Earth Sciences, Environmental Sciences, and Geoarchaeology

Master guide 2004/2005

vrije Universiteit amsterdam

Contents

1 Faculty of Earth and Life Sciences

1.1 Faculty organisation

1.1.1 Objectives of the faculty

The Faculty of Earth and Life Sciences (FALW) was established in the end of 2001 by the fusion of the faculty of Biology, the faculty of Earth Sciences and the Institute for Environmental Studies.
The mission of the faculty is to provide education of high scientific quality in Earth Sciences, Environmental Sciences and Life Sciences and to execute scientific research at a high international standard in these fields. Our degree programmes are organised within a setting of two 'Schools'.
The task of the School of Earth and Environmental Sciences and of the School of Life Sciences is to educate students to an academic level in these disciplines. The objectives of the bachelor programme are to give the students the basic theoretical and practical knowledge that enables them to undertake a master programme in Earth, Environmental, or Life Sciences, or a related speciality or – if they choose to do so – to enter the labour market at the academic bachelor level.

The objectives of the master programme are to impart to the students the knowledge, attitudes, skills, and insights which render the graduated master (1) capable of practising his/her profession independently, or (2) qualified for continuing training in scientific research, or (3) eligible to function as a teacher or science communication expert in his or her speciality. The graduated master should be competitive in his/her field on the international labour market, both for employment in trade and industry or government and within PhD-research programmes at international scientific institutions.

As a consequence of the rapid and continuous changes in present-day science and society the teaching programmes are designed to promote ‘life-time learning’. The programmes pay attention to individual and social development of the student by stimulating independent, communicative and co-operative behaviour. The objectives of the educational programme also include gaining an insight into the broad historical, philosophical and social context of the discipline. The programmes stimulate consciousness concerning the intellectual integrity and moral and ethical dimensions of scientific research and its applications.

The objectives of the educational programmes are specified in final attainment levels for knowledge, skills and insights. Specific aims at the course level can be found in detailed course descriptions.

1.1.2 The Faculty Board

The faculty is run by a faculty board and has several participatory bodies, which have a say in certain matters of faculty management. This structure has been laid down in the Statute of the Vrije Universiteit in conformity with the Act on Higher Education and Scientific Research (WHW).
The faculty board is in charge of:

- General management of the faculty;

- Conduct and organisation of the faculty with respect to educational matters and cultivation of science;
- Drawing up Education and Examination Regulations as well as their frequent assessment;
- Drawing up general guidelines for the cultivation of the Sciences;
- Drawing up the yearly research programme of the faculty;
- Monitoring of the implementation of the Education and Examination Regulations and of the yearly research programme.

Composition of the faculty board:
- Dean: prof.dr.ir. P. Vellinga
- Portfolio Research: prof.dr. B. Oudega
- Portfolio Education: prof.dr. J.F. Vandenberghe

The following persons have an advisory role during meetings of the faculty board;
- Dr. J.M.R.M. Neutelings (Operations director)
- Ms. W. Koot (member administrative employees)
- Mr. M. de Kuster (student)
- In matters relevant to the bodies concerned: head of the School of Life Sciences, head of the School of Earth and Environmental Sciences, and managing directors of the faculty's research institutes.

For more information and the original regulations (in Dutch)
- WHW, artikelen 9.23 tot en met 9.28;
- Statuut VU, artikelen 6.2 tot en met 6.7;
- Faculteitsreglement;
- MUB: de Modernisering Universitaire Bestuursorganisatie (wijziging WHW), artikelen 9.11 tot en met 9.49;
- URVU (het Universiteitsreglement van de Vrije Universiteit);
- RMS (de Regeling Medezeggenschap Studenten);
- WOR (de Wet op de Ondernemingsraden).

1.1.3 Participatory bodies

Faculty Student's Council
The Student's council (FSR) consists of nine elected student members who are in place for one year, starting as of September 1st. The RMS (Regulations for participation and role of students) defines the tasks and remit of the student council. These include, amongst other things: policy related to student affairs, service to and facilities for students, and working conditions. For questions or remarks contact the fsr at: fsr@falw.vu.nl or at Monday, Wednesday and Thursday between 12.30 and 13.30 hrs at room M-112.

Faculty Subcommittee
The faculty subcommittee is put forward by the works council and consists of nine elected employees of the faculty. The WOR (Employees Council Act) defines the tasks and remit of the works council and the subcommittee. These include, amongst other things: regulations with respect to social policy and conduct and certain employment conditions subjects (working conditions, work meetings and other employment policies).

The subcommittee consists of:
Dr. K. Beets, mr. L. Bouwer, mr. C. Dubbeldeman, drs. M. Groen, dr. N. Harms, ms. drs. E. Salomé, mr. F. Wolff, prof.dr. J. Smit, dr. H. Stel, ms. M. Wagner, dr. R. van Walraven, dr. P. van der Werff

Joint Faculty Assembly
The Joint Faculty Assembly consists of all members of the faculty's subcommittee and the Student's council. Tasks and remit of the joint meeting are laid down in the *Statuut VU* and include: right of approval of the faculty regulations and of certain parts of the Education and Examination Regulations. Right of approval of systems of quality control and advisory rights to the budget/annual account.

1.1.4 Faculty services

Faculty Office
The faculty office supports the faculty board in the execution of its tasks. The faculty bureau is managed by the operations director.

operations director:
Dr. J.M.R.M. Neutelings

Secretariat and support of the faculty board:
tel. (020) 444 7001, room F-148
Bureau of education:
Head: ms. dr. A.M. Wagner, tel. (020) 444 7167, room E-119
Personnel and Organisation:
Head: mr. C.L.M. van Veenendaal, tel. (020) 444 7244, room A-054
Financial affairs:
Head: mr. J. Roos, tel. (020) 444 7234, room A-013
Information, internationalisation and student recruitment:
Head: dr. B. Andeweg, tel (020) 444 7339, room C-154

Bureau of education
The members of the Bureau of Education deal with education- and teaching-associated topics. These include matters such as: co-ordination and organisation of classes belonging to the various degree programmes, study administration, support of educational committees and examination boards, programme development and educational policy, information and communication technology, student counselling, and quality control.
The bureau consists of the following employees:

- Head of the bureau: ms. dr. A.M. Wagner, tel. (020) 444 7167, room E-119;
- Educational co-ordination: ms.dr. P.A.C.M. de Boer, tel. (020) 444 7011 and ms. drs. A.L. Tasseron (020) 444 7257, room C-124 (degree programmes Life Sciences); dr.ir. M. Bergwerff, tel. (020) 444 7401, room C-124 (degree programmes Earth and Environmental Sciences);
- student counselling (Life Sciences): dr. H. Hillebrand, tel. (020) 444 7012, room C-148a; dr. N.D. de With, tel. (020) 444 7013, room C-148a;

- Study secretariat: ms. A. Kist, and ms. S. El Hamdi, tel. (020) 444 7010, room C-118b (Life Sciences), ms. M. Zadel-Vrind and ms. M. Duifs-Eshuis, tel. (020) 444 7350/7302, room C-118a (Earth and Environmental Sciences);
- Theory of education: ms. drs. G.J.M. Dirksen- de Tombe, tel. (020) 444 6987, room C-124a;
- Information and communication technologies in education: ms. drs. E.J.M. van de Grint, tel. (020) 444 6987 and ms. K. van der Wilt, tel. (020) 444 6937, room F-114.

Information, international affairs and student recruitment
- Head of the bureau: dr. B. Andeweg, tel. (020) 444 7339, room C-154;
- International affairs: ms. drs. E. Salomé, tel. (020) 444 7301, room F-122;
- Information and student recruitment: dr. B. Andeweg, tel. (020) 444 7339, room C-154 (Earth Sciences); vacancy (Life Sciences), tel. (020) 444 7190, room C-154;
- Website: mr. P. Strik, tel. (020) 444 9944, room C-154;
- Bachelor programme "Gezondheid en Leven" (Windesheim, Zwolle): ms. A. Blanksma, tel. (020) 444 5579, room F-122.

Technical and supporting services
The departments of the technical and supporting services, which include technical and administrative employees, consist of:
- Computing department, head: R. Mars, tel. (020) 444 9976, room F-238;
- Instrumental and electronic services, head: D.M. van Harlingen, tel (020) 444 7259, room F-021;
- Laboratory of Geochemical analysis, head: dr. P.Z. Vroon, tel. (020) 444 7404, room M-452;
- Laboratory of Sedimentary analysis, head: ing. M. Konert, tel. (020) 444 7378, room M-420;
- Rock treatment, head: ms. W. Koot, tel. (020) 444 7344, room F-421;
- Laboratory of Microanalysis, head: drs. E.A.J. Burke, tel. (020) 444 7345, room F-338;
- Mass spectrometry, head: dr. G.R. Davies, tel. (020) 444 7329, room F-030.

1.1.5 Convent of heads of department
The convent of heads of department forms an advisory body to the faculty board. It consists of all heads of the scientific departments.

1.1.6 Departments
All departments of the faculty of Earth and Life Sciences are involved in organising courses within the BSc and MSc degree programmes. Each department consists of scientific staff members, and supporting and administrative employees, that are involved in either research or education-related programmes. Each department, led by a head of department, manages research and classes in a certain speciality and/or scientific field. Members of the scientific staff both teach and carry out research. Some of the lecturers are involved in curricular or educational committees to develop and maintain high standard degree programmes in consultation with student representatives. In addition, some staff members are also members of an examining board.

The departments and heads of department of the faculty of Earth and Life Sciences are:

Animal Ecology
Head: prof.dr. N.M. van Straalen, tel. (020) 444 7070, room B-027

Biology and Society
Head: ms.prof.dr. J.F.G. Bunders, tel. (020) 444 7030, room A-068

Chemistry and Biology
Head: prof.dr. A. Brouwer, tel. (020) 444 9535, room C-529

Developmental and Behavioural Neurobiology
Head: prof.dr. M. Gahr, tel. (020) 444 7126, room B-262

Ecology and Ecophysiology of Plants
Hoofd: dr. J.A.C. Verkleij, tel. (020) 444 7054, room A-217

Economy and Technology
Head: dr. M.W. Hofkes (a.i.), tel. 020-4449563, room C-530

Environmental Policy Analysis
Head: prof.dr. F. Biermann, tel. (020) 444 9959, room C-522

Experimental Neurophysiology
Head: prof.dr A.B. Brussaard, tel (020) 444 7098, room B-338

Functional Genome Analysis
Head: prof.dr. M. Verhage, tel. (020) 444 6936, room A-435

Genetics
Head: Dr. A.R. Stuitje, tel (020) 444 7138, room M-554

Geoarchaeology
Head: prof.dr. H. Kars, tel. (020) 444 6438, room O-439

Hydrology and Geo-Environmental Sciences
Head: prof.dr. A.J. Dolman, tel. (020) 444 7358, room F-464

Isotope Geochemistry
Head: prof.dr. P.A.M. Andriessen, tel. (020) 444 7340, room H-325

Molecular Cell Physiology
Head: prof.dr. H.V. Westerhoff, tel. (020) 444 7230, room M-236

Molecular and Cellular Neurobiology
Head: prof.dr. A.B. Smit, tel (020) 444 7121, room C-340

Molecular Microbiology
Head: prof.dr. B. Oudega, tel. (020) 444 7177, room M-548

Nutrition and Health
Head: prof.dr.ir. J.C. Seidell, tel. (020) 444 46995, room O-552

Paleo-ecology en Paleo-climatology
Head: prof.dr. D. Kroon, tel. (020) 444 7261, room E-359

Petrology
Head: prof.dr. G.R. Davies, tel (020 4447329, kamer F-030

Quaternary Geology and Geomorphology
Head: prof.dr. J.F. Vandenberghe, tel. (020) 444 7368, room F-414

Sedimentology
Head: dr. A.R. Fortuin, tel. (020) 444 7351, room E-237

Spatial Analysis and Policy
Head: dr. R. Janssen (a.i.), tel. (020) 444 9512, room A-570

Structural Biology
Head: prof.dr. H. Lill, tel. (020) 444 7146, room M-538

Systems Ecology
Head: prof.dr. M.A.P.A. Aerts, tel. (020) 444 7211, room A-154

Tectonics
Head: prof.dr. S.A.P.L Cloetingh, tel. (020) 444 7341, room E-160
Theoretical Biology
Head: prof.dr. S.A.L.M. Kooijman, tel. (020) 444 7130, room B-121

Descriptions of the departments' research and educational programmes can be found in the next chapter, insofar as relevant to the School concerned.

1.2 Classes and education

1.2.1 Education institute

Bachelor and master programmes of the Faculty of Earth and Life Sciences are undertaken within the Education Institute of the Faculty. The Institute contains two Schools.

- The School for Life Sciences, for educational programmes in the fields of Biology, Biomedical Sciences, and Health Sciences,
- The School for Earth and Environmental Sciences, for educational programmes in the fields of Earth Sciences, Geoarchaeology, Hydrology, and Environmental Sciences.

The Education Institute is under management of the Educational Board of Directors which advises the Faculty Board on all matters concerning education. Furthermore, the Educational Board of Directors is responsible for contents and quality of degree programmes, organisation and co-ordination of teaching programmes, distribution of teaching responsibilities over the scientific staff, teaching facilities, information, and public relations.
The Educational Board of Directors consists of the following members:

Dr. K.S. Kits (chairman)
Dr. C. Biermann
Dr. M.A. van Drunen

1.2.2 Degree programmes

The faculty of Earth and Life Sciences provides for educational programmes and research in a wide variety of scientific fields. During the year 2004-2005, the following degree programmes will be offered.

Bachelor's degree programmes:

- Aardwetenschappen/Geoarcheologie (Earth Sciences/Geoarchaeology)
- Algemene Gezondheidswetenschappen (Health Sciences)
- Biologie (Biology)
- Bio-medische wetenschappen (Biomedical Sciences)

Master's degree programmes:

- Beleid, management en ondernemerschap voor natuur- en levenswetenschappen (Policy, Management and Enterprise for Sciences and Life Sciences)
- Biologie (Biology)
- Bio-medical Sciences
- Biomolecular Sciences
- Earth Sciences (incl. Geoarchaeology)
- Ecology

- Environment and Resource Management
- Geo-environmental Sciences
- Gezondheidswetenschappen (Health Sciences)
- Hydrology
- Neurosciences

In addition, specialised programmes in Science Communication and Education (teacher training) are offered. These two programmes can be incorporated in MSc programmes Biology, Bio-medical Sciences, or Earth Sciences.

1.3 Research

1.3.1 Research institutes and schools

The faculty participates in a large number of research interrelationships involving multiple faculties or universities, both on the national and international level. The life spans of these collaborative projects may differ from short-lived to long lasting. The most important are:

Research Schools:
SENSE: Socio-Economic and Natural Sciences of the Environment
NSG: Netherlands research school in Sedimentary Geology
ARCHON: Archaeology research school of the Netherlands
ONWA: Research school Neurosciences Amsterdam
BCA: Research school Biocentre Amsterdam
ICG: Inter-university Centre of Geo-ecological research

In addition, the faculty participates in a number of inter-faculty research institutes:
-ION: Inter-faculty research institute of Neurosciences
-IMBW: Inter-faculty research institute of Molecular Sciences.
At this moment, a number of new initiatives are undertaken, which are formally not called research institutes, but do, however, fulfil a similar function in the organisation.
Some examples:
1. Centre for Neurogenomics and Cognitive Research (CNCR)
2. Centre for Research of Complex Systems (CRCS, Bio-complexity)*
3. Centre for Bio-informatics (IBIVU)
4. Centre for Drug Discovery (CDD)*
5. Climate Centre VUA (CCVUA) and the related Centre for Earth Observation
6. Centre for Geo-biology and Ecogenomics*
7. Centre for Innovation and Societal Enterprise (CIMO)
8. Centre for Archaeology (faculties Earth and Life Sciences, and Arts)
9. Spinlab (faculties Earth and Life Sciences, and Sciences)
10.Centre for Science Communication (faculties Earth and Life Sciences, Arts, and Sciences)
* These centres have not yet been established, but are in preparation.

1.4 Facilities

1.4.1 General VU information and facilities

General information about the Vrije Universiteit and its facilities is no longer incorporated in the study guide. All relevant information, however, can be consulted at the university's website: http://www.vu.nl/

1.4.2 Opening hours buildings

FALW is located in the Maths and Natural Sciences building (W&N). Opening hours of the W&N building are: Monday to Friday, 7.00 to 22.30 hours, closed on Saterday.
Medical Faculty building opening hours:
Monday to Friday, 7.00 to 22.00 hrs, Saterday by appointment only.
All buildings are closed on Sundays, public holidays and between Christmas and New Year.

1.4.3 Restaurants

On ground floor level of the W&N building and at the Medical Faculty building, restaurants provide a wide range of lunchtime snacks. Opening hours W&N: 8.30 to 16.00 hrs. Opening hours Medical Faculty: 9.30 to 15.30 hrs.

1.4.4 Service point

Under the responsibility of the VU Buildings service, department of Civil Service (Sciences Building), a Service Point is maintained in the M-0 hall. All matters related to the building and its interior can be arranged here. This is the place to report technical trouble of copy machines, to request audio-visual facilities, to request information on telephone equipment and bicycle storage, and to buy telephone and copy cards. Tel. (020) 444 5888.

1.4.5 Lockers

Lockers can be found throughout the Sciences (W&N) Building. Instructions for use are posted at the spot. Coins will often be necessary, but are returned after use.

1.4.6 Bicycle storage

A bicycle storage is to be found in the basement underneath the D-wing. Part of it can be locked up. The key is available at the Service Point.

1.4.7 Faculty periodicals

The faculty of Earth and Life Sciences provides information to its students and employees by means of the following periodicals:

ALWeer, weekly communication paper with announcements regarding interim examinations, changes in course timetables, organised seminars and all other activities in and around the faculty. *ALWeer* appears every Monday and can be obtained from leaflet holders in the F-1, C-1 and A-0 corridors. *ALWeer* can also be consulted at the faculty's website: http://www.falw.vu.nl>nieuws>Alweer. Messages (with name of sender) to be published in *ALWeer* should be mailed to the editorial office at alweer@falw.vu.nl

Geoscoop, three monthly magazine with information on educational and research matters in earth and environmental sciences, on related technical departments and laboratories, and other faculty related subjects.

1.4.8 Mailboxes

All professors, scientific departments, technical and administrative departments, student associations and students of the Faculty of Earth and Life Sciences have mailboxes in a postal alcove in the F1-corridor (adjacent to F-140). In addition, staff members have their own mailboxes in the corridors of the departments concerned.

