
Module: 5-10		Co-ordinating staff: Dr. M. van der Meijde	
Start:	09-03-2009		
End:	08-05-2009		
Level: MSc, PG			U09-AES-131

Introduction

Leakage of hydrocarbon has a large economic and environmental impact. Traditional methods for investigating leakage and resulting pollution, such as drilling, are destructive, time consuming and expensive. Remote sensing is an alternative that is non-destructive and has been tested extensively for exploration of onshore hydrocarbon reservoirs and detection of hydrocarbons at the Earth's surface. In this project, a leaking pipeline is investigated through field and airborne reflectance spectrometry and the findings are validated with traditional drilling and geophysical measurements.

Contents

- Database handling: using a database of spectroscopic measurements, boreholes, and water samples
- Geochemistry: analysis of all available pollution level and its impact on the environment
- Geostatistics: interpolation of pollution information
- GIS: 2.5 D modelling of the pollution
- Spectroscopy: derive pollution levels from spectral data
- Geophysics: Analyse geophysical measurements for pollution
- Data integration: Integrate the different datasets for pollution analysis and assessment of possible environmental and/or engineering remediation efforts

Keywords

Spectroscopy, geophysics, hydrocarbon pollution, geochemistry, geostatistics, data integration, EIA

Objectives

Upon completion of the topic, the student should be able to:

- interpret surface and subsurface information in the form of maps, cross sections, borehole logs, water samples and translate that into a 2.5D model of pollution distribution in a GIS;
- apply various GE techniques for assessing surface and subsurface pollution;
- write a report relating various datasets into a conclusive recommendation on the extent of pollution and the possible remediation efforts.

Prerequisites

- Environmental geochemistry, engineering spectroscopy, EIA, active methods in RS

Recommended Knowledge

GIS, Soil mechanics, geostatistics, database design

Staff involved

Dr. M. van der Meijde, Dr. H.M.A. van der Werff, Prof.Dr. F.D. van der Meer

Hardware and Software Requirements

<u>Software:</u>

- GIS: Ilwis, ArcGIS
- Excel

Teaching Materials

Project description, Publications, library resources, teaching material pre-requisite courses

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O

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

Final report, presentation, oral examination

Note(s)

-

GH topic: Geo-Hazards and Image Interpretation		
Module: 5-10	Co-ordinating staff: Drs. R.P.G.A. Voskuil	
Start: 05-01-2009		
End: 23-01-2009		
Level: MSc, PG		U09-AES-132

Introduction

This topic will provide an introduction to hazard and risk assessment (definitions, context, types, trends, scales and objectives of hazard assessment, overview of types of hazards and hazard assessment). Depending on the type of hazard that is studied, base data is required from different sources and at different scales. Interpretation of aerial photographs and satellite images is an efficient way of collecting this data.
During the image interpretation, emphasis is placed on the extraction of geological and geomorphologic information for geohazard studies. Several techniques of image interpretation will be treated (from traditional stereoscopes to modern on-screen techniques). The aim is to provide basic knowledge regarding hazardous geomorphologic processes and the resulting spatial patterns (landforms) and how this knowledge can help in geo-hazard assessment.

Contents

- Lectures
- Exercises
- Self study

Keywords

Image interpretation, Geology, Geomorphology, Geo-Hazards

Objectives

At the end of this topic, the student should be able to:

- understand the basic geomorphologic processes leading to hazards;
- recognise specific landforms on images as indicators for geo-hazards;
- extract relevant information from images using various techniques;
- understand the requirements of hazard assessment at different scales.

Prerequisites

- Principles and Applications of Remote Sensing and GIS (ITC core modules or equivalent)
- Good stereoscopic vision

Recommended Knowledge

Background in Earth Sciences

Staff involved

Drs. R. Voskuil, Drs. N. Kingma, Dr. N. Kerle

Hardware and Software Requirements

Hardware:

- PC

Software:

- GIS (ILWIS, ArcGIS)
- RS (Erdas)

Teaching Materials

- Lecture notes on Natural Hazard and Disaster Management.
- Power point presentations
- Assignment handouts
- Data

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
10	16	8	4	10		

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 theory will be assessed during the written examination. Practical assignments will be evaluated and graded.