1.5 Student organisations

1.5.1 GeoVUsie

GeoVUsie, the student association of the School of Earth and Environmental Sciences, is open to all students of the faculty and has approximately 250 members. Membership fees are 30 euro for the entire duration of your studies. Anyone is welcome to become a financial supporter.
GeoVUsie's activities are centred round a number of committees:

- Geoflex b.v. b.v., organiser of earth science related excursions. Every year they organise an excursion of several days outside the Netherlands, and one or more excursions here in the Netherlands. Furthermore, Geoflex organises weekly earth scientific seminars by faculty staff members or guests from outside university, and movies;
- SBB-committee (Studenten Belangen Behartiging), their main goal of today is the making of a file filled with former exams;
- Party committee; responsible for the organisation of parties and the weekly drink called 'donderdorst';
- SI-committee; organises the yearly Social Introduction of new students, both during the introduction week halfway August and during the popular introduction weekend in the end of September. Their second job is helping on the days that future-students come and take a look at the university;
- Sports committee, organises sportive events of different kinds, like a sailingweekend and the 'van Alebeek' tournament;
- Geocult, takes care of the more cultural things within the association, like the IKEA-excursion and the yearly movies-night;
- VIP-committee (Vinger-in-de-Pap-committee), which consists of the older members of GeoVUsie, who are always willing to give advice and lend a helping hand whenever needed;
- GAT-cie, takes care of technical support during events like the weekly 'donderdorst' and the introduction weekend;
- GeoVizier, produces a yearly guide with tips and information about the first year's fieldwork in Spain. Their second job is the making of an alternative study-guide, filled up with information about classes, students, teachers, and the faculty.
- Geo Web-cie, takes care of the GeoVUsie website;
- Jaarboek-commissie, produces yearly a beautiful book (in coorporation with all the story-writing people) about all the activities and events that took place during the past GeoVUsie-year.

GeoVUsie furthermore organises congresses and scientific meetings.
GeoVUsie arranges collective purchases of study books, geological hammers, compasses, pocket-lenses and other utensils that might be handy during your studies.

Each Thursday, form 17.00 hrs. onwards, you can quench your thirst in student room A-001, during the weekly *Donderdorst.*
GeoVUsie is a lively association and needs active members to keep up the good work. Pro-active involvement, both inside and outside committees, is therefore greatly appreciated and encouraged. More information can be found at:
http://www.falw.vu.nl > studenten > studentenorganisaties > GeoVusie.
Of course you can always visit us at room M-138 or A-001.

1.5.2 Gyrinus natans

Gyrinus natans was founded in 1953 for students in Life Sciences in order to help each other in the process of studying, to prepare for the labour market which they enter after graduation, and last but not least, to provide a social context whilst studying at university and afterwards.
Gyrinus natans is an association consisting of both students and faculty staff members. It is made up of ten committees. The *Alcoholaat* and the *Tegenstelling* organise weekly drinks in our own café De Tegenstelling and drinks for students and their guests after their graduation or PhD-promotion. The Party Committee arranges several parties a year, inside and outside the university. In addition, the association takes care of a monthly special event in the Tegenstelling. And the Camp committee organises several camps each year. Other yearly activities include a Movie night and Cultural Banquet, at which students of different ethnic origins cook and serve dishes of their country of origin. Furthermore, the Nature committee organises, amongst other things, excursions to nature reserves.
By its wide variety in activities, Gyrinus offers room for everyone, resulting in a diverse gathering of people striving for a common goal: the famous Dutch conviviality (*gezelligheid*).
Membership, at only 5 euro a year, provides for discounts on Gyrinus' activities. For inquiries, e-mail gyrinus@bio.vu.nl, or just stop by at the Gyrinus room, C-153.
More information can be found at: http://www.bio.vu.nl/gyrinus

1.5.3 Underground

UNDERGROUND is the study association of the degree programmes in Archaeology (Faculty of Arts). Underground provides booksales for the students. It also organises drinks, parties and excursions. Further information can be found at the website http://www.studieverenigingunderground.tk/.

1.5.4 Student Assembly Earth and Life Sciences

The Student Assembly Earth and Life Sciences (SOAL: Studenten Overleg Aard- en Levenswetenschappen) consists of students in Earth Sciences, Biology, Biomedical Sciences, and Health Sciences. Students of these different degree programmes jointly commit themselves to the improvement of classes and general education issues. They participate in decisions on new educational programmes and assess existing programmes. Students having questions or remarks can contact SOAL at all times. SOAL is located at M112 and has a mailbox in the F1-corridor. E-mail: soal@falw.vu.nl.
More information (in Dutch) can be found at: www.falw.vu.nl/student

1.6 Exchange and international affairs

Studying abroad is an attractive prospect. First of all it will be a valuable asset for your cv and increase your opportunities in the labour market. Getting to know a foreign country with a different culture, a different student life, and a possibly different educational system, will also freshen up your outlook on Dutch customs and culture. In addition, a stay abroad will provide you with the useful experience of having to rely entirely on yourself in coping with all sorts of things and problems in unfamiliar surroundings. If you decide to spend part of your study programme at a foreign institute or organisation, you can participate in one of the existing exchange programmes, like the Socrates-Erasmus or Leonardo da Vinci programme for stays within Europe, GLOBE outside Europe, or the ISEP-programme for the U.S.

It is advised to start preparations for a stay abroad at least one year ahead. Information on grants, programmes and other things you need to take into consideration, like approval of your study abroad by the examining board, is provided by the faculty's contact person in international affairs: Mrs drs. E. Salomé-Munnik. She can be reached between 9.00 and 12.00 hrs. on Mondays, Tuesdays, Thursdays, and Fridays at her office in F-122, or by e-mail: ellen.salome@falw.vu.nl. She can also provide you with information on all universities with which our faculty has exchange agreements and on how many places are actually available for VU-students. In addition, information can also be obtained from the VU International Office, in the main building of this University. Opening hours are from 10.00 till 17.00 hrs. International Office also runs a web-site (www.internationaloffice.vu.nl) with information on programmes, cultural treaties and an online brochure "Studeren in het Buitenland".

2 School for Earth and Environmental Sciences

2.1 Introduction

2.1.1 What to find in this study guide

This study guide contains information on all master degree programmes provided by the School for Earth and Environmental Sciences. These programmes include the two-year programmes Earth Sciences, Geo-environmental Sciences, and Hydrology and the one-year degree programme Environment and Resource Management.

Separate bachelor and master degree programmes, that are in conformity with international models, only have a short history at our university. They started in 2002-2003 and were preceded by doctoral degree programmes of five years and, in the past, four-years. Course modules and other programme components belonging to previous degree programmes can no longer be taken.

All information with respect to the bachelor degree programme 'Aardwetenschappen' can be found in a separate bachelor guide (which holds information on four bachelor variants, variant I (Geology), variant II (Quaternary geology, Geomorphology), variant III (Environmental sciences) and Geoarchaeology.

2.1.2 Language of instruction

Dutch is the current language during the BSc programme, whereas MSc programmes are taught in English. Occasionally, bachelor courses are also taught in English, e.g. when master students join in to eliminate deficiencies in their bachelor education.

2.2 Structure of the academic year and course diagrams

2.2.1 University calendar and course time tables

Course years at the School for Earth and Environmental Sciences are largely structured in conformity with the academic calendar of the VU. The calendar is divided into six periods.
Period 1, weeks 37 to 44, September and October 2004;
Period 2, weeks 45 to 52, November and December 2004;
Period 3, weeks 2 to 5, January 2005;
Period 4, weeks 6 to 13, February and March 2005;
Period 5, weeks 14 to 22, April and May 2005;
Period 6, weeks 23 to 26, June 2005.
Occasionally, course modules are spread out over two periods, whereas in late spring and early summer field courses and research projects may not be scheduled in accordance with the university calendar. The last week of each period is generally designated for examination only.
Course timetables are posted on notice boards in the F-1 corridor. They can also be consulted at the faculty's web page and copies are at your disposal at the "infotheek" (C-148b). Detailed timetables for periods 1 and 2 are established in a final version during summer (July) and published online accordingly. Timetables for courses in periods 3 till 6 are made known in October. Website: http://www.falw.vu.nl > studenten > masterprogrammes.

2.2.2 Study load

Within each period of eight weeks an average study load of 12 credit points are scheduled. A complete academic year holds 60 credit points, which is the equivalent of 1680 study hours. One credit point is the equivalent of 28 study hours.

2.2.3 Changes in course timetables

Inevitably, timetables may in some cases change after they have been published, which is often long before courses actually start. Changes are timely published in our weekly faculty newspaper, *ALWeer*. If there are only minor changes to the previously communicated schedule, a short notice at the first lecture or at Blackboard may be sufficient. Remind yourself, however, to check *ALWeer* on a weekly basis so you do not miss out on important last-minute messages with respect to your courses.

2.3 Degree programmes and study areas

2.3.1 Bachelor Aardwetenschappen (Earth Sciences)

The bachelor's degree programme Earth Sciences (Aardwetenschappen) is taught in Dutch and offers a 3-year programme during which basic natural sciences (mathematics, physics, chemistry) and introductory and more specialised courses in earth sciences are combined. Fieldwork also makes up an important part of the BSc programme. Students differentiate during their second year within course programmes that focus either on Geology (variant I), on Quaternary geology/ Geomorphology (variant II), or on Geo-environmental Sciences (variant III).

2.3.2 Bachelor Aardwetenschappen, variant Geoarcheologie (Geoarchaeology)

Within the bachelor degree programme Earth Sciences, Geoarchaeology is a bit of an outsider in the sense that its programme differs from the other variants from the beginning onward. Yet, Geoarchaeology and Earth Sciences are closely related. Many of the courses are therefore shared with the other Earth Sciences students, some with Archaeology students (Faculty of Arts) and others are specifically designed for Geoarchaeology.

2.3.3 Master Earth Sciences

The master's degree programme Earth Sciences has several specialisations.
Lithosphere tectonics, petrology, and isotope geochemistry focuses on the deeper layers of the earth's crust, applying geophysics, (isotope) geochemistry and radiometric dating to understand the relations between subduction, volcanism, metamorphism, and to ascertain the rates of continental collision and uplift, subsidence or denudation and exposure.
Sedimentary and stuctural geology, basin analysis and surface processes deals with origins, filling, and deformation of basins. It provides understanding of the structures in which oil and gas can be found, and of relationships between deeper processes caused by intraplate stresses and related surface expressions and the sedimentary sequence.
Palaeo-climatology, palaeo-ecology and palaeo-oceanography studies the interaction between climate, ecosystems and oceans. Temperature changes in the oceans are unravelled by macro- and microfossils. Data are collected that will serve as input for climate models.
Quaternary geology and geo-ecology deals with drainage patterns and sedimentation or erosion in coastal and river ecosystems, relationships between changes in river

flows and changes in landscape and climate over time, and clues left behind in the landscape by warmer and colder periods.
Science communication and *Education* enable you to communicate or teach in your own scientific field, be it as a journalist, in a museum, in a teaching profession, or else.

2.3.4 Master Earth Sciences, variant Geoarchaeology

The variant Geoarchaeology aims to provide a systematic and thorough training in the application of modern scientific methods in archaeology. You can choose from two specialisations. *Archaeometry,* focuses on developing your numeracy and logical reasoning in a scientific environment. The student familiarises with mineralogical and physico-chemical instrumental analysis techniques, and aspects of material science pertaining to archaeological materials. *Landscape archaeology* covers all chronological periods, familiarising students with local geomorphological settings and land-use. How did mankind organise and exploit its environment? Within the specialisations you will also learn about Bio-archaeology which deals with modern techniques in bio-material studies. The specialisations are closely related in terms of archaeological prospection for field and site surveying and of conservation science.

2.3.5 Master Hydrology

Hydrology is an applied natural scientific discipline with a strong measure of social engagement. World-wide access to clean drinking water, a sustainable approach to groundwater supplies, and relationships between changes in water cycles and ecosystems and climate are issues that are dealt with. The MSc Hydrology programme is subdivided into two specialisations. *Hydrogeology*: dealing with saturated and unsaturated groundwater flow modelling, regional hydrology and groundwater exploration. *Ecohydrology* combines a solid foundation in hydrological concepts with soil-vegetation-atmosphere exchange, linking it very closely to ecology and the master's degree programme Geo-environmental Sciences.

2.3.6 Master Geo-environmental Sciences

Geo-environmental Sciences offers a scientific basis for studying and getting to grips with the influence of mankind on the earth as a system. Students will acquire a sound understanding of the major global biogeochemical cycles and their natural and anthropogenic disturbances. The programme deals with studying the exchange of C, N, P, and S between soil, water, atmosphere, and biota on global and local scales in different climatic zones and environments. It renders insight into the influence of biogeochemical cycles in the climate system, and their relation to the hydrological cycle, as well as the influence of climate on biogeochemistry. Of genuine interest is also quantification of fluxes using different measurement techniques. Besides a theoretical background, students acquire techniques and tools for moditoring and modelling changes, such as the use of GIS and (numerical) climate models.

2.3.7 Master Environment and Resource Management

Environment and Resource Management is a one-year master programme. It focuses on scientific concepts and methods needed to understand the causes for environmental change, and to help solve environmental problems. A significant part of the programme is devoted to concepts and methods that originate from environmental economics, mostly to assess the effectiveness and efficiency of solutions for environmental problems. Here, environmental problems are defined as anthropogenic disturbance of the relationships between the environment and society, as perceived by

certain groups of individuals, organisations or institutions. Hence, environmental problems are societal problems.

The primary objective of the Environment and Resource Management programme is to educate and train its students to become experts in environment and resource management, i.e. that they are able to apply concepts, techniques and methodologies to understand environmental problems and to contribute to solutions of environmental problems. 'Resource management' specifically refers to the use of space and natural areas. The programme aims to create a common language among experts from relevant disciplines, enabling them to effectively work on environmental problems in multidisciplinary settings. In addition, the programme provides a 'toolkit' of multidisciplinary techniques and methods.

2.4 Study progress

2.4.1 Study planning and study delay

Master students who are new to our faculty, or even new to the Dutch educational atmosphere and student life in general, have to get accustomed to many things during the first few months of their studies. This may cause some delay in your study progress.
Getting to know the faculty and especially familiarising yourself with the time schedule and planning of your course years is essential for smooth proceedings of your studies.
Especially those students that have been admitted to the masters with additional demands to their programmes in view of eliminating deficiencies in their previous education are requested to contact their master co-ordinator/counsellor to make up a personal study schedule which will suit them best. Again, proper planning is essential in avoiding too much delay.

Examinations are generally scheduled during the last week of each period. Failing an exam means you need to re-sit it at the next possible occassion. Exams for each course module are sat (at least) twice a year. Preferably, re-sits are not scheduled whilst other course modules are being taught, meaning that some days around Christmas holidays and the month of August are the designated periods for organising re-sits. Student(s) and lecturer may, in consultation, also decide to plan a re-sit in any other period, providing nobody has any problems with this and there is no interference with other courses.
Try to restrict yourself to a limited number of courses /exams each period as this will guarantee best results and may prevent disappointment and delay.

2.4.2 Study progress check

Each student receives a notification of his study progress twice a year. The first notification is scheduled before October 1st, and the second in the month of January. Each student’s study progress is determined by the examining board, based on the registered programme components belonging to the appropriate degree programme. The notification includes a statement with which the student is reminded of the possibility to appeal against apparent errors or inconsistencies in his/her registered study results.
Upon request the study secretary can supply an outline of registered study results at any time. Furthermore, access to the web-based programme TISVU, enables checking registered study results from around the world. To gain access to TISVU, an account

number is required. More details on the use of TISVU can be found on the faculty's website. Application for accounts can be done at http://tisvu.vu.nl.

Names of students receiving student financing according to the Dutch *Wet op de Studiefinanciering*, and who have not met the minimum requirements of study progress, are reported to the *Informatie Beheer Groep* before November 1st. The students concerned will be notified of this before November 1st, by the department of "Studentenadministratie en Onderwijsvoorlichting", on behalf of the Executive Board. This notification is accompanied by information with respect to the consequences for the received financial support in the previous year and the possibilities to appeal against measures taken.

2.5 Registration for courses and examinations

2.5.1 Courses, Research Projects and others

Students must register for participation in all course modules and other programme components at least **four weeks before** they start. Newly enrolled students to our faculty are exempted from this rule for course modules of the first period of the university calendar (September- October). They should, however, register for courses from the second period onwards.
The School uses TISVU, a web-based programme for the purpose of enrolment in courses. In addition, some lecturers may ask students to register by other means, for instance Blackboard or e-mail. In these cases, always make sure you are registered by TISVU as well. Students are informed about how to use TISVU at the beginning of their studies. During the year 2004-2005 TISVU will be replaced by another programme, called TIS, which is more user-friendly and entirely bilingual.
Registration to certain programme components may even have to be completed considerably earlier than four weeks beforehand. This holds for programme components that need elaborate and time consuming preparatory co-ordination, e.g. fieldwork or excursions abroad, or for Research Projects and Master Thesis projects which are, in addition, subject to procedures of admission by the examining board. Make sure to check the seperate course descriptions in the back of your paperback master guide or at www.studiegids.vu.nl for the registration windows set for each programme component, but it is best to check the dates in TISVU/TIS itself.
It is likely that these regulations are accompanied by sanctions in 2004-2005, meaning that failing proper registration for courses will have (financial) consequences, or perhaps even lead to exclusion of participation in the course/fieldwork. At the time of editing this master guide, both faculty board and student's council were still in process of making up these regulations. Final decisions with respect to these will therefore be communicated at the beginning of the course year.
Students wishing to take courses in Life Sciences, at the Faculty of Arts, or elsewhere, are reminded to check enrolment regulations with the appropriate study secretariat (or at the internet/ in study guides). Course registration by means of TISVU/TIS is compulsory in almost all cases. In addition, sanctions may apply when regulations are not followed properly.
Information on the use of TISVU and/or Blackboard can be obtained at the faculty's website (www.falw.vu.nl>studenten), or in Dutch or English at the "infotheek" (C-148b).

2.5.2 Examinations

Students must, in addition to registration for courses, also register for interim examinations, and re-sits thereof, by means of TISVU/TIS. Registration windows for exams are opened from 10 weeks until 1 week before the examination date. Cancelling your earlier registration can, therefore, also be done until 1 week before the examination.

2.6 Admission to courses, research projects and master theses

2.6.1 Admission to courses, research projects and master theses

Master students have access to all taught master courses and research projects without any restrictions. Field Courses and Master Theses, however, may have specific entry requirements. If applicable these are listed in the appropriate course descriptions of the study guide. Please make sure you check these out. Entry requirements are checked by the examining board. Students who are not admitted to a certain programme component receive written notification of this.
Bachelor students are allowed to start following master courses under certain conditions. In a nutshell, they are only allowed to follow taught courses of the compulsory master programmes if they have accumulated at least 150 credits of the bachelor programme. Participation in elective courses, field courses, research projects or master theses is not allowed to students without a bachelor degree. In addition, students should obtain their bachelor degree within 12 months from the moment they started participating in their first master course.

2.7 Education and examination regulations

2.7.1 Availabilty of the regulations

Each MSc programme of the faculty has its own Education and Examination Regulation (EER) in which regulations with respect to classes, programmes and examinations are formally laid down. The EER can be consulted at, or downloaded from the faculty's website (falw.vu.nl > studenten > reglementen > Onderwijs- en examenregelingen). In case of differences between the information in the master guide and the EER, regulations as embedded in the EER are in force.

2.8 Interim examinations; regulations and guidelines

2.8.1 Preconditions for participants in interim examinations

While sitting your exam, please act according to the following preconditions:

- Your university registration card should be placed on the table for inspection.
- Mobile phones must be switched off.
- The use of books, readers, summaries, et cetera is not allowed unless explicitly permitted by the examiner in question.
- Writing paper will be provided. The use of own notebooks or paper is not permitted.
- After distribution of the first examination questionnaire, talking is no longer permitted.
- Produced writing during the interim examination must be handed in when finished.

In case of fraud, the examiner/surveyor can restrain the candidate from further participation in the examination concerned. The examiner should immediately report fraud to the examining board, in writing.

2.8.2 Partial interim examinations

Interim examinations are listed in course timetables. The examiner may divide the interim examination into partial interim exams. In this case, the final grade will be established by taking the weighted average of the components. Therefore, grading in a system from 1 to 10 is compulsory, also in cases of fieldwork.
At the student's request, the opportunity to sit the overall interim examination will be given at least once a year, with exception of components such as fieldwork activities or practicals, for which a partial interim examination is organised.

2.8.3 Re-sits in interim examinations

Interim exams for which a satisfactory result has been awarded already, cannot be retaken.
Once a student has retaken a previously insufficient interim examination, the mark obtained in the later interim examination will be taken as the result for the examination component in question. The student can request a second re-sit, administered by two members of the academic staff.
In cases where the candidate has failed to achieve a satisfactory result even after repeated re-sits, the examination board, at the request of the examiner or the examination candidate, will decide on how the candidate might be given another opportunity for evaluation of his knowledge and skills in relation to the examination component concerned.

Students have the opportunity to sit interim examinations in taught course modules on at least two occasions during the academic year. A first time directly after finishing classes of the module concerned, a second time either directly after Christmas holidays (January) or during the second half of August (or any other designated period). During the following year students are allowed to re-sit in previously failed interim exams on set dates listed in course timetables.

2.8.4 Administration of study results

The study secretary maintains a personal document file for each student with study results and additional study-related documents. Students automatically receive a copy of registered study results twice a year. In addition, a study result overview can be provided at any time at the student's request, or they can be checked in the web-based programme TISVU/TIS (http://tisvu.vu.nl). Inaccuracies and errors should be reported as soon as possible to the study secretariat.
Registration of individually taken interim exams is done by filling out a 'interim examination note' (*tentamenbriefje*) by the student, which is then completed by the lecturer with the result mark and a signature. The form is then passed on to the study secretary and results are compiled.
Registration of interim exams taken by multiple students, occurs by each student stating his/her name on the enrolment form during the interim exam, or by registration by TISVU/TIS beforehand. After assessment of the exam concerned, the examiner will add marks to the names on the list and have this list registered at the study secretariat.

Results of interim examinations are posted on a notice board in the F-1 corridor within thirty days after sitting the exam. Results of fieldwork reports should be made known within six weeks after handing in the final version. For reasons of privacy, marks are listed with registration numbers instead of names.

At your own request and within a period of 30 days after the results of an interim examination have been published, you have the right to inspect the work evaluated, the questions asked and/or assignments set.

2.8.5 Exemption from interim examinations

Provided that a favourable recommendation is received from the examiner in question, the examination board can, at a student's request, grant exemption from the requirement to sit an interim examination. This is subject to the condition that the student can demonstrate that he possesses the requisite knowledge. Acceptable evidence to this effect would be satisfactory results in previous interim or final examinations, or knowledge or skills obtained outside the context of higher education. Students must submit requests for exemption from an examination component to the examination board, in writing. The request must be accompanied by accurate documentation concerning the nature and extent of the knowledge and skills relevant to the examination component in question. If appropriate, an official document detailing interim examinations passed in the examination component in question should also be enclosed.

2.9 Practical regulations with respect to final examinations

2.9.1 Requirements for final examination and graduation

An MSc examination consists of a number of course modules, practicals, fieldwork, and excursions, and of a written thesis (or theses); all of which are completed at different times.

All programme components of the master examination should be completed with a satisfactory result. The exact programme requirements are described in the Education and Examination Regulations (EER). Any mark lower than 6.0 (on a scale from 1 to 10) is considered insufficient. All programme components and achieved marks will be stated in the appendix of the degree certificate.

2.9.2 Programme approval

In order to complete an MSc examination, the student's individual programme, comprised of all educational components to be incorporated in the exam, will have to be approved by the examining board. Programme approval should be arranged at least 3 months before the desired date of examination. Our study secretary will provide you with administrative means, such as digital approval forms, and pass on your request for approval to the examining board.

The programme should meet the requirements stated in the Education and Examination Regulations (EER) of the academic year in which the examination is taken. Contrary to above, the examining board may approve of programme components stated in EERs that are not older than three years preceding the year in which the exam is taken, including EERs of the five-year degree programmes which preceded the present bachelor-master programmes.

Any changes (for instance in optional course modules) in a programme that has already been approved of, require re-approval by the examining board.

2.9.3 Application for MSc examination and issuing of certificates

A written application for the examination can be done, when all educational components of the approved examination programme have been completed. Application forms can be obtained from the study secretary. Application should be done at least four weeks before the desired date of final examination.

The examining board will decide on fulfilment of all demands judged from the registered study results of the candidate, in agreement with regulations in the EER. The board then determines whether the exam is passed and awards a classification. The examining board meets once a month, with exception of the month of July. The final MSc examination can consequently be passed each month (apart from July). Certificates are dated at the date the board has established fulfilment of all demands.

In awarding the classifications the following conditions apply, based on weighted averages of marks: 'distinction' = 8.0; 'high merit' = 7.5 and 'merit' =7.0. For the classification 'distinction' several other conditions apply with respect to total study time and grade distribution. With regard to these additional regulations, please refer to the 'examination board's rules and guidelines'. These are attached to the Education and Examination Regulations.

Appeal against the examining board's resolutions is possible at the "*College van beroep voor de examens*". For all appeals, refer to the faculty part of the student's statute, or check http://www.vu.nl > organisatie > bestuur > Reglementen.

Issuing of certificates
A request for 'issuing MSc degree certificate' needs to be submitted to the study secretariat. Certificates can only be issued to students who are registered at the central Study Administration (either as 'student', or 'extranaeus') and who have paid their fees at the time of submission of this request. Again, all educational components of the approved programme (see EER) need to be registered at this time.
It is advisable to ask the study secretary for an outline of personal registered study results/marks some weeks before the actual request for final examination and issuing of certificate, in order to check whether all passed interim examinations have indeed been registered correctly.

The final award of the degree certificate, will take place in public during the final (public) part of the examining board's meeting at least one month after the official examination date. During this public ceremony, the candidate will be addressed personally by one of the faculty staff members. Meetings of the examining board (master programmes Earth Sciences, Hydrology and Geo-environmental Sciences) always take place on the second Wednesday of the month (none in July), apart from August, when the meeting is scheduled on the last Wednesday. The examining board Environment and Resource Management meets separately each second Tuesday of the month.

2.9.4 Termination of registration

A student who leaves the VU, for instance, after having passed the final examination, needs to request termination of registration at University. This requires a form to be filled out and handed in at the study secretariat simultaneously with the request for 'issuing of certificate'. Registration will then be ended in the month following the month in which the examination was completed, with exception of July and August.

2.9.5 Dossier declaration

If the student interrupts or ends his studies before having taken the final examination, there is an option to apply for a *dossier declaration* with the examining board. This declaration, which states all programme components that have been concluded with a

satisfactory result (supplied with credits and marks), can only be issued when at least two programme components have been completed satisfactorily.

2.10 Work placement/internship and thesis regulation

2.10.1 Work placement/internship and thesis regulation

The faculty has drawn up a specific 'work placement and thesis regulation' which has reference to programme components in which students more or less independently carry out a research project that is concluded with the writing of a report or thesis. Details with respect to this regulation can be consulted on the internet page: http://www.falw.vu.nl under: > studenten > Reglementen > Stage- scriptie regelingen (in Dutch). A list of all programme components that are subject to the 'work placement and thesis regulation', can also be found at this webpage, and in the back of your paperback master guide.
Prior to participating in any of these programme components, both student and faculty staff member involved should fill out a written agreement form. This agreement form (for traineeships, internships, research projects) can be downloaded from the above-mentioned web page, or obtained from the study secretariat.
The agreement concerns details on supervision, amount of time to be invested, allotted study credits, safety regulations, etc.

In order to comply with this regulation, and to have your mark registered by the study secretary, the student should hand in two copies of the thesis, the original agreement form, an evaluation form, and a digital version of the thesis' abstract (either on diskette, or by email) to the administrative secretary of the appropriate examining board:
Earth Sciences/Hydrology/Geo-environmental Sciences: dr.ir. M. Bergwerff, room C-124, tel. (020-) 444 7401, mail: maarten.bergwerff@falw.vu.nl
Environment and Resource Management: ms. E.W. Breet, els.breet@ivm.vu.nl, room A-503, tel. (020)-444 9540.

One of the two copies of the thesis will be sent to the scientific library, where it will remain available for public consultation. Reports or theses will not be subject to loan.

An expense allowance is possible in case the total reproduction costs of the two copies of the thesis exceed EUR 10. The refund will consist of the amount of money spent, exceeding the threshold of EUR 10. Declaration forms with respect to this expense allowance can be filled out with dr. ir. M. Bergwerff, room C-124 (Monday to Thursday).

Additional copies of your thesis will often be required by your supervisors and/or department involved, or external organisation at which you executed your traineeship/ research project. Expense allowances for these copies may be available at the department or external organisation concerned. Check with your supervisor for specific arrangements.

Work placement/ Research project/ Master thesis
The faculty does not have a service office specifically providing information about the possible subjects for, and organisations at which to execute a traineeship, research project, or master thesis. Please ask any of the faculty staff members for options inside and outside university.

2.10.2 External work placement/traineeship/research project

A number of projects can be executed outside the university proper, for instance in trade and industry, or at a foreign university. All of these projects are subject to the 'work placement and thesis regulation'. The external trainee ships/research projects are, in addition, subject to the following rules and guidelines:

1.The student will be informed by the study advisors about the various possibilities for finding external traineeships or research projects:
- by way of a contact person at the faculty;
- by way of STIP-VU;
- by way of the *Transferpunt*;
- by way of the info centre "Study and Career" (Studie en Loopbaan);
- by means of networking (relatives, friends, fellow students);
- with the help of internet;
- with the help of newspapers, journals, and
- mediation offices and services (*stagebemiddelingsbureau*).

2. The external traineeship/research project is executed under supervision and responsibility of a tutor/supervisor who is affiliated with the degree programme concerned. Students first find a supervisor before making arrangements with external parties.
3. The faculty's supervisor communicates with the supervisor of the external organisation on at least two occasions, i.e. at the start and at the end of the traineeship/research project.
4. At the end of the traineeship/research project, the external supervisor provides a written assessment with respect to the student's activities and progress. The faculty's supervisor will incorporate this advice into the final assessment of the traineeship/research project.
5. The activities of the student should not serve as a replacement of employee's activities of the external organisation.
6. The external organisation should accept liability for any injury, accident or damage inflicted upon the student during his/her presence at the institution concerned, or while executing his/her activities in as far as the injury, accident or damage is inflicted on purpose, or by fault of the organisation or one of its employees.
7. It is recommended that the student takes out liability insurance at the start of the traineeship/research project.
8. The Vrije Universiteit does not accept legal liability for any damage inflicted by the student, or inflicted upon the student.

2.10.3 Thesis guidelines

In general, a thesis is handed in to the supervisor(s) in draft first, before finishing a final version in which comments by the supervisor(s) have been taken into account. Students should inform themselves of the presence of supervisors, when planning dates for handing in draft and final versions. This is especially important in summer and some months preceding summer. Supervisors may be absent during these times due to e.g. fieldwork abroad, and will therefore not be able to amend and assess a thesis at short notice.

The first page of a report/thesis should include statement of:
- The title of the report or thesis;
- The author and date of publication;

- The name of the external organisation at which the project was done (if applicable);
- The name of the faculty's supervisor;
- The name of the external organisation's supervisor (if applicable);
- The programme component's code(s) (45xxxx) and credits.

2.11 Fieldwork: safety, subsidies and travel insurance

2.11.1 Safety

The School of Earth and Environmental Sciences actively pursues a policy on safety and minimised health risk during field activities. To this effect, the faculty has drawn up a document 'Veiligheid rond Veldwerk" (Safety during Fieldwork). Part of this document involves a risk evaluation, which is meant to inform participants in fieldworks and excursions about the possible dangers and risks to their health. This risk evaluation will be dealt with during introductory meetings prior to field activities. More information on 'safety in the field' can be obtained at the web page: http://www.falw.vu.nl under: studenten > bacheloropleidingen > info alle opleidingen > veiligheid (in Dutch).

2.11.2 Subsidy for compulsory fieldwork and excursions

Compulsory fieldwork and excursions are financially subsidised by the faculty provided the field activity is part of a study programme, approved of by the Examining Board. Both in the case of a collectively or individually organised field activity, students are allowed financial support on the basis of an estimate made by the responsible teacher and approved of by the Head of the School of Earth and Environmental Sciences.

Students will receive subsidy under the following conditions:

- Enrolment of the student at the Vrije Universiteit,
- The field activity is part of the bachelor programme Aardwetenschappen or the master programmes Earth Sciences, Hydrology, or Geo-environmental Sciences,
- The field activity is (or is part of) a course within the approved individual study programme of the student,
- The student has fulfilled all requirements for admission with respect to previous courses or programme components.

In all cases, unjustified received financial support will be reclaimed.

In order to receive financial support the student should have passed his/her administrative financial data (name, bank account etc.) to the Financial Administration. If you have not done this yet, please contact the Financial Administration to learn which personal administrative financial data are required and how you should deliver these.

Collectively organised fieldwork and excursions

- For compulsory fieldwork and excursions that are organised and financially managed by the Vrije Universiteit (responsible teacher), students have to pay an 'own financial contribution'. This contribution consists of 30% of travel expenses + 50% of the local residential costs. The financial subsidy to the student is calculated according to the model: subsidy = student portion of the fieldwork/excursion expenses – student's own financial contribution.

- Subsidy for travel costs to and from the fieldwork/excursion area is limited to a maximum of EUR 350
- The total financial support for fieldwork and excursions within a course subject is limited to EUR 900 per student.

Students receive an invoice from the Financial Administration for the amount of their own financial contribution. As long as the invoice has not been paid, students will no longer receive financial support for coming fieldwork and excursions.

Individually organised fieldwork
For compulsory fieldwork in which the student organises his/her travel and residence individually, students receive subsidy that is calculated according to the following rules:

- Students receive 70% of travel expenses (plane or train tickets) based on the approved estimate. Subsidy for travel costs towards and from the fieldwork/excursion area is limited to a maximum of EUR 350
- For residential costs the student receives a standard amount of EUR 15 per day (hotel costs, meals, telephone, etc.),
- Travel expenses for local transport are only subsidised if fieldwork is part of the bachelor thesis or research projects/ master theses within the master programmes. These expenses should be motivated and specified in the fieldwork estimate, made by the responsible teacher. Financial support for local travel expenses has a maximum of EUR 7.50 per person/per day to a maximum of 28 days (= EUR 210).
- The total financial support for fieldwork and excursions within a course subject is limited to EUR 900 per student.

Fieldwork financial estimate
The responsible teacher should hand in the financial estimate for a specific fieldwork or excursion at the Financial Administration at least one month before start of the field activity. The financial estimate should contain specifically the following information:

- responsible teacher, participating teachers and students
- administrative code of the course
- information on whether the course is a collectively organised activity financially managed by the responsible teacher, or an individual fieldwork managed financially by the students
- the exact data of the fieldwork or excursion
- the location of the fieldwork or excursion
- the way transport towards and from the fieldwork/excursion area is organised
- how local transport within the fieldwork/excursion area is organised
- the expenses, specified in (1) travel costs (plane, train, rented cars, petrol, etc.), (2) residential costs (hotels, meals), (3) additional costs (maps, aerial photographs, etc.) and (4) insurance costs.
- Incoming funds from third parties (contributions from industry or other funds).

After the fieldwork/excursion the responsible teacher should hand in a list of students that actually have participated in the field activity. On this list it should also be reported which students have prematurely left the field activity and the date of their

leave. Students that leave a fieldwork or excursion prematurely will have to pay back the subsidy received for the unused fieldwork period.

Further information
The above text on subsidy for compulsory fieldwork and excursions is a summary of the faculty document: 'Regulations on subsidising compulsory fieldwork and excursions Earth Sciences' (Dutch text) that is valid from January 1, 2004. The text is available at the faculty website: www.falw.vu.nl under: studenten > bacheloropleidingen > Aardwetenschappen en Geoarcheologie > subsidieregeling excursie en veldwerk.

2.11.3 Travel insurance

A collective travel insurance will be concluded by the faculty of Earth and Life Sciences for all students participating in fieldwork and excursions. The insurance policy's conditions will be made known to participants before leaving for a field course. They can also be obtained at the Financial Administration department.
If students interrupt a fieldwork period (for example for vacation) or travel earlier towards the fieldwork area or stay longer than necessary, they individually have to conclude an insurance for the non-covered period at their own expenses. The student has to take initiative to arrange this himself.
During a traineeship or practical term abroad, the student will be covered by insurance free of charge, for the first two months of his/her stay. This initial coverage paid for by the faculty can be extended at the student's costs. Information with respect to insurance matters can be obtained at the financial administration department of the faculty.

2.12 Student facilities

2.12.1 Study secretary and study co-ordination

Study secretariat
The study secretary can be consulted for general information about your studies, applications for final examinations and certificates, print outs with an overview of your study progress and grades, and for reporting personal changes related to study administration. Each student has to report any change in address, termination of your study activities, or lengthy interruptions of your studies immediately to the secretariat. Students who are registered for the first time and hence new to the faculty have to report to the secretary at the start of the academic year, in order to arrange administration of personal data (please take along a passport-sized photograph).