Note(s)

-

GH topic: Data Collection for Geo-Hazard Assessment			
Module: 5-10		Co-ordinating staff: Ir. B.G.C.M. Krol	
Start:	26-01-2009		
End:	23-02-2009		
Level: MSc, PG			U09-AES-133

Introduction

Many factors prepare, control or trigger hazardous surface processes. These factors can be static (e.g. bedrock) or dynamic (e.g. precipitation) and can result in slow, continuous processes (e.g. erosion) or in rapid events (e.g. landslides). Hence, the study of geo-hazards requires knowledge and information from multiple disciplines (such as geology, geomorphology, pedology and geology) and data sources (examples: images, existing maps, digital terrain models).

In this module focus is on two interrelated topics:

- construction and use of digital elevation models for terrain parameterization;
- RS-based change detection for geo-hazard monitoring.

Contents

- Lectures
- Exercises
- Self study

Keywords

Not applicable

Objectives

At the end of this topic, the student should be able to:

- Carry out Digital Terrain Modelling and construct relevant hydro-morphometric parameter maps;
- Use satellite images for RS-based change detection and monitoring of hazards.

Prerequisites

- Principles and Applications of Remote Sensing and GIS (ITC core modules or equivalent)

Recommended Knowledge

- Background in Earth Sciences
- Basic understanding of physics, statistics and mathematics

Staff involved

Ir. B. Krol, Drs. M. Damen, Dr. N. Kerle

Hardware and Software Requirements

Hardware:

- PC

Software:

- GIS (ILWIS, ArcGIS)
- RS (Erdas)

Teaching Materials

- Lecture notes
- Power point presentations
- Assignment handouts
- Data

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
14	12		8	6	14	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

The theory will be assessed during the written examination.

Note(s)

-

GH topic: Hazard Analysis 1: Data Driven Modelling for Geo-Hazard Assessment			
Module: 5-10		Co-ordinating staff: Drs. D. Alkema	
Start:	26-01-2009		
End:	06-03-2009		
Level: MSc, PG			U09-AES-134

Introduction

Hazard assessment is the identification and prediction of potentially hazardous areas. For this we need a tool to help us make these predictions: a model. For hazard assessment there are several approaches, ranging from very simple to very complicated. In this topic we will deal with approaches that are based on observations of the phenomena and how these correlate with spatial factors like geology, slope, etc. Also heuristic approaches will be discussed, as well as scale issues, input data requirements and modelling principles like calibration and validation.

Contents

- Lectures
- Exercises
- Self study

Keywords

Empirical modeling, knowledge-based models, data-driven models, weights-of-evidence modeling, modeling principles

Objectives

At the end of this topic, the student should be able to:

- know of different approaches to hazard modelling;
- understand how models can be used for predictions regarding geo-hazards
- understand the reach and limitations of the various approaches to modelling;
- understand the importance of model calibration and validation;

Prerequisites

- Principles and Applications of Remote Sensing and GIS (ITC core modules or equivalent)

Recommended Knowledge

- Background in Earth Sciences
- Basics of geo-information science (GIS / RS)
- Basic understanding of physics, statistics and mathematics

Hardware and Software Requirements

Hardware:

- PC

Software:

GIS (ILWIS, ArcGIS)

Teaching Materials

- Lecture notes on Natural Hazard and Disaster Management.
- Power point presentations
- Assignment handouts
- Data

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
12	18		8	6	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

The theory will be assessed during the combined written examination that also includes the topics Image Interpretation and Data Collection. Project 1 will offer the opportunity to apply the modelling approaches and there it will be graded in the project report (group-work) and during the oral exam (individual).