Study secretariat Earth and Environmental Sciences:
Mrs. M.J.C. Zadel-Vrind, Ms. M. Duifs-Eshuis, tel 444 7350, room C-118a.
Opening hours: Monday 8.30-10.30 and Tuesday-Thursday 7.30-9.30 and 12.30-14.00, the study secretariat is closed on Friday.

Study secretariat Life Sciences (for information on courses/ regulations at Life Sciences)
Ms. A. Kist and ms. S. El Hamdi; room C-118b, tel. (020) 444 7010 or (020) 444 6939. Opening hours: Monday to Thursday from 11:00 - 13:00 hrs. Closed on Fridays.

Educational co-ordination
The head of the School of Earth and Environmental Sciences and the educational co-ordinator are responsible for educational issues that involve the entire School, including educational policies, course time tables, and edition of this study guide.
Head of School: dr. C. Biermann, cees.biermann@falw.vu.nl, room E-152, tel. (020) 444 7260.
Educational co-ordinator (Earth Sciences, Geo-environmental Sciences, Hydrology): dr.ir. M. Bergwerff, maarten.bergwerff@falw.vu.nl, room C-124, tel. 444 7401.
Educational co-ordinator (Environment & Resource Management): dr. M. van Drunen, michiel.van.drunen@ivm.vu.nl, room A-645, tel (020)-444 9534.

2.12.2 Study advice and guidance

Each master degree programme, or specialisation within a degree programme, has its own co-ordinator/counsellor. These counsellors are members of faculty staff that have been appointed specific co-ordination, information and advisory tasks with respect to students or candidate students in a specific study programme. In general, personal contact between faculty staff and students is good at our faculty, providing for easy exchange of information, help and advice, and guidance in case of individual problems. Do not hesitate to contact your specific co-ordinator/counsellor whenever you need. It concerns the following staff members:

Earth Sciences
Lithosphere tectonics, petrology, and isotope geochemistry and
Sedimentary and structural geology, basin analysis, and surface processes:
Ms.dr. Reini Zoetemeijer, tel 444 7382, room E-154, reini.zoetemeijer@falw.vu.nl; and ms.dr. Marlies ter Voorde, tel. 020- 444 7843, room H-352, e-mail: marlies.ter.voorde@falw.vu.nl
Palaeoclimatology, Palaeo-ecology, Palaeo-oceanography and
Quaternary geology, geo-ecology:
Dr. Gerald Ganssen, tel.020-444 7329, room E-327, e-mail: gerald.ganssen@geo.falw.vu.nl; and dr. Sjoerd Bohncke, tel. 020-444 7348, room M-428, e-mail: sjoerd.bohncke@geo.falw.vu.nl
Archaeometry/Landscape Archaeology:
Prof.dr. Henk Kars, tel. 47364, room O-439, henk.kars@falw.vu.nl
Science communication
Dr. Jaap Willems, tel. 47034, room B-029, jaap.willems@falw.vu.nl
Education:
Dr. Hans Zloch, tel. 49242, room OG-25, h.zloch@ond.vu.nl

Hydrology and Geo-environmental Sciences
Dr. Maarten Waterloo, tel: 47319, room O-420, maarten.waterloo@falw.vu.nl

Environment and Resource Management
Ms. drs. Mieke Tromp Meesters, tel. 49567, room A-529, mieke.tromp.meesters@ivm.vu.nl

If needed, the faculty study advisor can refer you to other advisory bodies, like the student counsellors at the department of Student Services, or the Psychological Counselling Service of the Vrije Unversiteit.

Drs. H. Boswijk (tel. (020) 444 5020, e-mail: h.boswijk@dienst.vu.nl) is student counsellor for the Faculty of Earth and Life Sciences. Foreign students wishing specific aid in getting acquainted with the Dutch educational system, Dutch language courses, discrimination issues, cultural adjustment to Dutch society, and related subjects, are requested to contact Ms. Nanny Meyster, tel. 020-4445028. Please also refer to www.vu.nl > during your course > assistance and advice (English).

2.12.3 Quality control and programme assessment

Course modules and other programme components are subject to periodic assessment. These evaluations are done by questionnaires provided by the *Onderwijscentrum VU*. This bureau works up these questionnaires to evaluation reports which are sent to the head of School of Earth and Environmental Sciences, who in turn, assures distribution among members of the educational programme committees.
When necessary, the head of School discusses the outcome of course assessments with the staff member(s) and head(s) of department concerned, taking into account the outcome of the discussion by the educational programme committee. In addition, the *Onderwijscentrum VU* provides for a summary of assessed programme components, at certain stages of the degree programmes.
The educational programme committee advises the Faculty Board on the quality of education of the entire degree programme and of the separate programme components, based on the outcome of the aforementioned assessments.
Individual staff members can also opt for assessment of their course modules, outside scheduled evaluation procedures. Students can, by intervention of the educational programme committee, request assessment of certain courses.

2.12.4 Lecture theatres and classrooms

Classrooms used by the School for Earth and Environmental Sciences are all within the W & N-building (Sciences building) at the De Boelelaan 1085. Larger lecture theatres, are located on the first floor, F-123 and F-153. Practicals mainly take place in F401 (computing), F-253 (palaeontology and rock collections), and F-201 (microscopy). In addition, the smaller rooms F-301, F-453, H-358, and M-462 are used.

2.12.5 Libraries

The libraries of Earth Sciences and Environmental Sciences are part of the main Beta-department of the VU University Library. This Beta-department further consists of sub departments Chemistry, Biology, Physics and astronomy, and Mathematics and Informatics. It is located at the sixth floor of the Sciences building, De Boelelaan 1083, entry P-wing.
Opening hours: Monday to Friday from 9.00 to 18.00 hrs., in July and August from 9.00 to 17.00 hrs. Telephone: 444 5230.
Collections can be consulted largely without intervention of library employees. Lending of books is available on membership-base only. Journals are not lent out, but there are photocopy facilities at hand.
A guide for visitors to the Vrije Universiteit Library can be obtained at the loan desk. It has further information on membership, library regulations, other libraries at the VU, catalogues and on-line bibliographic services.
Contact persons:
Librarians Earth Sciences: mr. M.G. Gerzon (m.gerzon@ubvu.vu.nl) and ms. A.A. de Maesschalck (a.d.maesschalck@ubvu.vu.nl) room P620, phone (020)4445238.

Other VU libraries specialised in Social Sciences, Law & Economics, Humanities and others are located in de VU main building. More information is available at: http://www.ubvu.vu.nl

2.12.6 Study books and readers

Books and literature related to your studies can be bought at the VU bookshop in the main university building (tel. 644 4355). Course notes are either sold by the VU bookshop or by members of faculty staff themselves.
The faculties' student associations GeoVUsie (Earth & Environmental Sciences) Gyrinus Natans (Life Sciences) and Underground (Archaeology) arrange collective book purchases at reduced prices. Their services provided for specialised master course modules may be limited.

2.12.7 Computing facilities

Students who enrol in the Faculty of Earth and Life Sciences will automatically be registered as users of the faculty computing network, and are given a personal email address and access to internet. One can use network facilities from computers around the faculty, for instance in room F-229. Prior to usage, however, personal access to the computing network, needs to be activated. To do so, contact the helpdesk of the computing department (room F-222). In order to obtain printing facilities a user should have a printing budget. The initial 500 prints are free of charge. Beyond this number, each additional 300 prints will cost EUR 11.00 to be paid at Frans Stevens of the computing department at room F230. The printing budget will then be raised during the night following payment!
A significant amount of information with regard to network PC's and software can be consulted at the internet page of the helpdesk: http://www.falw.vu/helpdesk
A special computing room with access to all students is located at F-229. MSc students can, in addition, use computing facilities made available at the appropriate departments.

2.12.8 Student facilities faculty of Arts (Archaeology) for students Landscape Archaeology and Archaeometry

study secretary
Study secretary: room 10A-14, tel. 444 6424
Opening hours: Monday, Tuesday and Thursday from 10.00-15.00 hrs, Wednesday and Friday from 10.00- 13.00 hrs.

library
The Archaeology library is located at the 9th floor of the VU main building.
Opening hours:
Loan desk: Monday to Friday from 10.00 to 16.45 hrs.
Study hall: Monday to Friday from 9.00 to 17.00 hrs.
In addition to the ABVU catalogue you can use the following electronic bibliographic services:

- NCC (Nederlandse Centrale Catalogus); encompasses book titles and journals present in Dutch libraries.
- OLC (OnLine Contents) Humaniora: specialised in journals in the field of Humaniora.

Of special interest for archaeology are also:

- Cetedoc Library of Christian Latin Texts; the complete text of the Corpus Christianorum, Series Latina and Continuato Mediaeualis; supplemented with editions from the Patrologiae Latinum Supplementum and Corpus Scriptorum Ecclesiasticorum Latinorum.
- Packard's Humanities Institute: contains complete texts of the entire Latin corpus until the second century A.D. Also texts on papyri and ostraca, and inscriptions.
- Thesaurus Linguae Graecae: contains complete texts of the entire Greek corpus until the 4th century A.D.

Other departments of interest:
Manuscripts and Old Prints: dr. W. Heijting, room 1B-41, tel.: (020) 444 5149, e-mail: w.heijting@ubvu.vu.nl.
Information desk Library: room 1A-01, tel.: (020) 444 5200, More info on the website: http://www.ubvu.vu.nl. Comprehensive information is to be had at the loan desk.

computing
Since the degree programmes in Archaeology and Geoarchaeology work with specific applications in computer hard- and software, a computing room has been installed specifically for archaeology students in 10A-02. Students who wish to use the available terminals for course-related tasks and reports should request a separate log-in name with the system operator of Archaeology.
In addition, log-in name and password of the faculty of Arts renders all other terminals in faculty computing rooms available.

2.13 Programme committees and examining boards

2.13.1 Task and remit of educational programme committees

Each degree programme has its own educational programme committee. An equal number of staff members and student members take part in an educational programme committee. In principle, any student can be appointed as member of the educational programme committee of his own degree programme.
The educational programme committee has:

- an advisory role with respect to the educational programmes, including the Education and Examination Regulations.
- a role in assessing the way in which the Education and Examination Regulations are enforced.
- an advisory role in all matters concerned with the education and courses of a particular degree programme.

2.13.2 Programme committee Earth & Environmental Sciences

The programme committee Earth and Environmental Sciences (BSc Aardwetenschappen, MSc Earth Sciences, MSc Geo-environmental Sciences, MSc Hydrology) consists of the following members:
dr. K. Kasse, dr. R. Zoetemeijer, dr. H. Vonhof, dr. K. van Huissteden en drs. F. Beunk.
student members: J. van Hagen, Y. Kremer, J. Laanbroek and two students to be appointed.

2.13.3 Programme committee Environment & Resource Management

The programme committee Environment and Resource Management consists of the following members:
dr. ir. J.E. Vermaat (chair), ms. drs. M.I. Tromp Meesters, a vacancy and three student members (to be appointed).

2.13.4 Examining board Earth & Environmental Sciences

The examining board Earth & Environmental Sciences manages issues related to the bachelor degree programme "Aardwetenschappen" and master degree programmes Earth Sciences, Hydrology, and Geo-environmental Sciences. The board defines rules with regard to interim examination matters. It determines the result of the final examination, designates examiners and can provide them with guidelines with respect to the assessment of interim exams. It furthermore handles admission requests to the degree programmes, approval of examination programmes, exemptions from sitting interim exams, et cetera.
The examining board for the above-mentioned degree programmes consists of the following members: dr. A.A. van de Griend, prof. dr. J. Smit, dr. M.A. Zakrzewski and a new to be selected member.
Correspondence to the examining board can be addressed to the administrative secretary: Dr.ir. M.Bergwerff, maarten.bergwerff@falw.vu.nl, room C-124, tel. (020)-444 7401, (Monday to Thursday). The board meets each second Wednesday of the month (not in July). In August its meeting is scheduled at the last Wednesday. Correspondence to the board should be sent well before its meeting dates (at least one week).

2.13.5 Examining board Environment and Resource Management

The examining board Environment and Resource Management manages issues related to the master programme under the same name. The board defines rules with regard to interim examination matters. It determines the result of the final examination, designates examiners and can provide them with guidelines with respect to the assessment of interim exams. It furthermore handles admission requests to the degree programmes, approval of examination programmes, exemptions from sitting interim exams, et cetera.
The examining board ERM consists of the following members:
Prof. dr. F. Berkhout (chair), dr. M.A. van Drunen (secretary), ms. drs. M.A. Molendijk.
Correspondence to the examining board can be addressed to the administrative secretary: Ms. E.W. Breet, els.breet@ivm.vu.nl, room A-503, tel. (020)-444 9540.
The board will meet at the following dates: 14 Sept. 2004, 12 Oct. 2004, 9 Nov. 2004, 14 Dec. 2004, 11 Jan. 2005, 8 Feb 2005, 8 Mar 2005, 12 Apr. 2005, 10 May 2005, 14 Jun. 2005, 12 Jul. 2005, 9 Aug. 2005.

2.13.6 Library committee

The library committee advises the librarian. The committee (speciality in Earth Sciences) consists of the following members: dr. S. Luirink (chair), ms. dr. B.P. Zoetemeijer, ms. dr. M.H. Lamoree, mr. J. v.d. Lubbe (student)

2.14 Research departments

2.14.1 Hydrology and Geo-Environmental Sciences

Head of department: Prof.dr. A.J. Dolman, room M438.

phone 444 7358, e-mail: han.dolman@falw.vu.nl
More information can be found at: http://www.falw.vu.nl > onderzoeksinstituten > IAW-Earth Sciences > Dept. of Hydrology)

The department of Hydrology and Geo-Environmental Sciences is responsible for the master programmes in Hydrology and Geo-environmental Sciences.

The Hydrology programme
The hydrology programme focuses its research on the analysis and synthesis of hydrological systems in order to:
* enhance our knowledge of the role of water in the System Earth,
* quantify human impact on hydrological systems,
* develop strategies for sustainable use and management of the earth's water resources, through theoretical and applied research with an emphasis on the development of applicable models for transport and exchange of water, solutes and energy, on the basis of sound physical and chemical theory. This programme has two specializations: *Hydrogeology* and *Eco-hydrology*

Hydrogeology
Hydrogeological research is carried out within the framework of the *Netherlands School for Sedimentary Geology (NSG)* and is principally directed towards the study of hydrological processes, taking into consideration its geological framework.
Ongoing research activities:

- Hydrogeological processes and evolution in Quaternary coastal areas, taking into consideration the influence of changes in sea level and coastal morphology (Netherlands, Surinam, Egypt).
- Influence of texture and structure on hydrogeological properties of sediments and its impact on transport processes.
- Hydrochemical processes and transport modeling and its application to hydrogeological reconstructions and groundwater contaminant studies.
- Regional studies to understand groundwater conditions and resources as a result of the interaction of the various recent and paleo earth scientific processes (Kalahari, Mediterranean).

Eco-hydrology
Research concentrates on quantifying and predicting the effects of climate and land use change on water, energy, carbon, nutrient and sediment dynamics at the on-site to meso-catchment scale. Particular attention is given to the interaction of water with the carbon cycle (CO2 and CH4). Staff members participate in two research schools: SENSE and ICG.
Ongoing or recently completed research themes include:

- Effects of changes in climate, land use or regional water management on hydro(meteoro)-logical, geomorphological and ecological (GHG emissions) processes in the temperate zone.
- Water, carbon and nutrient dynamics of tropical forest ecosystems and effects of disturbance or conversion to other land uses.
- Water and carbon studies in east Siberian taiga's and tundra's on permafrost.

- Energy and water budgets of tropical forests and grasslands vis < vis catchment water yield or regional climate (Fiji, Puerto Rico, Amazonia).
- Assessment of the Eurpean carbon balance at local to regional scales (CarboEurope)

2.14.2 Isotope Geochemistry

Head of the research group: prof. dr. P.A.M. Andriessen, office H-325, tel 444 7340, e-mail: paul.andriessen@falw.vu.nl
(More information can be found on website: http://www.falw.vu.nl
under: onderzoeksinstituten > IAW-Earth Sciences > Dept. of Isotope Geochem.)

Isotope geochemistry focuses its activities on the origin and evolution of planet Earth and the processes operating in the various domains of system Earth. The occurrence of natural decay systems is used to determine ages of geological materials (rocks and minerals). The radiogenic systems also provide geochemical tracers to be used to determine and explain (re)cycling and exchange of mass and material between the different reservoirs or components of the planet: mantle, lithosphere (oceanic and continental), hydrosphere and atmosphere.
Thermogeochronology is the determination of time-temperature paths using the decay systems and fission tracks and in combination of mineral thermo-barometry, fluid inclusion analyses and structural geology it is a powerful mean to reconstruct and unravel P-T-t paths of geologic terrains and orogenies.

The research program concentrates on two themes, a) the determination of ‘absolute’ ages and rates of geologic processes, and b) the determination of transport between different chemical reservoirs and components of system Earth to obtain mass-balances. Both themes provide crucial information on how fundamental processes like plate-tectonics, the differentiation between mantle and lithosphere, convective mixing in the mantle and long-term isolation of mantle components. A second target of the research program is the quantification and timing of long-term, global scale processes such as uplift and subsidence histories, denudation, exhumation and erosion. Although the expressions of these processes are found at the outer Earth, they are parts mechanism operative at the inner Earth.
Recent developments in isotope geochemistry, in particular noble-gas isotopes, enable to date and quantify short-term, small-scale exogene processes.

An important activity of the research group concerns the improvement and development of analytical methods and techniques. Especially the determination of minute amounts of material (micro and Pico grams) with high precision and accuracy remains a challenge. Beside the analytical aspect of earth science the group pays much attention to field studies and modeling. It is rather common that research projects are performed in a multidisciplinary environment in partnership with the groups of Petrology, Sedimentology and Tectonics and structural geology and all other groups of the Institute of Earth Sciences and some departments of biology.
The research group of Isotope Geochemistry participates in the research school NSG and is partner of the national top research school ISES.

The isotope geochemistry group teaches in the Bachelor ‘Earth Sciences’ and jointly with Petrology, Tectonics and Structural Geology and Quaternary Geology and

Geomorphology in the Research ('O-') and Societal ('M-') variants of the MSc program 'Earth Sciences'.
Research projects for Bachelors students at the end of the third year are listed on the web page of Isotope Geochemistry (see above).
Students have the possibility to specialize in Isotope Geochemistry and Petrology by choosing appropriate courses and research topic in the fifth year. Depending on the interest of the student one can develop a more in depth expertise in a) instrumental analyses, methods and techniques that are extensively used in industry and governmental and non-governmental institutes, and b) (numerical) modeling techniques, preparing students for the job market in which IT knowledge and expertise is required.
Various research topics and projects for the MSc program are part of the ongoing research projects of PhD students and post-docs of Isotope Geochemistry and staff members supervise the projects. In most cases a sampling and field campaign is accompanied with analytical work in the laboratory. Research projects and topics are available on the web page of Isotope Geochemistry.