Note(s)

-

GH topic: Hazard Analysis II: Process-Based Modeling and Applied Hydrology			
Module: 5-10		Co-ordinating staff: Prof.Dr. V.J. Jetten	
Start:	09-03-2009		
End:	27-03-2009		
Level: MSc, PG			U09-AES-136

Introduction

Many geohazards result from hydrological processes that act as a driving force or trigger. Examples are soil moisture and drought/crop failure, groundwater fluctuations and slope instability, runoff leading to erosion and flooding. Moreover many of these processes are related: a hurricane often leads to storm runoff, flooding, and slope instability, so that we have to deal with multiple hazards. Hazardous processes are spatial in nature so a good knowledge of the landscape (for example by image interpretation) and integration of various data sources with models is needed. The emphasis will be on those aspects of hazardous processes that are needed in risk assessment.
This module will teach you how to predict the frequency and severity of these hazards, based on a simulation of the processes. The module will start with the basics of hydrological processes, making use of land use data, soil physical properties and relief. The theory will be alternated with practical exercises, in which you will learn how to build a water balance model step by step using the PCRaster software. The second part of the model concentrates on hazardous aspects of processes, modelling slope instability, runoff and erosion and flooding, using various models.
To get good model results, sensitivity analysis, calibration and validation are important. Also attention will be given to frequency-magnitude analysis. This will allow you to create meaningful hazard scenarios and may answer "what if" questions.

Contents

- Lectures
- Exercises
- Self study

Keywords

Process modeling, hydrology, hazardous processes, scenario predictions

Objectives

At the end of this topic, the student should be able to:

- gain process knowledge in a context of modelling (with an emphasis on hydrology triggered or related hazards);
- understand which landscape factors are important;
- know the strengths and limitations of this type of modelling approach;
- understand the importance of calibration, validation and sensitivity analysis;
- create scenarios that are important for risk analysis.

Prerequisites

Principles and Applications of Remote Sensing and GIS (ITC core modules or equivalent); AES-GH Modules 5-7 are a plus.

Recommended Knowledge

- Background in Earth Sciences
- Basics of geo-information science (GIS / RS)
- Basic understanding of physics, statistics and mathematics

Staff involved

Prof.Dr. V. Jetten, Dr. D. Alkema, Dr. G. Parodi, Dr. D. Shrestha

Hardware and Software Requirements

Hardware:

- PC

Software:

- GIS (PCRaster, ILWIS, ArcGIS)
- Various modelling software (LISEM, SOBEK, FLO-2D)

Teaching Materials

- Lecture notes on Natural Hazard and Disaster Management.
- Scientific background reading
- Power point presentations
- Assignment handouts
- Data

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
24	30		20		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

The theory will be assessed during the written examination. Practical assignments will be evaluated and graded.

Note(s)

-

GH topic: Vulnerability and Risk Assessment			
Module: 7-10		Co-ordinating staff: Dr. C.J. van Westen	
Start:	30-03-2009		
End:	08-05-2009		
Level: MSc, PG			U09-AES-137

Introduction

This topic will give an introduction to how the hazard information which has been analyzed in the previous modules can be used for vulnerability and risk assessment. Risk can be defined as the expected losses due to particular hazardous events in a given area and within a given period of time. In order to analyse risk information should be available on (1) the temporal and spatial probability of hazardous phenomena and the expected magnitudes; (2) the types and amounts of elements at risk and their characteristics. The topic introduces you to both qualitative and quantitative approaches for risk assessment, concentrating mostly on hydro-meterological hazards. The risk assessment focuses on an urban environment and is centered on the RiskCity training package, which guides you through the full process of multi-hazard risk assessment in an urban environment. Emphasis is given to the collection of data using RS, mobile GIS, participatory approaches, etc. as well as the assessment of the vulnerability of e.g. people, buildings, society, etc. It further will deal with different types of risk assessment: specific risk, annual risk, flood risk, landslide risk, multi-hazard risk, etc.

Contents

- Lectures
- Exercises
- Self study

Keywords

Elements at risk mapping, vulnerability assessment, participatory GIS, multi-hazard risk

Objectives

At the end of this topic, the student should be able to:

- understand the principles of risk assessment;
- know the data requirements for a risk assessment;
- know some techniques to do a risk assessment for a particular type of risk;
- carry out an element-at-risk mapping;
- carry out a vulnerability assessment;
- carry out both qualitative and quantitative risk assessments.

Prerequisites

Principles and Applications of Remote Sensing and GIS (ITC core modules or equivalent)

Recommended Knowledge

Basic knowledge of GIS, RS and geo-hazard assessment

Staff involved

Dr. C. van Westen, Drs. N. Kingma, Dr. N. Kerle

Hardware and Software Requirements

Hardware:

- PC

Software:

GIS (ILWIS)

Teaching Materials

- Lecture notes on Natural Hazard and Disaster Management.
- RiskCity training package with exercises materials and digital data.
- Power point presentations
- Assignment handouts
- Data

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
30	45		22		22	18

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 theory will be assessed during the written examination. Practical assignments will be evaluated and graded
The end of the topic consists of a final project, where participants have to select one component of risk assessment, related to the RiskCity training package, and work this out during several days, after which a short report and a presentation should be given.

Note(s)

This topic is also offered as a distance education course which will be given simultaneously for outside participants

GH Project 1: Hazard Assessment		
Module: 5-7	Co-ordinating staff: Drs. N.C. Kingma	
Start: 16-02-2009		
End: 06-03-2009		
Level: MSc, PG		U09-AES-135

Introduction

This project will run parallel to the Geo-Hazards topics "Image Interpretation", "Data Collection" and "Empirical Modelling". The aim is to apply the techniques and theory taught during the classes and exercises on a real-world problem. In small groups you will cooperate to identify potential hazards, create a geo-database and carry out a hazard assessment. During the project you will link theory and practice. During the project you will also deal with literature study, project management, presentation and reporting skills, etc.

Contents

- Self study
- Group work
- GIS- and RS analysis
- Presentation and reporting

Keywords

Image Interpretation, geo-database construction, empirical modeling, hazard assessment

Objectives

Upon completion of the topic, the student should be able to:

- extract relevant information from RS-imagery for geo-hazard assessment;
- construct and manage a geo-database;
- carry out a preliminary hazard assessment.

Prerequisites

Principles and applications of Remote Sensing and GIS (ITC core modules or equivalent)

Recommended Knowledge

- Background in Earth Sciences
- Basics of geo-information science (GIS / RS)
- Basic understanding of physics, mathematics and statistics

Staff involved

Drs. N.C. Kingma, Drs. M. Damen, Dr. C. van Westen. Drs. R. Voskuil, Ir. B. Krol, Dr. D. Shrestha

Hardware and Software Requirements

Hardware:

- PC

Software:

- GIS (Ilwis, ArcGIS)
- MS-Office (MS-Word, MS-Powerpoint, MS-Excel)

Teaching Materials

See topics: "Image Interpretation", "Data Collection" and "Empirical Modelling"

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O

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

Group report, group presentation and individual oral examination.

Note(s)

-

GH Project II: Risk Assessment			
Module: 7-10		Co-ordinating staff: Dr. C.J. van Westen	
Start:	30-03-2009		
End:	08-05-2009		
Level: MSc, PG			U09-AES-138

Introduction

This project will run parallel to the topic "Process-based Modelling" and is an integrated part of the topic "Vulnerability and Risk Assessment". It will deal with the analysis and evaluation of risks from natural and man-induced hazards (such as flooding, earthquakes, landslides and technological hazards). The risk can be assessed using qualitative, semi-quantitative or quantitative approaches and ultimately the projects will work towards a multi-hazard risk assessment. Such a risk assessment forms an important input for disaster risk management, for the design of development plans and emergency response planning. You will be taken through the entire and process of risk assessment and you will learn about hazard assessment, elements at risk mapping and vulnerability assessment and to apply GIS in these analyses.