2.14.3 Paleoecology and paleoclimatology

Head of department: prof. dr. D. Kroon, room: E-359, tel. 444 7322,
e-mail: dick.kroon@falw.vu.nl
(Detailed info: http://www.falw.vu.nl > onderzoeksinstituten > IAW-Earth Sciences > Dept. of Paleoecology)

Science aims of the department of Paleoecology and Paleoclimatology are to understand causes of natural climate evolution and effects on marine, coastal, and terrestrial geo-ecosystems on varying time scales. We study decadal-centennial records of climate change in the Holocene-Pleistocene including Holocene sea level changes. We try to document and model decadal-centennial records of climate change and possibly link them to solar variation or other mechanisms. In addition, we document decadal-centennial records of climate change during extreme warm events, e.g. warm interglacial periods in Pleistocene and the Paleocene-Eocene boundary. We link the climate changes to biogeochemical cycles, e.g. influence of methane reservoirs on global climate.
To enhance interpretations of climate change the 'proxies' of climate change need to be improved. Therefore we study modern processes and quantify relationships between the environmental signal and the chemistry in shells of biota (proxy development). This is a multi-disciplinary approach in the area of biogeology. We study the ecology of both marine and lacustrine mollusks, marine foraminifers, coccolithophorids, and in particular the chemistry of their shells. Stable isotopes and trace elemental analysis of the shells play an important role in climate research. Students will get actively involved in making analyses themselves in various projects.
The department has an active seagoing program to take samples from the ocean surface, down to the seabed and the sedimentary record for the study of modern ocean processes and paleoclimate reconstruction.
The department is also actively involved in paleoclimate reconstructions from terrestrial archives, e.g. stalagmites for rainfall reconstruction and bivalves from rivers and lakes, and other lake deposits. We aim to make land-sea correlations that help to decipher climatic processes on a big scale. We have an active fieldwork program on land to collect material from caves, lakes and rivers in many parts of the world. Examples of fieldwork activities are in Peru, Brazil, Portugal, North Atlantic

Ocean, Indian Ocean and also in our own country. Many big projects are in collaboration with other departments in the faculty but also with other institutes in the Netherlands, such as NIOZ at the island of Texel (National Oceanographic Research Institute) and the Natuurhistorisch Museum Naturalis in Leiden (Natural History Museum).

2.14.4 Petrology

Head of department: prof. dr. G.R. Davies,
Room F-032, phone +31-20-444 7329, e-mail: gareth.davies@falw.vu.nl
(More information at: http://www.falw.vu.nl > onderzoeksinstituten > IAW-Earth Sciences > Dept. of Petrology)

Slow cooling of the Earth drives all large-scale geodynamic processes and the heat flow from within leads to melting of rocks and powers volcanoes. Magmas from the Earth's mantle solidify to form oceanic crust and deliver the materials from which the continental crust is built. Elsewhere, internal heat makes new rocks by recrystallisation during metamorphism.
Petrology is the science of the physical and chemical properties of rocks, particularly of magmatic and metamorphic rocks. Petrological research gives us insight in the dynamics of the mantle and crust, continental as well as oceanic, but it also contributes to climate and environment studies. Volcanism, for instance, is the keystone of the CO2-cycle, while submarine volcanism partly determines the chemistry of the oceans. Moreover, magmatic and metamorphic processes produce the greater part of our natural metallic resources. The most important tools for petrological research are field observation and chemical analyses of rocks and minerals and their fluid and magmatic micro-inclusions. In addition, petrologists devise thermodynamic models and perform experiments to model and predict rock-forming processes. Our field of science has a strong (geo)chemical streak ('the Earth as a chemical melting pot') and relies partly on isotope geochemistry, which we use for the analysis of the time factor in the evolution of rocks (geochronology, the age dating of rocks and processes by natural radioactive decay); and, as tracers of rock forming processes.

In addition to the core subject of Petrology, the department teaches Mineralogy, Geochemistry, Volcanology and the Geology of Natural Resources. The Research ('O-') and Societal ('M-') variants of the MSc programme in Endogene Geology are taught jointly with the Departments of Isotope Geochemistry and Tectonics and contain contributions from these disciplines. The flexiblity of the MSc-programme allows students to acquire additional training in Petrology, Mineralogy, or (Isotope) Geochemistry by choosing appropriate courses during the second master year. An inherent part of our teaching is training in relevant analytical techniques. These methods are extensively used by industry and research agencies in Material Sciences, hence experience in a wide variety of analytical techniques has the additional value of preparing Petrology students for jobs outside the traditional energy sector. In addition, cooperation with the Department of Geoarcheology gives students the opportunity to apply our analytical tools to the study of archeological artefacts.

Students can participate in departemental research from the end of bachelor year 3 (Bachelor thesis). At present, research concentrates on two major themes:

- Magmatic processes and volcanism of mid-ocean ridges, hot-spots and subduction zones. These are crucial elements of the endogene cycling of surface materials through the mantle. An important component of such studies is the geochemistry of high temperature processes, viz. the partioning of elements and isotopes among rocks and minerals.
- Formation and thermotectonic evolution of the continental lithosphere, usually involving fieldwork in deeply eroded Precambrian Shields or younger orogens. Magmatic as well as metamorphic processes are studied, including interactions between mantle and crust, fluids and rocks, and the formation of mineral deposits. The structural geology of high grade rocks is an important component of such studies. At present, projects are accessible in Tanzania (kimberlite volcanism), Namibia (Late Proterozoic orogenesis) and in the Caledonian (Early Paleozoic) orogen of Norway.

For students of the societal ('M-') variant of the MSc programme traineeships are usually available outside the university (e.g. with SHELL, TNO, DeBeers….). Availability of such projects depends on supply and demand. Recent examples include the exploitation of geothermal energy and the long-term behaviour of building materials (natural stones, concrete). A topical list is available on the web page of the Department (see above).

2.14.5 Quaternary Geology and Geomorphology

Head of departement: prof. dr. Vandenberghe, room F-414, tel: 444 7368
e-mail: jef.vandenberghe@falw.vu.nl
(Detailed information at: http://www.falw.vu.nl > onderzoeksinstituten > IAW-Earth Sciences > Dept. of Quaternary Geology and Geomorphology)

The research of the department of Quaternary Geology and Geomorphology focuses on the investigation of functioning and evolution of geomorphological systems and environments, and the palaeoclimatic evolution within these systems. Special attention is given to the way in which the evolution of, especially fluvial, systems is driven by external factors as climate, tectonics and human interference. The high variation of the studied geo- and ecosystems require a multidisciplinary approach involving a large diversity in the applied disciplines (from geomorphology to sedimentology and ecology) and analyses (from geochemistry and palaeobotany to numerical modelling and geophysics). The required information is obtained from field, laboratory and desk studies at different space and time scales within the Quaternary period.

More specifically the research of the department is directed towards
1/ reconstructing and modelling river activity and fluvial environments at decadal to millennial time scales and from subrecent to Pleistocene times, with special emphasis on the distinction between external driving forces and internal dynamics;
2/ analysis and evolution of palaeoclimate systems and conditions (particularly temperate, periglacial and monsoonal climates) by means of detailed geological reconstructions and model simulations, and the comparison between both (in cooperation with the department of Palaeo-ecology and –climatology).
The link between both themes is obvious in the (palaeo)climate as forcing factor in fluvial evolution.

The department is teaching in subjects of geomorphology, geoecology and Quaternary geology.

2.14.6 Sedimentology

Head of department (ad-interim): dr. A.R. Fortuin, room E-237, tel. 444 7351
e-mail: anne.fortuin@falw.vu.nl
(For more information see the web: http://www.falw.vu.nl > onderzoeksinstituten > IAW-Earth Sciences > Dept. of Sedimentology)

Sedimentology is the study of the processes of formation, transport and deposition of material which accumulates as sediment in both continental and marine environments. In a reverse sense it deduces the conditions of deposition which led to the formation of the sedimentary record. Sedimentology is intimately associated with stratigraphy and marine geology. Stratigraphy is concerned with the study of temporal and spatial relationships of bodies of strata.. The objective of Marine geology is the exploration of the sea and ocean floors on this planet, which together occupy over 70% of the earth's surface. Courses offered by the sedimentology group comprise a broad range of different sedimentological and erosional features, with a focus on the processes involved, including three-dimensional accommodation of sediments (sedimentological architecture) and their relation in time with their sedimentary environments and other aspects like diagenesis, petrophysics, marine geology, seismic stratigraphy, and historical geology.
This is done in co-operation with the department Paleoecology and paleoclimatology and the Tectonics department.
The research, in which students will be involved, focus on sedimentary basins, in particular carbonate rocks (reefs), Neogene basins, petrophysics, seismic interpretation and research-cruises in the Mediterranean Sea. These projects are carried out in co-operation with international science organisations, oil companies in Europe and North America, or fit within big international research programs like the Ocean Drilling Program (ODP).

2.14.7 Tectonics

Head of department: prof.dr. S.A.P.L. Cloetingh, office E-160, tel. 444 7341,
e-mail: sierd.cloetingh@falw.vu.nl
(More information see the web: http://www.falw.vu.nl > onderzoeksinstituten > IAW-Earth Sciences > Dept. of Tectonics)

The research of the Tectonics Department concentrates on the study of deformation processes in the crust and the lithosphere of the Earth.
An important part is the study of the formation of sedimentary basins, in which the reconstruction of the sedimentary record, vertical motions and the mechanics of the crust and the lithosphere are central.
Numerical and analogue modeling techniques are widely used advanced methods in these analyses of tectonic processes.
Research takes place in both extensive and compressional study areas and is mainly process-oriented.
Structural fieldwork in several areas, such as the Iberian peninsula, Italy and eastern Europe, concentrates on acquiring data on paleostress fields, on deformation and deformation mechanisms, as well as on the structural development and the evolution of sedimentary basins.

A wide range of numerical and analogue modeling techniques available through the Numlab and Teclab support the research of the development of stress fields in the lithosphere, of the deformation processes on lithosphere and basin scale, and of numerous applications within the research fields of energy and environment.
Main topics of research are: fluid flow in relation to tectonics, patterns of uplift and subsidence, formation and development of sedimentary basins, and the modeling of thermal perturbations during deformation.
Intensive cooperation with other departments of the Faculty and in an international framework are of essential importance for the successful research of the Department of Tectonics.

2.14.8 Biology and Society

Head of department: ms. Prof. dr. J.G..F. Bunders, tel 020-444 7031, room A-068.

Information about this department can be found at: www.falw.vu.nl > onderzoeksinstituten > IITO-Biology & Society.

2.14.9 Animal Ecology

Head of department: Prof.dr. N.M. van Straalen, tel: 020-444 7070, room B095, e-mail: nico.van.straalen@ecology.falw.vu.nl

Information about this department can be found at: http://www.falw.vu.nl > onderzoeksinstituten > IEW-ecological Sciences > Animal ecology.

2.14.10 Ecology en physiology of plants

Head of department:: dr. J.A.C.Verkleij, tel (020) 444 7054, room A-207, e-mail: jos.verkleij@ecology.falw.vu.nl

The research is focussed on the adaptation of plants to abiotic and biotic stress factors from the molecular to the whole plant level. The following aspects are investigated:

- Evolution and characterization of ion transporters involved in the uptake and compartmentation of cadmium, copper, nickel, and zinc, and in the hyperaccumulation of heavy metals. Population-specific regulation of metal translocation under exposure to multi-metal combination. Potential of metal resistant plants for the decontamination and phytoremediation of metal contaminated sites.
- Molecular and physiological basis of dehydration tolerance in higher plants focussing on studies with the resurrection plant *Craterostigma plantagineum* and the lab model *Arabidopsis thaliana*.
- Molecular basis of salt tolerance in higher plants using the halophyte plant *Thellungiella halophila* (salt cress) and the lab model *Arabidopsis thaliana*.
- Evolution of plant adaptation to fluctuating water levels in wet coastal dune slacks and the consequences for the maintenance and restoration of dune slacks.
- Resistance mechanisms of crops to infestation by the angiospermous holoparasites *Orobanche* and *Striga*.

More information can be found at the faculty's website: http://www.falw.vu.nl > onderzoeksinstituten > IEW-ecological Sciences > Ecol. & phys. of plants.

2.14.11 Systems Ecology

Head of department: prof.dr. Rien Aerts, tel. 020-4447211/7007, room A-154, e-mail: Rien.Aerts@ecology.falw.vu.nl

The main research topic of the Department of Systems Ecology is the interaction between the atmosphere, the soil and its micro-organisms, and primary producers (plants), involving both productive processes (plant growth, symbioses between plants and micro-organisms) and destructive processes (herbivory, decomposition).

We particularly focus on the way in which components of global change (climate warming, elevated CO2-concentrations, higher levels of UV-B radiation, increased atmospheric nitrogen deposition, changes in precipitation and large-scale hydrology) affect carbon and nutrient cycling as well as biodiversity of terrestrial and aquatic ecosystems.

We also investigate how changes in carbon and nutrient capture or storage of terrestrial ecosystems feed back into the climate through the altered emission patterns of greenhouse gases (CO2, methane and nitrous oxide) into the atmosphere. In this research we focus on litter decomposition and chemical transformation processes in the soil such as mineralisation, nitrification and denitrification. Another feedback of particular research interest is how belowground diversity (mycorrhizal fungi, nitrogen-fixing bacteria) affects ecosystem structure and functioning and *vice versa*.

We conduct our own experimental studies mainly in cool and cold ecosystems such as peatlands, dune grasslands, heathlands and tundras, extending from Antarctica,via temperate and boreal sites (The Netherlands, Sweden) to various sub-arctic and arctic sites (particularly Sweden and Spitsbergen).We are also actively involved in international research networks and meta-analyses that are synthesising data and insights on some of the above issues from many biomes worldwide.

Keywords:
belowground interactions, biodiversity, biogeochemistry, carbon cycling, global change, greenhouse gases, higher latitudes, litter decomposition, micro-organisms, nutrient cycling.

Website: http://www.falw.vu.nl > onderzoeksinstituten > IEW-ecological Sciences > Dept. Systems ecology.

2.14.12 Geoarchaeology

Head of department: prof.dr. H. Kars, room O-439, tel. 4447364, e-mail: henk.kars@falw.vu.nl
(For detailed information see the web: http://www.falw.vu.nl > onderzoeksinstituten > IBGA- Geo & Bioarcheologie

Geoarchaeology is a modern way of finding out more about our past. As a geoarchaeologist your expertise will be founded on a thorough grounding in the natural sciences.
You will possess an expert understanding of what the landscape used to look like in times past and the capability to date any materials found. You will employ the latest technology in order to learn about the ancient technologies available to the people

who produced the materials and objects found. Many archaeological finds are buried in the ground and your knowledge of that subterranean world will therefore be essential to understanding these finds in their proper context.
Your knowledge will further be essential when it comes to tracking down sites, deciding whether a dig should take place or how the remains should be preserved in situ for future generations of researchers
The VU is the only university in mainland Europe to offer this unique combination between earth science, biology and archaeology. Interdisciplinarity is the key to the Master's programmes in Geoarchaeology. The programme aims to provide a systematic and thorough training in the application of modern scientific methods in archaeology. It will also give you the necessary scientific and technological insight to apply scientific theory to archaeology. You can choose between two specializations leading to an MSc in Earth Sciences/Geoarchaeology: i.e. Archaeometry and Landscape Archaeology.

Archaeometry This specialization focuses on developing your numerical skills and logical reasoning in a scientific environment. You will spend considerable time in the laboratory acquiring a wide-range of hands-on experience in the extensive suite of laboratories present within the Faculty of Earth and Life Sciences. In this way, you will become familiar with the entire range of relevant mineralogical and physico-chemical instrumental analysis techniques. You will also become acquainted with many aspects of material science pertaining to archaeological materials. The lectures also deal with subjects like how to understand and interpret ancient technologies.
Landscape Archaeology This specialization covers all chronological periods. The wide range of contexts requires you to familiarise yourself with different methods and techniques according to local geomorphological settings and land use. However, these are bound together by a common approach to enable you to understand how humans have organised and exploited their environments. As you can imagine, this specialisation involves spending considerable time out in the field.

In both specialisations we offer a thorough training in the full range of modern techniques for biomaterial studies, in our landscape-oriented course with a strong emphasis on ecological archaeology, while in the archaeometry course you can specialize in biomolecular archaeology.
Although the various specialisations diverge in terms of approach, their aims and objectives are closely related. This can be seen in archaeological prospection for field and site surveying, where both specializations train you in the fundamental principles and practice of prospection techniques in archaeology. The same holds for the field of conservation science, which concentrates on the in situ degradation and differential preservation of the archaeological materials present in a variety of burial environments.

Geoarchaeologists are very much in demand in the near future, not only in the Netherlands, but throughout Europe. You could soon be one of the first geoarchaeologists on the market, with plenty of opportunity to become a leading authority on location methods, archaeological finds or the landscapes of the past.

2.14.13 Institute for Environmental Studies

Director per 1 september 2004: Prof. dr. F. Berkhout, room C-530, tel: 020 4449525.
The Institute for Environmental studies (IVM) consists of 4 departments:

- Department of chemistry and biology, head: prof.dr. A. Brouwer, room C-529, phone 020 4449530, e-mail: mailto:bram.brouwer@ivm.falw.vu.nl
- Department of economics and technology, head: dr. M.W. Hofkes (a.i.), room A-530, phone 020 4449563, e-mail: mailto:marjan.hofkes@ivm.falw.vu.nl
- Department of environmental policy analysis, head: prof. dr. F. Biermann, room A-C522, phone 020 4449959, e-mail: mailto:frank.biermann@ivm.falw.vu.nl
- Department of spacial analysis and decision support, head: dr. R. Janssen (a.i.), room A-570, phone 020 4449512, e-mail: mailto:ron.janssen@ivm.falw.vu.nl

(Detailed information can be found at: http://www.falw.vu.nl > onderzoeksinstituten > IVM- Environmental Studies)

Being the oldest environmental research institute in the Netherlands, the Institute for Environmental Studies (IVM) has built up considerable experience in dealing with the complexity of environmental issues. Its purpose is to contribute to sustainable development and the rehabilitation and preservation of the environment through academic research and education. IVM addresses challenging environmental problems and offers both pragmatic and innovative solutions. It employs approximately 100 researchers and supporting staff.
Over the last few decades there has been a marked increase in environmental research and data acquisition. Indeed, the point has been reached where it is no longer appropriate for policy-makers to say that ‘little is known about the environmental impacts of this decision’. However, a major gap still exists between the available data and the information needed to gain more insight into environmental processes, problems and long-term, i.e. sustainable solutions. Much work has been done to analyse the flow of pollutants and their environmental effects, but too little attention has been paid to the question of how this information should be organised to enable effective and efficient overall environmental management. In its present research programme, IVM aims to create and develop innovative approaches to the gathering and structuring of information on natural and societal processes and their interactions. Our research programme has been inspired by the concept of sustainable development. This concept has the merit of forcing all stakeholders to take a more integrated view of environmental issues. In contrast, many scientists tend to focus on those aspects that are closely related to their own discipline. For scientific research to contribute to a sustainable future, a more integrated and multidisciplinary approach is needed, whilst maintaining the discipline-based requirements of sound scientific work.
We focus on the following four core programmes:

- **Measurement techniques and strategies.** This core programme aims to develop and integrate expertise on measurement technologies, environmental processes and environmental models within and between scientific disciplines (e.g. chemistry, biology and earth sciences), thus enabling more efficient and effective measurement and monitoring of the environment.
- **Analysis and management of the spatial component of the environment.** This core programme focuses on the spatial relations between environment, economy and society; it aims to improve the effectiveness of spatial data for the transfer and exchange of information between stakeholders, and to design decision aids that support evaluation and management.
- **Industrial transformation.** This core programme aims at 1) understanding the complexity of technological, economic, social and cultural aspects of industrial

activities, and 2) exploring options for a transformation towards sustainability and a decoupling of economic growth from increasing environmental impacts.