Contents

- Group work
- Self study
- GIS analysis
- Presentation and reporting

Keywords

Multi-hazard risk assessment, hazard assessment, elements at risk, mapping, vulnerability, disaster risk management

Objectives

Upon completion of the topic, the student should be able to:

- understand the procedure to carry out a multi-hazard risk assessment;
- have insight in the data requirements;
- apply RS for hazard assessment and elements at risk mapping;
- understand the different approaches to risk management;
- understand the role of multi-hazard risk assessment in disaster risk management;
- quantify the effects of mitigation options.

Prerequisites

Principles and applications of Remote Sensing and GIS (ITC core modules or equivalent)

Recommended Knowledge

- Background in Earth Sciences
- Basics of geo-information science (GIS/RS)
- Basic understanding o physics, mathematics and statistics

Staff involved

Dr. C. van Westen, Dr. D. Alkema, Prof.Dr. V. Jetten, Drs. N. Kingma, Drs. M. Damen

Hardware and Software Requirements

Hardware:

- PC

Software:

- GIS (Ilwis, ArcGIS)
- MS-Office (MS-word, MS-Powerpoint, MS-Excel)

Teaching Materials

See topics “Process based modelling” and “Vulnerability and Risk Assessment”

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O

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

Group report, group presentation and individual oral examination.

Note(s)

-

AES Block 3:

PG Diploma – Final Project
MSc Degree – Research Profile

Final Project			
Module: 11 & 12		Co-ordinating staff: Drs. B. de Smeth	
Start:	18-05-2009		
End:	26-06-2009		
Level: PG			U08-AES-121

Introduction

The final project is an integral part of the Applied Earth Science Post-Graduate Diploma course. It provides course participants an opportunity to apply the knowledge and skills acquired in core and domain modules of the course under (simulated) professional working conditions.
Focus is on the application of advanced survey techniques and data acquisition methods for the generation of stream relevant earth scientific information and understanding. The project also provides an opportunity for the development of 'life skills' (e.g. teamwork, project planning, problem-solving, presentation and communication).
Students will work in small -possibly multi-disciplinary- teams. Each team will plan and carry out a number of tasks according to agreed upon terms of reference. These tasks can be group- or individual tasks.
Project deliverables include a project report and a documented GIS database.

Contents

Data acquisition/fieldwork and data processing/reporting are considered to be an essential element of applied earth science training. The final project is organized in three phases; preparation, execution and reporting phase.
The set up of the final project is as follows:

Preparation phase

- introduction to the project, presentation of terms of reference;
- identification of project objectives, and planning of project tasks per team;
- review of selected literature, analysis of existing data (RS images, topographical data, geological maps, and other multi-scale, multi-theme data);
- preparation of preliminary/interpretation maps, design of project geo-database;
- development of a plan for field verification and data collection, selection of relevant operations and analysis procedures;

Execution phase

- Practical training in the use of field instruments and mobile GIS/GPS devices combined with field validation of interpretation maps; recording geological, geomorphic and soil field information; and field mapping of relevant surface and subsurface structures and processes. This will probably take place in the Bentheim sandstone quarry near Ahaus 15 km from Enschede.
- Data collection from various sources or data generation e.g. in ITC's GeoScience Laboratory. For some projects this could imply a few fieldwork days within 200 km of Enschede

Post-fieldwork phase

- processing of the collected or laboratory generated geochemical or spectral data or field observations
- analysis of results and construction of final maps, plots etc.
- preparation of a full technical project report, possibly in groups,
- presentation (PowerPoint) of results

Objectives

The common learning objectives for the group project are described as follows.
Upon completion of this module students should be able to:

- design and plan a practical work project with or without fieldwork;
- identify data requirements, collect or generate and process data, present the information required according to agreed upon terms of reference;
- analyse the data collected, and formulate relevant conclusions and recommendations based on this analysis;
- present their work to an audience of earth scientists in a convincing way;
- perform project activities as a professional team.

The earth science application objectives are in line with the stream of choice and dependant on the choice of fieldwork area.

Prerequisites
AES modules 1 to 10 or equivalent

Recommended Knowledge
Not applicable

Hardware and Software Requirements
Hardware and software as used during the modules 1 to 8; mobile GIS/GPS kit; field geology equipment; selected instruments for field measurements.

Teaching Materials
Not applicable

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
15	15		25	5	15	5

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
Project report and presentation will form the main base for assessment mark but also the individual performance during the execution of the project and in the final presentation will be taken into consideration.

Note(s)
The specific projects will be chosen in consultation with the course participants and will also depend on the number of participants in each AES Stream.

<table>
<tr><th colspan="3">MSc Research Skills</th></tr>
<tr><td>Module: 11</td><td colspan="2" rowspan="3">Co-ordinating staff:
Dr. D.G. Rossiter</td></tr>
<tr><td>Start: 18-05-2009</td></tr>
<tr><td>End: 05-06-2009</td></tr>
<tr><td>Level: MSc</td><td></td><td>P09-EDU-100</td></tr>
</table>

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 thesis. This module provides a set of generic research skills applicable to all MSc students at ITC to improve performance in the subsequent thesis research. The module 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. The module finally aims to create common understanding of what is expected of a thesis and how it will be assessed, to allow you to comply with these expectations.

Contents

- Logic and structure of scientific research.
- Inference in various scientific disciplines.
- Literature search, citation and bibliography.
- Abstracting and reviewing scientific research.
- Scientific writing and argumentation.
- Research quality and thesis assessment.
- How to structure an MSc thesis.
- Ethics and professionalism in research.

Keywords

-

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,
- present scientific research at a standard acceptable to the scientific community,
- find, evaluate, and summarize the most relevant and up-to-date scientific literature to support research, and
- structure an MSc thesis research according to academic expectations.

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;
- Communicate about technical subjects in written English;
- Understand the importance of innovation, quality and independent thinking in science.

Besides participants are expected to have:

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

Staff involved

Dr. P.M. van Dijk, Director Graduate Programme
Dr. D.G. Rossiter, overall coordinator module 11

Delegate coordinators per course:
Dr. N. Kerle (AES)
Dr. J.E. Stoter (GFM)
Drs. J.C. de Meijere (GSIM)
Ir. W.T. de Vries (LA)
Dr. J. de Leeuw (NRM)
Dr. R.V. Sliuzas (UPM)
Dr. A.S.M. Gieske (WREM)

other departmental staff and supporting staff (Library, RC, IT)

Hardware and Software Requirements

Networked PCs, Word, End note and access to scientific bibliographic databases.

Teaching Materials

Digital presentations, description of assignments, reader, scientific articles and MSc theses for review.

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 four 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. Assessing a published thesis from your course according to ITC criteria;
4. Arguing a scientific position in correct, compact and direct structured technical English.

Advanced topics 12 & 13		
Module: 12 & 13	Overall Co-ordinating staff: Dr. P.M. van Dijk	
Start: 08-06-2009		
End: 17-07-2009		
Level: MSc		P09-EDU-101/102

Introduction

Modules 12 and 13 form the backbone of the third Block of the MSc programme. Following module 11 on research skills and before the engagement in research themes during modules 14-15, students are equipped with advanced subjects for their research. During modules 12 and 13 students will learn in depth about specific research tools, methodologies and applications that are important for their envisaged MSc research. Participants have to make a logical choice that fits with their envisaged MSc research 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 12th 2008) and before the start of module 11 (exact date and format to be specified).
The final list of choice for the 2008/09 courses will be available by January 2009, after evaluation of the 2007/08 courses and final approval by the Academic Board. The subjects may be updated/changed, new subjects may be added and some may be deleted.
In this generic study guide description the 24 advanced subjects of the 2007/08 course are mentioned to show the range of subjects. Their descriptions can be viewed in the "Search module descriptions" option on internet: http://www.itc.nl/education/courses/modules.aspx , select studyguide = 2007-2008, level = MSc and module = 12, respectively 13.