- **International environmental agreements within the North-South relationship.** This core programme focuses on international environmental agreements within the context of the North-South relationship. It investigates the reasons for failure of the implementation of such agreements and scope for improvement.

3 Earth Sciences

3.1 Introduction

3.1.1 The programme and its specialisations

The MSc programme Earth Sciences is subdivided into several different specialisations, each with their own requirements and educational programmes. The different specialisations are:

- Litosphere tectonics, petrology, and isotope geochemistry
- Sedimentary and structural geology, basin analysis, and surface processes
- Palaeoclimatology, palaeo-ecology, palaeo-oceanography
- Quaternary geology, geo-ecology
- Archaeometry
- Landscape Archaeology
- Science communication
- Education (teacher training)

Apart from Science communication and Education, all specialised programmes are divided into two profiles:
1. The societal profile (M);
2. The research profile (O).

The programme is only available in a full time setting. The study load is 120 credit points (or study points = stp.) divided over 2 years (60 points per year). One credit point equals 28 hours of study (in conformity with the European Credit Transfer System, ECTS) and consists of actual participation in lectures and practical courses, preparation and other homework, doing fieldwork and writing of reports, studying for interim examinations. The study load of each of the course modules is stated at the course descriptions in this guide.

Further online information with respect to the Earth Sciences programme and course module descriptions can be found at: http://www.studiegids.vu.nl > Aard- en Levenswetenschappen > Earth Sciences.

3.1.2 Aim of the programme

The aim of the programme is to impart to the student the knowledge, skills and insight required to operate as an independent professional within the field of earth sciences and to be a suitable candidate for a subsequent course of study leading to a career in research.

3.2 Admission

3.2.1 Admission requirements to Earth Sciences

Students with a Bachelor degree in Earth Sciences from the Vrije Universiteit will receive direct admission to the Master's programme in Earth Sciences.
The four different BSc variants (Variant I: Geology, hydro(geo)logy; variant II: Physical geography, Quaternary geology, geo-ecology, hydro(geo)logy; variant III: Environmental sciences, and variant IV: Geoarchaeology) warrant admission to the following specialisations:

- Litosphere tectonics, petrology, and isotope geochemistry: BSc variant I.
- Sedimentary and structural geology, basin analysis, and surface processes: BSc variant I.
- Palaeoclimatology, palaeo-ecology, palaeo-oceanography: BSc variants I, II, and III.
- Quaternary geology, geo-ecology: BSc variant II.
- Archaeometry: BSc Geoarchaeology
- Landscape Archaeology: BSc Geoarchaeology
- Science communication: all BSc variants
- Education: all BSc variants (provided you have taken Sociale Geografie I (450099) and 12 stp. of "Oriëntatie op CE"- courses)

Students who do not receive *direct* admission to a certain Master's specialisation, because their BSc variant is not entirely appropriate for this specialisation, may still be admitted by a decision to that effect taken by the examing board. The examining board will, in such cases, make additional demands of the student before granting admission to the Master's programme.

Students who hold a certificate of higher vocational education (HBO) or an equivalent of a Vrije Universiteit BSc degree obtained at an institution inside or outside of the Netherlands may be admitted to the Master's programme in Earth Sciences on the basis of a decision to that effect taken by the examining board. The examining board will determine whether the qualification in question is sufficiently relevant to warrant admission. The examination board may make additional demands of the student before granting admission to the programme.

Participation in master courses without your BSc degree
The examination board may decide to admit the student to certain interim examinations of an MSc programme (specified in EER) even before he or she has successfully completed the BSc degree, provided that the student has accumulated at least 150 credit points within the appropriate BSc programme at the Vrije Universiteit.
The maximum period for which a student without a BSc degree can participate in components of the master's programme is 12 months, calculated from the beginning of the academic year.

3.3 Final attainment levels

3.3.1 What should you learn?

General desired learning outcomes
The graduate should:

- Have sufficient theoretical and practical knowledge of the Earth Sciences (respectively Geoarchaeology), notably within the field of his/her specialisation, to enable him/her to successfully complete a PhD thesis or to take up a position at an academic level with government or government-related institutions, with private companies, or elsewhere.
- Be experienced in carrying out research. This experience is gradually developed through the confrontation with research and with active researchers and subsequently through active participation in research, in a manner that enables the

student to consciously decide whether he/she prefers to continue his/her studies in order to obtain a PhD degree or to take up a position outside the academic world.
- Function in his/her discipline at an academic level, both mentally and in daily practice, and recognise the need to continue his/her education (the graduate is aware of the need to keep in touch with relevant developments within his/her discipline, and is prepared to realise this).
- Be able to successfully compete in the international labour market.

Functioning at an academic level implies
The graduate should be able:
- To independently collect information
- To select and structure information
- To independently and critically judge information
- Of reflection with regard to his/her personal thinking and learning
- To connect different types of factual information
- Of thinking within a multidisciplinary framework
- To formulate hypotheses and explanations
- To develop models suited for the testing of hypotheses
- To apply scientific knowledge to problems raised in society
- To clearly present information, both written and orally
- To recognise and to judge ethical aspects of science and of the application of science.

Desired learning outcomes related to the subject area
The graduate should be able:
- To function independently in a specialisation within the subject area.
- To get acquainted with one of the other specialisations within the subject area in the course of a few months
- To get acquainted within a reasonable time with a subject area within the discipline which is different from the one of the degree programme.
- To transfer knowledge and skills related to his/her subject area to other persons and to adequately reply to questions and problems posed within society.

Desired general learning outcomes
The graduate should be able:
- To collect and to critically compile the literature significant to a specific topic to be studied (either as a personal choice or as a task defined by teaching staff).
- To read and write publications and reports in Dutch or in English
- To formulate a problem based on raw data and/or data from the literature
- To design an approach to research a scientific problem which has been posed
- To complete, to supervise and/or to organise a comparatively simple empirical investigation
- To apply certain techniques, specific to the subject area
- To complete a report on trainee work, subject matter studied, or research carried out
- To lecture for colleagues from the same subject area on a topic that was independently studied
- To actively and constructively participate in discussions and meetings
- To work together with one or several colleagues.

The graduate should have an understanding of:

- The existence and significance of related subject areas
- The subject area's limits, i.e. realise that at a certain stage other expertise should be brought in, or that there is a need for interdisciplinary co-operation
- His/her personal stronger and weaker points, affinities, development potential and preferences in relation to the discipline chosen and the related professional potential.

3.4 Further study and career prospects

3.4.1 Orientation towards a career and the labour market

Spending part of your study in external traineeships and research projects is a good way to prepare for and familiarise yourself with the labour market. All programme components called 'Research project' and 'Master thesis' are subject to the Work placement and thesis regulations drawn up by the faculty. Please take note of these regulations and act accordingly.
The School of Earth and Environmental Sciences does not have a specific office or service mediating in external or internal traineeships and research projects. Students are advised to contact their study advisors/master co-ordinator or other staff members of faculty, as many of them will have elaborate contacts in trade and industry and external research institutes and universities.

In addition, orientation towards the labour market is much helped by so-called 'bedrijvendagen' (businesses' days), organised by GeoVUsie, and by attending seminars given by people from trade and industry, that are organised throughout the year at the faculty.

Each year, the 'Stichting Bèta Bedrijvencontactdag Amsterdam' (SBBA) organises a business contact day intended for MSc and PhD students in (bèta) Sciences at the Vrije Universiteit (VU) and the Universiteit van Amsterdam (UvA). This day is customarily organised in March or April and students receive an invitation, programme, and registration form beforehand. Businesses and companies present themselves and inform students about career perspectives, either at information booths or by plenary seminars. Students can also request a personal appointment with representatives of a certain company by sending in their cv. This may result in an invitation for a personal conversation at one of the 'gesprekkendagen' organised in May. More information on SBBA can be obtained at www.sbba.nl

3.4.2 Postgraduate degree programmes

After the doctoral or master degree programmes, there are opportunities to continue your educational career in a number of programmes at the Vrije Universiteit: PhD degree programmes (*AIO- or OIO-opleiding*), Teacher training programme Geography and a postgraduate programme in European Environmental Management.

PhD degree programmes
PhD-programmes are organised within a number of research schools:
- Inter University Centre for Geo-ecological Research (ICG)
- Netherlands Research School for the Socio-Economic and Natural Sciences of the Environment (SENSE)
- Research School Sedimentary Geology (NSG)

- School for Atmospheric and Maritime Research (SAMO).

The PhD programme always consists of carrying out a research project, leading to a PhD thesis/dissertation, and of several compulsory or elective course modules. For more information on PhD-programmes and Research Schools please refer the internet: www.falw.vu.nl > onderzoeksinstituten.

Teacher training programme Geography
Within the new bachelor-master programme structure, the certification of 'first grade' teacher in the Netherlands can be obtained through the Education specialisation of the MSc programme Earth Sciences.
Otherwise, students who already have an MSc or drs. certification in Physical Geography (or closely related programme in) are eligible to admission in the Teacher training programme Geography. This programme is taught in Dutch (see below).
Lerarenopleiding (60 stp.)
De inhoud van de opleiding is erop gericht dat studenten kennis en vaardigheden ontwikkelen voor een toekomstige baan als eerstegraads docent Aardrijkskunde. De opleiding kan voltijds en in deeltijd gevolgd worden. De cursus bestaat uit vijf onderdelen:

- stage op een school voor voortgezet onderwijs (30 stp.)
- clusterdidactiek gammavakken (9 stp.)
- vakdidactiek aardrijkskunde (9 stp.)
- praktijkonderzoek (8 stp.)
- vrije ruimte/keuzemodulen (4 stp.)

Tijdens de stage in het voortgezet onderwijs geeft de docent in opleiding (DIO) 120 uur zelfstandig les. Onder bepaalde voorwaarden kan een baan in het voortgezet onderwijs als stage gelden. Voor meer informatie kun je de studiegids van de lerarenopleiding van de VU raadplegen. Contactpersoon is dr. J.A. van der Schee, tel. (020) 444 9213, kamer 0G-12 (hoofdgebouw), e-mail: j.vanderschee@ond.vu.nl. De vakken Sociale geografie I (450099) en Sociale geografie II (450168) zijn verplicht voor studenten die de lerarenopleiding willen volgen.

European Post-graduate Course in Environmental Management (EPCEM)
This postgraduate course takes place at the Vrije Universiteit and is a one-year, fulltime course preparing experts for environmental problem solving with an interdisciplinary approach and an orientation to policy making. Participants who successfully complete the course are entitled to an advanced Master degree in environmental policy and management (MEM). More information is available at http://www.profetas.nl/epcem/index.html, of from the programme secretariat EPCEM, tel. (020) 444 9580.

3.5 Lithosphere tectonics, petrology, and isotope geochemistry

The programme Lithosphere tectonics, petrology, and isotope geochemistry consists of 45 credit points (stp.) of compulsory course modules, 45 credit points of core optional package modules, and 30 credit points of elective optional modules. Students should either choose core optional package A, or core optional package B.

3.5.1 Lithosphere tectonics, petrology, and isotope geochemistry (compulsory modules)

From the list below, choose only one Master Thesis for a research (O) or societal (M) profile respectively.

Course code	*Course name*	*Stp.*	*Period*
450108	Master Thesis Lithosphere Tectonics, Petrology, and Isotope Geochemistry (M-variant)	27	variable
450107	Master Thesis Lithosphere Tectonics, Petrology, and Isotope Geochemistry (O-variant)	27	variable
450013	Metamorphism	6	Periode 2
450053	Orogenesis	6	Period 4
450019	Tectonomorphology	6	Period 1

3.5.2 Lithosphere tectonics, petrology, and isotope geochemistry (core optional package A)

Course code	*Course name*	*Stp.*	*Period*
450005	Exogene Isotope Geochemistry: Proxies and Tracers in the Sedimentary Record	6	Period 1
450048	Exogene Isotope Geochemistry: Radiometric Dating Techniques	6	Period 4
450011	Magmatic Processes	6	Period 2
450109	Research Project Petrology and Isotope Geochemistry	27	Period 6

3.5.3 Lithosphere tectonics, petrology, and isotope geochemistry (core optional package B)

Course code	*Course name*	*Stp.*	*Period*
450016	Polyphase Deformation in Orogens and Forelands	6	Period 2
450056	Regional Basin Geology	6	Period 4
450110	Research Project Endogene Geology	27	Period 6
450018	Tectonics and Global Geophysics	6	Period 1

3.5.4 Lithosphere tectonics, petrology, and isotope geochemistry (elective options)

The scope for optional components (total 30 credit points) involves opting for components of the Master's programme not yet taken. As an alternative, the optional component may also be partly or completely fulfilled by taking components from other university Master's programmes. This alternative requires the prior permission of the examination board. Before granting permission, the examination board will evaluate the content and cohesion of the programme.
The optional component can also be partly or completely fulfilled by taking components not yet taken belonging to the Bachelor's programme in Earth Sciences at the Vrije Universiteit.
The scope for optional components can be fulfilled within the Master's programme in Earth Sciences by extending the Master's thesis requirement which exists within the

various Master's specialisations by 12 credits. This extension is registered separately by the course secretariat as course component 450149 - 'Extension of Master's thesis in Earth Sciences'.
Please also refer to the list of elective course modules at the end of this chapter.

3.6 Sedimentary and structural geology, basin analysis, and surface processes

The programme Sedimentary and structural geology, basin analysis and surface processes consists of 51 credit points of compulsory course modules, 39 credit points of core optional package modules, and 30 credits points of elective optional modules. Students should either choose core optional package A, or core optional package B.

3.6.1 Sedimentary and structural geology, basin analysis, and surface processes (compulsory modules)

From the list below, choose only one Master Thesis for a research (O) or societal (M) profile respectively.

Course code	*Course name*	*Stp.*	*Period*
450112	Master Thesis Sedimentary and Structural Geology, Basin Analysis, and Surface Processes (M-variant)	27	variable
450111	Master Thesis Sedimentary and Structural Geology, Basin Analysis, and Surface Processes (O-variant)	27	variable
450056	Regional Basin Geology	6	Period 4
450017	Sedimentology for Masters	6	Period 2
450059	Simple and Applied Reflection Seismics	6	Period 4
450019	Tectonomorphology	6	Period 1

3.6.2 Sedimentary and structural geology, basin analysis, and surface processes (core optional package A)

Course code	*Course name*	*Stp.*	*Period*
450016	Polyphase Deformation in Orogens and Forelands	6	Period 2
450113	Research Project Structural Geology and Tectonics	27	Period 6
450018	Tectonics and Global Geophysics	6	Period 1

3.6.3 Sedimentary and structural geology, basin analysis, and surface processes (core optional package B)

From the list below, choose only one of the two Research Projects.

Course code	*Course name*	*Stp.*	*Period*
450005	Exogene Isotope Geochemistry: Proxies and Tracers in the Sedimentary Record	6	Period 1
450012	Marine Geology	6	Period 2
450115	Research Project Marine Geology	27	Period 6
450114	Research Project Sedimentology	27	Period 6

3.6.4 Sedimentary and structural geology, basin analysis, and surface processes (elective options)

The scope for optional components (total 30 credit points) involves opting for components of the Master's programme not yet taken. As an alternative, the optional component may also be partly or completely fulfilled by taking components from other university Master's programmes. This alternative requires the prior permission of the examination board. Before granting permission, the examination board will evaluate the content and cohesion of the programme.
The optional component can also be partly or completely fulfilled by taking components not yet taken belonging to the Bachelor's programme in Earth Sciences at the Vrije Universiteit.
The scope for optional components can be fulfilled within the Master's programme in Earth Sciences by extending the Master's thesis requirement which exists within the various Master's specialisations by 12 credits. This extension is registered separately by the course secretariat as course component 450149 - 'Extension of Master's thesis in Earth Sciences'.
Please also refer to the list of elective course modules at the end of this chapter.

3.7 Palaeoclimatology/palaeo-ecology/palaeo-oceanography

The programme Palaeoclimatology, palaeo-ecology, and palaeo-oceanography consists of 90 credit points (stp.) of compulsory course modules and 30 credit points of elective optional modules.

3.7.1 Palaeoclimatology/palaeo-ecology/palaeo-oceanography (compulsory modules)

From the list below, choose one Master Thesis for a research (O) or societal (M) profile respectively.

Course code	*Course name*	*Stp.*	*Period*
450044	Advanced Paleo-Oceanography and Sea-level Change	6	Period 4
450004	Climate Modelling	6	Period 1
450005	Exogene Isotope Geochemistry: Proxies and Tracers in the Sedimentary Record	6	Period 1
450048	Exogene Isotope Geochemistry: Radiometric Dating Techniques	6	Period 4
450118	Master Thesis Paleoclimatology/Paleo-ecology/Paleo-oceanography (M-variant)	27	variable
450117	Master Thesis Paleoclimatology/Paleo-ecology/Paleo-oceanography (O-variant)	27	variable
450015	Paleo-ecological Environments	6	Period 2
450116	Research Project Paleo-climatology/Paleo-ecology/Paleo-oceanography	27	Period 6
450017	Sedimentology for Masters	6	Period 2

3.7.2 Palaeoclimatology/palaeo-ecology/palaeo-oceanography (elective options)

The scope for optional components (total 30 credit points) involves opting for components of the Master's programme not yet taken. As an alternative, the optional component may also be partly or completely fulfilled by taking components from

other university Master's programmes. This alternative requires the prior permission of the examination board. Before granting permission, the examination board will evaluate the content and cohesion of the programme.
The optional component can also be partly or completely fulfilled by taking components not yet taken belonging to the Bachelor's programme in Earth Sciences at the Vrije Universiteit.
The scope for optional components can be fulfilled within the Master's programme in Earth Sciences by extending the Master's thesis requirement which exists within the various Master's specialisations by 12 credits. This extension is registered separately by the course secretariat as course component 450149 - 'Extension of Master's thesis in Earth Sciences'.
Please refer to the list of elective course modules at the end of this chapter.