Contents

Module 12:	Title	Chair	Module Coordinator
M09-EOS-100	Advanced image analysis	Prof. A. Stein	Dr. V.A. Tolpekin
M09-GIP-100	Design and Implementation of Spatial Databases	Prof. M.J. Kraak	Dr. R.A. de By
M09-ESA-100	Essentials of physical process modelling	Prof. V.G. Jetten	Prof. V.G. Jetten
M09-EOS-101	Geostatistics	Prof. A. Stein	Dr. D.G. Rossiter
M09-ESA-101	Hyperspectral Remote Sensing	Prof. F.D. van der Meer	Dr. H.M.A. van der Werff
M09-EOS-102	Inferential statistics	Prof. A. Stein	Dr. J. de Leeuw
M09-EOS-103	Laser scanning and InSAR	Prof. M.G. Vosselman	Prof. M.G. Vosselman
M09-PGM-100	Managing geoinformation systems in the public sector	Dr. C.M.J. Paresi	Dr. D.D. Navarra
M09-NRS-100	SAR Remote Sensing	Prof. A.K. Skidmore	Dr. Y.A. Hussin
M09-PGM-101	Spatial growth and spatial interaction modelling	Dr. R.V. Sliuzas	Dr. M.H.P. Zuidgeest
M09-PGM-102	Spatial planning support systems and scenario development	Dr. C.M.J. Paresi	Dr. M.A. Sharifi
M09-PGM-103	Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA) applying Spatial Decision Support tools	Prof. A. van der Veen	Drs. J.M. Looijen
M09-GIP-101	Time series	Prof. M.J. Kraak	Prof. M.J. Kraak

Module 13:	Title	Chair	Module Coordinator
M09-EOS-104	3D Geoinformation	Prof. M.G. Vosselman	Dr. M. Gerke
M09-EOS-105	Advanced statistics	Prof. A. Stein	Prof. A. Stein
M09-PGM-104	Applying research methods for public sector geoinformation management	Dr. C.M.J. Paresi	Dr. D.D. Navarra
M09-GIP-102	Design and implementation of Geoinformation Services for SDI	Prof. M.J. Kraak	Ir. R.L.G. Lemmens
M09-ESA-102	Geophysics and 3D geo-visualization of the subsurface	Prof. F.D. van der Meer	Dr. M. van der Meijde
M09-ESA-103	Multi-Hazard Risk Assessment	Prof. V.G. Jetten	Dr. C.J. van Westen
M09-WRS-100	Large scale process modelling and data Assimilation	Prof. Z. Su	Prof. Z. Su
M09-PGM-105	Participatory GIS – principles and applications	Dr. R.V. Sliuzas	Dr. M.K. McCall
M09-WRS-101	Quantitative retrieval of geo(bio)physical parameters	Prof. W. Verhoef	Prof. W. Verhoef
M09-PGM-106	Scenario analysis and collaborative decision support	Dr. C.M.J. Paresi	Dr. M.A. Sharifi
M09-NRS-101	Spatial modelling of biological Ecosystem Properties	Prof. A.K. Skidmore	Dr. P.E. van Laake

Objectives
Specified per advanced subject.

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

Recommended Knowledge
Specified per advanced subject.

Staff involved
Appointed per advanced subject.

Hardware and Software Requirements
Specified per advanced subject.

Teaching Materials
For each advanced subject a collection of resources will be available in the digital learning environment Blackboard, the library or in hard copy.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
16	20	0	30	30	40	8

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
Specified per advanced module, the assessment must result in a mark.

<table>
<tr><th colspan="3">Research Themes / MSc Qualifier</th></tr>
<tr><td colspan="2">Module: 14 & 15</td><td rowspan="3">Overall Co-ordinating staff:
• Dr. P.M. (Paul) van Dijk
• Research project coordinators appointed per research theme
• 2 MSc supervisors appointed beforehand for each participant</td></tr>
<tr><td>Start:</td><td>20-07-2009</td></tr>
<tr><td>End:</td><td>28-08-2009</td></tr>
<tr><td colspan="2">Level: MSc</td><td>P09-EDU-103</td></tr>
</table>

Introduction

Modules 14 and 15 form the last part of Block 3 of the MSc programme. While Modules 11 to 13 have instrumented 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 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 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	Prof. A. de Gier
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

Contents

Two main activities run parallel in Module 14 and 15:

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

1. 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) methodology, a flowchart, and time allocation. All data should be available at the time of the proposal presentation. The research proposal should be presented before a Thesis Admission Committee (see MSc assessment regulations paragraph 5.1.1). Acceptance of the proposal is a prerequisite for the start of module 16. The MSc student will draft a supervision plan with the two appointed MSc supervisors.

2. Group research project

The purpose of the group project is:

- To let students place their own MSc research project and research interests in a wider scientific context.
- To give students a possibility to practice conducting a research project before their individual MSc research project.
- To give students an opportunity to practice doing research in a team.
- To give students the opportunity to share their knowledge in a multi-disciplinary context.

These are considered important as a preparation for conducting the individual MSc research in Block 4, as well as the professional academic working practice afterwards in which projects are often conducted in multi-disciplinary groups.

Research projects can be defined by one or several research themes. In any case, the projects are defined with a wide angle in order to cater for a variety of research approaches and interests, as well as the relevance for society. Projects are described with a title, a problem definition, and available dataset. The student group, consisting of a maximum of 5 students, is responsible for working this out into various activities according to an agreed plan. The student group has the freedom to make their own choices, supported by a tutor. The available projects will be made known early in 2009 in order to give the participants the opportunity to select a project that matches with 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 the students groups. The tutors will convene plenary sessions (in principle per research group) to monitor the progress of all participating students and exchange experiences in a discussion forum.

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 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.

Prerequisites
Completion of Module 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. Students who want to choose a research theme which differs from their choice in Block 1 and 2, have to provide evidence that they have the right background.

Recommended Knowledge
To be specified per research theme.

Staff involved
Overall coordination: Dr. P.M. van Dijk, Director Graduate programme:
- Research project coordinators appointed per research theme;
- 2 MSc supervisors appointed beforehand for each participant.

Hardware and Software Requirements
Identified per research theme.

Teaching Materials
For each research theme a collection of resources will be available in the digital learning environment Blackboard, the library or in hard copy.

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 lectures, (max. 10 = 5 hr/week during 2 weeks of project)
SP supervised practical,
UP unsupervised practical,
GA group assignment (= Group Research Project, incl. supervision),
IA individual assignment (= MSc proposal writing, incl. supervision),
S self study (8hr/week = 48 hr outside normal class/office hours),
O overhead (last week reserved for MSc proposal presentations).

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

Assessment
1. Group report of the research project.
2. Individual written reflection report on the group research project.
3. Individual MSc research proposal (written and oral presentation).

AES Block 4: MSc Research

MSc Research and Thesis Writing			
Module: 16-23		Co-ordinating staff: Dr. P.M. van Dijk, Director Graduate Programme Course directors of all MSc courses 2 MSc supervisors per student	
Start:	07-09-2009		
End:	26-02-2010		
Level: MSC		AES, GFM, GSIM, LA, NRM, UPM, WREM	U09-EDU-111

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 the project the students develop their research skills further, interact with their fellow students, PhD's and staff members, and have to demonstrate that they have achieved the course objectives for the Master of Science degree by research, on academic level.

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.
- Preparation and execution of a (data collection) fieldwork (optional).
- 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 original data and results).
- A critical review of 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.

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.

Prerequisites
Successful completion of MSc modules 1-15, and the ability to do research independently (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.

Hardware and Software Requirements

Any hardware and software with authorisation of the MSc supervisors.

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 carry out the individual assessment based on the thesis and a presentation plus defence. The assessed aspects are:

- Research skills;
- Contribution to the development of the scientific field;
- Independent working;
- Critical and professional thinking;
- Scientific report 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 (M.Sc.) Degree (September 2008);
- Instructions for Thesis Assessment Board.

ITC Assessment Regulations