3.8 Quaternary geology/geo-ecology

The programme Quaternary geology and geo-ecology consists of 84 credit points (stp.) of compulsory course modules, 6 credit points of core optional package modules, and 30 credit points of elective optional modules.

3.8.1 Quaternary geology/geo-ecology (compulsory modules)

From the list below, choose only one Master Thesis for a research (O) or societal (M) profile respectively.

Course code	***Course name***	***Stp.***	***Period***
450001	Advanced Spatial Analysis Techniques	6	Period 1
450004	Climate Modelling	6	Period 1
450048	Exogene Isotope Geochemistry: Radiometric Dating Techniques	6	Period 4
450049	Geo-ecological Environments	6	Period 4
450121	Master Thesis Quaternary Geology/ Geo-ecology (M-variant)	27	variable
450120	Master Thesis Quaternary Geology/ Geo-ecology (O-variant)	27	variable
450015	Paleo-ecological Environments	6	Period 2
450119	Research Project Quaternary Geology/Geo-ecology	27	Period 6

3.8.2 Quaternary geology/geo-ecology (core optional package)

Choose one of the two course modules listed below.

Course code	***Course name***	***Stp.***	***Period***
450014	Ecohydrology	6	Period 2
450021	Unsaturated Zone and Near Surface Hydrological Processes	6	Period 2

3.8.3 Quaternary geology/geo-ecology (elective options)

The scope for optional components (total 30 credit points) involves opting for components of the Master's programme not yet taken. As an alternative, the optional component may also be partly or completely fulfilled by taking components from other university Master's programmes. This alternative requires the prior permission

of the examination board. Before granting permission, the examination board will evaluate the content and cohesion of the programme.
The optional component can also be partly or completely fulfilled by taking components not yet taken belonging to the Bachelor's programme in Earth Sciences at the Vrije Universiteit. The scope for optional components can be fulfilled within the Master's programme in Earth Sciences by extending the Master's thesis requirement which exists within the various Master's specialisations by 12 credits. This extension is registered separately by the course secretariat as course component 450149 - 'Extension of Master's thesis in Earth Sciences'.
Please also refer to the list of elective course modules at the end of this chapter.

3.9 Archaeometry

The programme Archaeometry consists of 93 credit points (stp.) of compulsory course modules and 27 credit points of elective optional modules.

3.9.1 Archaeometry (compulsory modules)

The following list constitutes the compulsory programme of Archaeometry. Choose only one Master Thesis for a research (O) or societal (M) profile respectively.

Course code	***Course name***	***Stp.***	***Period***
450001	Advanced Spatial Analysis Techniques	6	Period 1
450289	Archaeometry III (Analytical Methods)	6	Period 5
450291	Biological Archaeometry	6	Period 2
450294	Capita Selecta Geoarchaeology (Introduction Nikopolis)	3	Period 3
450005	Exogene Isotope Geochemistry: Proxies and Tracers in the Sedimentary Record	6	Period 1
450052	Hydrochemistry	6	Period 4
450299	Master Thesis Archaeometry (M-variant)	27	variable
450300	Master Thesis Archaeometry (O-variant)	27	variable
450296	Research Project Archaeometry	27	Period 6
450017	Sedimentology for Masters	6	Period 2

3.9.2 Archaeometry (elective options)

The scope for optional components (total 27 credit points) involves opting for components of the Master's programme not yet taken. As an alternative, the optional component may also be partly or completely fulfilled by taking components from other university Master's programmes. This alternative requires the prior permission of the examination board. Before granting permission, the examination board will evaluate the content and cohesion of the programme.
The optional component can also be partly or completely fulfilled by taking components not yet taken belonging to the Bachelor's programmes in Earth Sciences or Archaeology at the Vrije Universiteit. The scope for optional components can be fulfilled within the Master's programme in Earth Sciences by extending the Master's thesis requirement which exists within the various Master's specialisations by 12 credits. This extension is registered separately by the course secretariat as course component 450302 - 'Extension of Master's thesis in Archaeometry'.
Please refer to the list of elective course modules below. Additional elective courses may be organised in due course. Please check with Prof. Kars for latest developments and options.

Course code	*Course name*	*Stp.*	*Period*
450293	Advanced Geophysical Prospection	3	yet unknown
450305	Archaeobotany	3	yet unknown
450306	Archaeozoology	3	yet unknown
450302	Extension Master Thesis Archaeometry	12	variable
450049	Geo-ecological Environments	6	Period 4
450058	Sediment Petrography of Heavy Minerals	3	Period 3

3.10 Landscape archaeology

The programme Landscape archaeology consists of 90 credit points (stp.) of compulsory course modules and 30 credit points of elective optional modules.

3.10.1 Landscape archaeology (compulsory modules)

The following list constitutes the compulsory programme of Landscape Archaeology. Choose only one Master Thesis for a research (O) or societal (M) profile respectively.

Course code	*Course name*	*Stp.*	*Period*
450001	Advanced Spatial Analysis Techniques	6	Period 1
450291	Biological Archaeometry	6	Period 2
450294	Capita Selecta Geoarchaeology (Introduction Nikopolis)	3	Period 3
450094	Geobotanie (plantkunde)	6	Periode 5
450292	Historical Geography	6	Period 1
450297	Master Thesis Landscape Archaeology (M-variant)	27	variable
450298	Master Thesis Landscape Archaeology (O-variant)	27	variable
450054	Palaeo-ecology/Palynology	3	Period 3
450015	Paleo-ecological Environments	6	Period 2
450295	Research Project Landscape Archaeology	27	Period 6

3.10.2 Landscape archeaology (elective options)

The scope for optional components (total 30 credit points) involves opting for components of the Master's programme not yet taken. As an alternative, the optional component may also be partly or completely fulfilled by taking components from other university Master's programmes. This alternative requires the prior permission of the examination board. Before granting permission, the examination board will evaluate the content and cohesion of the programme.
The optional component can also be partly or completely fulfilled by taking components not yet taken belonging to the Bachelor's programme in Earth Sciences or Archaeology at the Vrije Universiteit. The scope for optional components can be fulfilled within the Master's programme in Earth Sciences by extending the Master's thesis requirement which exists within the various Master's specialisations by 12 credits. This extension is registered separately by the course secretariat as course component 450301 - 'Extension of Master's thesis in Landscape archaeology'.
Please refer to the list of elective course modules below. Additional elective courses may be organised in due course. Please check with Prof. Kars for latest developments and options.

Course code	*Course name*	*Stp.*	*Period*
450305	Archaeobotany	3	yet unknown
450306	Archaeozoology	3	yet unknown
450005	Exogene Isotope Geochemistry: Proxies and Tracers in the Sedimentary Record	6	Period 1
450301	Extension Master Thesis Landscape Archaeology	12	variable
450049	Geo-ecological Environments	6	Period 4
450052	Hydrochemistry	6	Period 4
450058	Sediment Petrography of Heavy Minerals	3	Period 3

3.11 Science communication

The two-year master programme Science communication (C-variant) basically consists of one year of further education and specialisation in Earth Sciences and one year of specific communication training. It is recommended not to try to take both earth scientific and C-courses within one year, as programme schedules are not compatible. C-courses are shared with master students from the School for Life Sciences, and from the Faculty of Sciences. The C programme (60 credit points) is taught in Dutch.

3.11.1 Earth Sciences/ Geography (compulsory modules)

The programme of Earth Sciences (minimum of 60 credit points) should at least contain an Earth Sciences Research Project (4501XX). All other course modules (total 33 stp.) are considered elective options and can be chosen from the various master's degree programmes of the School for Earth and Environmental Sciences.

Course code	*Course name*	*Stp.*	*Period*
450XXX	Research Project Earth Sciences	27	Period 6

3.11.2 Communication (compulsory modules)

The C-programme consists of the following compulsory course modules. In addition to these, students complete their programme with a compulsory Report (Scriptie, 9 stp.) and a Work Placement (Stage, 18 stp.) with variable course codes. The entire programme thus consists of 60 stp.

Course code	*Course name*	*Stp.*	*Period*
471027	Communicatie en educatie via internet	3	15.11.2004 - 26.11.2004
471006	Communicatiewetenschappen	6	06.09.2004 - 01.10.2004
471015	Information Representation/ Multimedia 1	6	10.01.2005 - 04.02.2004
991000	Interpersoonlijke communicatie	3	01-11-2004 / 12-11-2004
471026	Museologie en buitenschoolse educatie	6	29.11.2004 - 24.12.2004
471025	Popular Science Writing	3	07.02.2005 - 8.02.2005
471014	Wetenschapsjournalistiek	6	04.10.2004 - 29.10.2004

3.12 Education (teacher training)

The two-year master programme Education (E-variant) basically consists of one year of further education and specialisation in Earth Sciences and one year of specific teacher training. It is recommended not to try to take both earth scientific and E-courses within one course year, as programme schedules may not be not compatible. E-courses are shared with master students from the School for Life Sciences, and from the Faculty of Sciences. The E-programme (60 credit points) is taught in Dutch.

3.12.1 Earth Sciences programme

The programme of Earth Sciences (minimum of 60 credit points) should at least contain an Earth Sciences Research Project (4501XX) and two other compulsory modules listed below. The remainder of the programme (total 15 stp.) is to be filled with elective options which can be chosen from the various master's degree programmes of the School for Earth and Environmental Sciences.

Course code	***Course name***	***Stp.***	***Period***
450049	Geo-ecological Environments	6	Period 4
450XXX	Research Project Earth Sciences	27	Period 6
450168	Sociale geografie II	12	Ter eigen keuze

3.12.2 Educational programme (lerarenopleiding Aardrijkskunde)

The educational programme is taught in Dutch and consists of 60 stp. of compulsory modules.

Course code	***Course name***	***Stp.***	***Period***
990001	Algemene didactiek / pedagogiek 1 en 2	9	30-08-2004 / 31-08-2005
990004	Keuzemodulen	4	
990002	Praktijk 1 en 2	30	30-08-2004 / 31-08-2005
990003	Praktijkonderzoek	8	
990000	Vakdidactiek 1 en 2	9	30-08-2004 / 31-08-2005

3.13 Elective options

Course modules listed below are considered elective optional modules of the various MSc programmes of the School of Earth and Environmental Sciences. Students can choose from any of these courses within their free elective programmes.

Elective options			
Course code	***Course name***	***Stp.***	***Period***
450293	Advanced Geophysical Prospection	3	yet unknown
450045	Analogue Modelling of Tectonic Processes	2	Period 3
450142	Applied Geophysical Analysis	3	variable
450137	Aquatic Ecology	6	04.10.2004 - 29.10.2004
450305	Archaeobotany	3	yet unknown
450306	Archaeozoology	3	yet unknown
450134	Capita Selecta Event Stratigraphy	6	Period 2

450144	Capita Selecta Structural Geology and Tectonics	2	Period 4
450133	Contaminant Hydrogeology	3	Period 5
450047	Environmental Management in River Basins and Coastal Lowlands	6	Period 5
450147	Environmental Mineralogy	3	Period 2
470055	Evolutie van de mens	6	10.01.2005 - 04.02.2005
450302	Extension Master Thesis Archaeometry	12	variable
450301	Extension Master Thesis Landscape Archaeology	12	variable
450149	Extension Master Thesis in Earth Sciences	12	variable
450150	Extension Master Thesis in Geo-environmental Sciences	12	variable
450151	Extension Master Thesis in Hydrology	12	variable
450287	Field Course Applied Geology	6	Period 5
450152	Field Course Endogene Geology	6	Period 5
450153	Field Course Sedimentology/Structural Geology	6	Period 5
450304	Geobiology	6	Period 5
450132	Geomicrobiology / Groundwater Microbiology and Geochemistry	6	Period 1
450050	Geotechnics	6	Period 5
450148	Isotope Hydrology	3	Period 5
450155	Land Husbandry	3	Period 3
450167	Magmatic Processes Capita Selecta (Melt Inclusions)	3	Period 1 and 2
450158	Microstructures in Tectonites	6	Period 4
201796	Milieurecht (B3/M)	6	06 / 15
450161	Numerical Modelling in Tectonics	6	Period 5
450159	Ore Microscopy	3	Period 1
450162	Ore Petrology	3	Period 1
450054	Palaeo-ecology/Palynology	3	Period 3
450055	Petroleum Systems	2	Period 3
450164	Precambrian Geology	3	Period 3
450165	Remote Sensing in Hydrology	6	Period 4
450058	Sediment Petrography of Heavy Minerals	3	Period 3
450160	Spatial Variability and Multivariate Statistical Analyses	6	Period 2
470045	Toegepaste ecologie	6	01.11.2004 - 26.11.2004
450131	Transport Processes in Groundwater	6	Period 3
450286	Veldexcursie ecosystemen Ardennen	2	Periode 5
450061	Volcanism	3	Period 3

3.14 Inter faculty elective options

Inter faculty elective options (see below) are not part of the approved master's degree programmes, but may be added to your individual programme with prior permission of the examining board.

Course code	***Course name***	***Stp.***	***Period***
520160	Ges es: 3e j. wc: Natuur en vooruitgang 1500-2000	10	Periode 4 en 5
60000010	Ontwikkelingsvraagstukken (interfacultair)	6	Periode 1, 2, 3 en 4

4 Hydrology

4.1 Introduction

4.1.1 The programme and its specialisations

The MSc programme Hydrology is subdivided into two different specialisations, each with their own educational programmes. The two specialisations are:

- Hydrogeology
- Ecohydrology

Both specialisation programmes are divided into two profiles:
1. The societal profile (M);
2. The research profile (O).

The programme is only available in a full time setting. The study load is 120 credit points (study points = stp.) divided over 2 years (60 points per year). One credit point equals 28 hours of study (in conformity with the European Credit Transfer System, ECTS) and consists of actual participation in lectures and practical courses, preparation and other homework, doing fieldwork and writing of reports, studying for interim examinations. The study load of each of the course modules is stated at the course descriptions in this guide.

Further online information with respect to the Hydrology programme and course module descriptions can be found at: http://www.studiegids.vu.nl > Aard- en Levenswetenschappen > Hydrology.

4.1.2 Aim of the programme

The aim of the programme is to impart to the student the knowledge, skills and insight required to operate as an independent professional within the field of hydrology and to be a suitable candidate for a subsequent course of study leading to a career in research.

4.2 Admission

4.2.1 Admission requirements to Hydrology

Students with a Bachelor degree in Earth Sciences from the Vrije Universiteit will receive direct admission to the Master's programme in Hydrology.

Students who hold a certificate of higher vocational education (HBO) or an equivalent of a Vrije Universiteit BSc degree obtained at an institution inside or outside of the Netherlands may be admitted to the Master's programme in Hydrology on the basis of a decision to that effect taken by the examining board. The examining board will determine whether the qualification in question is sufficiently relevant to warrant admission. The examination board may make additional demands of the student before granting admission to the programme.

Participation in master courses without your BSc degree

The examination board may decide to admit the student to certain interim examinations of the MSc programme (specified in EER) even before he or she has

successfully completed the BSc degree, provided that the student has accumulated at least 150 credit points within the BSc programme at the Vrije Universiteit.
The maximum period for which a student without a BSc degree can participate in components of the master's programme is 12 months, calculated from the beginning of the academic year.

4.3 Final attainment levels

4.3.1 What should you learn?

General desired learning outcomes

The graduate disposes of an academic attitude and of academic skills. This implies the graduate's ability to:

- Independently collect information in the field of hydrology, and to analyse and critically evaluate this information;
- Select and structure information, to discern between primary and secondary elements, and to recognise and define connections;
- Think in a multidisciplinary manner and to recognise disciplines and sub-disciplines that are of importance in relation to the subject area;
- Independently and critically judge research, both with regard to its design and its effectuation and results;
- Design a research plan, including the description of the design, the realisation and the analysis of the research;
- Clearly present information, both written and orally, in English and also, for native speakers, in Dutch;
- Apply scientific knowledge to problems raised in society;
- Contribute to scientific discussions related to research development or the evaluation of research results;
- Evaluate personal functioning, both through self-reflection and by discussions with other persons;
- Reflect on ethical aspects of (applied) scientific research and to include such considerations in decision-making.

Knowledge

The graduate should:

- Have mastered the apparatus of understanding, and overview the present situation with regard to the development of theory in the field of hydrology, together with an understanding of today's leading research questions in this particular field;
- Command the major hydrological methodologies, including transport models as well as discharge-generation models and soil-vegetation-atmosphere transfer models (SVATs);
- Understand the position of the hydrological discipline within the natural and engineering sciences;
- Be acquainted with both scientific journals of a general nature (Science, Nature) and specialised hydrological journals;
- Understand the scientific and societal relevance of hydrology and of the present hydrological research;
- Command mathematics, statistical methods, and physics and/or chemistry to an extent that matches the present state of hydrological research.

Skills
The graduate should:
- Be able to understand and compile scientific hydrological literature;
- Be able to design and conduct hydrological (field) experiments;
- Be able to work jointly with scientists from other disciplines;
- Command relevant methods in the field of information and communication technology.

4.4 Further study and career prospects

4.4.1 Orientation towards a career and the labour market

Spending part of your study in external traineeships and research projects is a good way to prepare for and familiarise yourself with the labour market. All programme components called 'Research project' and 'Master thesis' are subject to the Work placement and thesis regulations drawn up by the faculty. Please take note of these regulations and act accordingly.
The School of Earth and Environmental Sciences does not have a specific office or service mediating in external or internal traineeships and research projects. Students are advised to contact their study advisors (see previous chapter under 'Student facilities' and 'Study support and guidance') or other staff members of faculty, as many of them will have elaborate contacts in trade and industry and external research institutes and universities.

In addition, orientation towards the labour market is much helped by so-called 'bedrijvendagen' (businesses' days), organised by GeoVUsie, and by attending seminars given by people from trade and industry, that are organised throughout the year at the faculty.

Each year, the 'Stichting Bèta Bedrijvencontactdag Amsterdam' (SBBA) organises a business contact day intended for MSc and PhD students in (bèta) Sciences at the Vrije Universiteit (VU) and the Universiteit van Amsterdam (UvA). This day is customarily organised in March or April and students should receive an invitation, programme, and registration form beforehand. Businesses and companies present themselves and inform students about career perspectives, either at information booths or by plenary seminars. Students can also request a personal appointment with representatives of a certain company by sending in their cv. This may result in an invitation for a personal conversation at one of the 'gesprekkendagen' organised in May. More information on SBBA can be obtained at www.sbba.nl

4.4.2 Postgraduate degree programmes

After the doctoral or master degree programmes, there are opportunities to continue your educational career in a number of programmes at the Vrije Universiteit: PhD degree programmes (*AIO- or OIO-opleiding*) and a postgraduate programme in European Environmental Management.

PhD degree programmes
PhD-programmes are organised within a number of research schools:
- Inter University Centre for Geo-ecological Research (ICG)
- Netherlands Research School for the Socio-Economic and Natural Sciences of the Environment (SENSE)

- Research School Sedimentary Geology (NSG)
- School for Atmospheric and Maritime Research (SAMO).

The PhD programme always consists of carrying out a research project, leading to a PhD thesis/dissertation, and of several compulsory or elective course modules. For more information on PhD-programmes and Research Schools please refer the internet: http://www.falw.vu.nl > onderzoeksinstituten.

European Post-graduate Course in Environmental Management (EPCEM)
This postgraduate course takes place at the Vrije Universiteit and is a one-year, fulltime course preparing experts for environmental problem solving with an interdisciplinary approach and an orientation to policy making. Participants who successfully complete the course are entitled to an advanced Master degree in environmental policy and management (MEM). More information is available at http://www.profetas.nl/epcem/index.html, of from the programme secretariat EPCEM, tel. (020) 444 9580.

4.5 Hydrogeology

The programme Hydrogeology consists of 90 credit points (stp.) of compulsory course modules, 12 credit points of core optional modules, and 18 credits points of elective optional modules.

4.5.1 Hydrogeology (compulsory modules)

From the compulsory programme below, choose one Master Thesis for a research (O) or societal (M) profile respectively.

Course code	***Course name***	***Stp.***	***Period***
450003	Catchment Response Analysis	6	Period 1
450128	Field Course Algarve, Portugal	3	Period 6
450126	Field Course Netherlands (Measurements Techniques)	3	Period 5
450127	Field Course North Italy (hydrology)	9	Period 6
450008	Groundwater Flow Modelling	6	Period 2
450009	Groundwater Hydraulics	6	Period 1
450052	Hydrochemistry	6	Period 4
450123	Master Thesis Hydrogeology (M-variant)	27	variable
450122	Master Thesis Hydrogeology (O-variant)	27	variable
450057	Regional Hydrogeology and Groundwater Management	6	Period 4
450129	Thematic Research Project Hydrology	12	variable
450021	Unsaturated Zone and Near Surface Hydrological Processes	6	Period 2

4.5.2 Hydrogeology (core options)

From the list below, choose a minimum of 12 credit points.

Course code	***Course name***	***Stp.***	***Period***
450132	Geomicrobiology / Groundwater Microbiology and Geochemistry	6	Period 1
450148	Isotope Hydrology	3	Period 5

450165	Remote Sensing in Hydrology	6	Period 4
450131	Transport Processes in Groundwater	6	Period 3

4.5.3 Hydrogeology (elective options)

The scope for optional components (total 18 credit points) involves opting for components of the Master's programme not yet taken. As an alternative, the optional component may also be partly or completely fulfilled by taking components from other university Master's programmes. This alternative requires the prior permission of the examination board. Before granting permission, the examination board will evaluate the content and cohesion of the programme.
The optional component can also be partly or completely fulfilled by taking components not yet taken belonging to the Bachelor's programme in Earth Sciences at the Vrije Universiteit.
The scope for optional components can be fulfilled within the MSc programme in Earth Sciences by extending the Master's thesis requirement which exists within the various Master's specialisations by 12 credits. This extension is registered separately by the course secretariat as course component 450151 - 'Extension of Master's thesis in Hydrology'.
Please refer to the list of elective course modules at the back of this chapter.

4.6 Ecohydrology

The programme Ecohydrology consists of 90 credit points of compulsory course modules, 12 credit points of core optional modules, and 18 credits points of elective optional modules.

4.6.1 Ecohydrology (compulsory modules)

From the complusory programme below, choose one Master Thesis for a research (O) or societal (M) profile respectively.

Course code	***Course name***	***Stp.***	***Period***
450003	Catchment Response Analysis	6	Period 1
450014	Ecohydrology	6	Period 2
450128	Field Course Algarve, Portugal	3	Period 6
450126	Field Course Netherlands (Measurements Techniques)	3	Period 5
450127	Field Course North Italy (hydrology)	9	Period 6
450009	Groundwater Hydraulics	6	Period 1
450052	Hydrochemistry	6	Period 4
450125	Master Thesis Ecohydrology (M-variant)	27	variable
450124	Master Thesis Ecohydrology (O-variant)	27	variable
450060	Soil Vegetation Atmosphere Exchange	6	Period 4
450135	Thematic Research Project Ecohydrology	12	
450021	Unsaturated Zone and Near Surface Hydrological Processes	6	Period 2

4.6.2 Ecohydrology, (core options)

From the core options list below, choose 12 credit points.

Course code	***Course name***	***Stp.***	***Period***
450001	Advanced Spatial Analysis Techniques	6	Period 1

450137	Aquatic Ecology	6	04.10.2004 - 29.10.2004
450008	Groundwater Flow Modelling	6	Period 2

4.6.3 Ecohydrology, (elective options)

The scope for optional components (total 18 credit points) involves opting for components of the Master's programme not yet taken. As an alternative, the optional component may also be partly or completely fulfilled by taking components from other university Master's programmes. This alternative requires the prior permission of the examination board. Before granting permission, the examination board will evaluate the content and cohesion of the programme.
The optional component can also be partly or completely fulfilled by taking components not yet taken belonging to the Bachelor's programme in Earth Sciences at the Vrije Universiteit.
The scope for optional components can be fulfilled within the MSc programme in Hydrology by extending the Master's thesis requirement which exists within the various Master's specialisations by 12 credits. This extension is registered separately by the course secretariat as course component 450151 - 'Extension of Master's thesis in Hydrology'.
Please refer to the list of elective course modules at the back of this chapter.

4.7 Elective options

Course modules listed below are considered elective optional modules of the various MSc programmes of the School of Earth and Environmental Sciences. Students can choose from any of these courses within their free elective programmes.

Elective options			
Course code	***Course name***	***Stp.***	***Period***
450293	Advanced Geophysical Prospection	3	yet unknown
450045	Analogue Modelling of Tectonic Processes	2	Period 3
450142	Applied Geophysical Analysis	3	variable
450137	Aquatic Ecology	6	04.10.2004 - 29.10.2004
450305	Archaeobotany	3	yet unknown
450306	Archaeozoology	3	yet unknown
450134	Capita Selecta Event Stratigraphy	6	Period 2
450144	Capita Selecta Structural Geology and Tectonics	2	Period 4
450133	Contaminant Hydrogeology	3	Period 5
450047	Environmental Management in River Basins and Coastal Lowlands	6	Period 5
450147	Environmental Mineralogy	3	Period 2
470055	Evolutie van de mens	6	10.01.2005 - 04.02.2005
450302	Extension Master Thesis Archaeometry	12	variable
450301	Extension Master Thesis Landscape Archaeology	12	variable
450149	Extension Master Thesis in Earth Sciences	12	variable
450150	Extension Master Thesis in Geo-environmental Sciences	12	variable
450151	Extension Master Thesis in Hydrology	12	variable
450287	Field Course Applied Geology	6	Period 5

450152	Field Course Endogene Geology	6	Period 5
450153	Field Course Sedimentology/Structural Geology	6	Period 5
450304	Geobiology	6	Period 5
450132	Geomicrobiology / Groundwater Microbiology and Geochemistry	6	Period 1
450050	Geotechnics	6	Period 5
450148	Isotope Hydrology	3	Period 5
450155	Land Husbandry	3	Period 3
450167	Magmatic Processes Capita Selecta (Melt Inclusions)	3	Period 1 and 2
450158	Microstructures in Tectonites	6	Period 4
201796	Milieurecht (B3/M)	6	06 / 15
450161	Numerical Modelling in Tectonics	6	Period 5
450159	Ore Microscopy	3	Period 1
450162	Ore Petrology	3	Period 1
450054	Palaeo-ecology/Palynology	3	Period 3
450055	Petroleum Systems	2	Period 3
450164	Precambrian Geology	3	Period 3
450165	Remote Sensing in Hydrology	6	Period 4
450058	Sediment Petrography of Heavy Minerals	3	Period 3
450160	Spatial Variability and Multivariate Statistical Analyses	6	Period 2
470045	Toegepaste ecologie	6	01.11.2004 - 26.11.2004
450131	Transport Processes in Groundwater	6	Period 3
450286	Veldexcursie ecosystemen Ardennen	2	Periode 5
450061	Volcanism	3	Period 3

5 Geo-environmental Sciences

5.1 Introduction

5.1.1 The programme

The MSc programme Geo-environmental Sciences consists of only one specialisation programme:

- Geo-ecosystems and climate

The programme is divided into two profiles:
1. The societal profile (M);
2. The research profile (O).

The programme is only available in a full time setting. The study load is 120 credit points (study points = stp.) divided over 2 years (60 points per year). One credit point equals 28 hours of study (in conformity with the European Credit Transfer System, ECTS) and consists of actual participation in lectures and practical courses, preparation and other homework, doing fieldwork and writing of reports, studying for interim examinations. The study load of each of the course modules is stated at the course descriptions in this guide.

Further online information with respect to the Geo-environmental Sciences programme and course module descriptions can be found at: http://www.studiegids.vu.nl > Aard- en Levenswetenschappen > Geo-environmental Sciences.

5.1.2 Aim of the programme

The aim of the programme is to impart to the student the knowledge, skills and insight required to operate as an independent professional within the field of geo-environmental sciences and to be a suitable candidate for a subsequent course of study leading to a career in research.

5.2 Admission

5.2.1 Admission requirements to Geo-environmental Sciences

Students with a Bachelor degree in Earth Sciences (variant II (Physical geography, Quaternary geology, geo-ecology, hydro(geo)logy) and variant III (Environmental Sciences)) from the Vrije Universiteit will receive direct admission to the Master's programme in Geo-environmental Sciences.

Students who do not receive *direct* admission to a certain Master's specialisation, because their BSc variant is not entirely appropriate for this specialisation, may still be admitted by a decision to that effect taken by the examing board. The examining board will, in such cases, make additional demands of the student before granting admission to the Master's programme.

Students who hold a certificate of higher vocational education (HBO) or an equivalent of a Vrije Universiteit BSc degree obtained at an institution inside or outside of the Netherlands may be admitted to the Master's programme in Geo-

environmental Sciences on the basis of a decision to that effect taken by the examining board. The examining board will determine whether the qualification in question is sufficiently relevant to warrant admission. The examination board may make additional demands of the student before granting admission to the programme.

Participation in master courses without your BSc degree
The examination board may decide to admit the student to certain interim examinations of the MSc programme (specified in EER) even before he or she has successfully completed the BSc degree, provided that the student has accumulated at least 150 credit points within the appropriate BSc programme at the Vrije Universiteit.
The maximum period for which a student without a BSc degree can participate in components of the master's programme is 12 months, calculated from the beginning of the academic year.

5.3 Final attainment levels

5.3.1 What should you learn?

General desired learning outcomes

The graduate disposes of an academic attitude and of academic skills. This implies the graduate's ability to:

- Independently collect information in the field of geo-environmental sciences, and to analyse and critically evaluate this information;
- Select and structure information, to discern between primary and secondary elements, and to recognise and define connections;
- Think in a multidisciplinary manner and to recognise disciplines and sub-disciplines that are of importance in relation to the subject area;
- Independently and critically judge research, both with regard to its design and its effectuation and results;
- Design a research plan, including the description of the design, the realisation and the analysis of the research;
- Clearly present information, both written and orally, in English and also, for native speakers, in Dutch;
- Apply scientific knowledge to problems raised in society;
- Contribute to scientific discussions related to research development or the evaluation of research results;
- Evaluate personal functioning, both through self-reflection and by discussions with other persons;
- Reflect on ethical aspects of (applied) scientific research and to include such considerations in decision-making.

Knowledge

The graduate should:

- Have mastered the apparatus of understanding, and overview the present situation with regard to the development of theory in the geo-environmental sciences, together with an understanding of today's leading research questions in this particular field;
- Command the major relevant methodologies, including transport models as well as discharge-generation models and soil-vegetation-atmosphere transfer models (SVATs);

- Understand the position of the geo-environmental sciences within the natural sciences;
- Be acquainted with both scientific journals of a general nature (Science, Nature) and specialised journals in the field of environmental science;
- Understand the scientific and societal relevance of the geo-environmental sciences and of the present research in this field;
- Command mathematics, statistical methods and physics and/or chemistry to an extent that matches the present state of geo-environmental research.

Skills
The graduate should:
- Be able to understand and compile scientific geo-environmental literature;
- Be able to design and conduct geo-environmental (field) experiments;
- Be able to work jointly with scientists from other disciplines;
- Command relevant methods in the field of information and communication technology.

5.4 Further study and career prospects

5.4.1 Orientation towards a career and the labour market

Spending part of your study in external traineeships and research projects is a good way to prepare for and familiarise yourself with the labour market. All programme components called 'Research project' and 'Master thesis' are subject to the Work placement and thesis regulations drawn up by the faculty. Please take note of these regulations and act accordingly.
The School of Earth and Environmental Sciences does not have a specific office or service mediating in external or internal traineeships and research projects. Students are advised to contact their study advisors (see previous chapter under 'Student facilities' and 'Study support and guidance') or other staff members of faculty, as many of them will have elaborate contacts in trade and industry and external research institutes and universities.

In addition, orientation towards the labour market is much helped by so-called 'bedrijvendagen' (businesses' days), organised by GeoVUsie, and by attending seminars given by people from trade and industry, that are organised throughout the year at the faculty.

Each year, the 'Stichting Bèta Bedrijvencontactdag Amsterdam' (SBBA) organises a business contact day intended for MSc and PhD students in (bèta) Sciences at the Vrije Universiteit (VU) and the Universiteit van Amsterdam (UvA). This day is customarily organised in March or April and students should receive an invitation, programme, and registration form beforehand. Businesses and companies present themselves and inform students about career perspectives, either at information booths or by plenary seminars. Students can also request a personal appointment with representatives of a certain company by sending in their cv. This may result in an invitation for a personal conversation at one of the 'gesprekkendagen' organised in May. More information on SBBA can be obtained at www.sbba.nl

5.4.2 Postgraduate degree programmes

After the doctoral or master degree programmes, there are opportunities to continue your educational career in a number of programmes at the Vrije Universiteit: PhD degree programmes (*AIO- or OIO-opleiding*), and a postgraduate programme in European Environmental Management.

PhD degree programmes

PhD-programmes are organised within a number of research schools:
- Inter University Centre for Geo-ecological Research (ICG)
- Netherlands Research School for the Socio-Economic and Natural Sciences of the Environment (SENSE)
- Research School Sedimentary Geology (NSG)
- School for Atmospheric and Maritime Research (SAMO).

The PhD programme always consists of carrying out a research project, leading to a PhD thesis/dissertation, and of several compulsory or elective course modules. For more information on PhD-programmes and Research Schools please refer the internet: http://www.falw.vu.nl > onderzoeksinstituten.

European Post-graduate Course in Environmental Management (EPCEM)

This postgraduate course takes place at the Vrije Universiteit and is a one-year, fulltime course preparing experts for environmental problem solving with an interdisciplinary approach and an orientation to policy making. Participants who successfully complete the course are entitled to an advanced Master degree in environmental policy and management (MEM). More information is available at http://www.profetas.nl/epcem/index.html, or from the programme secretariat EPCEM, tel. (020) 444 9580.

5.5 Geo-ecosystems and climate (compulsory modules)

The programme Geo-ecosystems and climate consists of 93 credit points (stp.) of compulsory course modules and 30 credits points of elective optional modules. From the list with compulsory modules below, choose one Master Thesis for a research (O) or societal (M) profile respectively.

Course code	***Course name***	***Stp.***	***Period***
450001	Advanced Spatial Analysis Techniques	6	Period 1
450004	Climate Modelling	6	Period 1
450014	Ecohydrology	6	Period 2
450126	Field Course Netherlands (Measurements Techniques)	3	Period 5
450051	Global Biogeochemical Cycles	6	Period 4
450140	Master Thesis Geo-ecosystems and Climate (M-variant)	27	variable
450139	Master Thesis Geo-ecosystems and Climate (O-variant)	27	variable
450138	Research Project Geo-ecosystems and Climate	27	Period 6
450060	Soil Vegetation Atmosphere Exchange	6	Period 4
450021	Unsaturated Zone and Near Surface Hydrological Processes	6	Period 2

5.6 Geo-ecosystems and climate (elective options)

The scope for optional components (total 27 credit points) involves opting for components of the Master's programme not yet taken. As an alternative, the optional component may also be partly or completely fulfilled by taking components from other university Master's programmes. This alternative requires the prior permission of the examination board. Before granting permission, the examination board will evaluate the content and cohesion of the programme.
The optional component can also be partly or completely fulfilled by taking components not yet taken belonging to the Bachelor's programme in Earth Sciences at the Vrije Universiteit.
The scope for optional components can be fulfilled within the MSc programme in geo-environmental Sciences by extending the Master's thesis requirement by 12 credits. This extension is registered separately by the course secretariat as course component 450150 - 'Extension of Master's thesis in Geo-environmental Sciences'.
Please refer to the descriptions of elective course modules at the back of this study guide.

5.7 Elective options

Course modules listed below are considered elective optional modules of the various MSc programmes of the School of Earth and Environmental Sciences. Students can choose from any of these courses within their free elective programmes.

Elective options			
Course code	***Course name***	***Stp.***	***Period***
450293	Advanced Geophysical Prospection	3	yet unknown
450045	Analogue Modelling of Tectonic Processes	2	Period 3
450142	Applied Geophysical Analysis	3	variable
450137	Aquatic Ecology	6	04.10.2004 - 29.10.2004
450305	Archaeobotany	3	yet unknown
450306	Archaeozoology	3	yet unknown
450134	Capita Selecta Event Stratigraphy	6	Period 2
450144	Capita Selecta Structural Geology and Tectonics	2	Period 4
450133	Contaminant Hydrogeology	3	Period 5
450047	Environmental Management in River Basins and Coastal Lowlands	6	Period 5
450147	Environmental Mineralogy	3	Period 2
470055	Evolutie van de mens	6	10.01.2005 - 04.02.2005
450302	Extension Master Thesis Archaeometry	12	variable
450301	Extension Master Thesis Landscape Archaeology	12	variable
450149	Extension Master Thesis in Earth Sciences	12	variable
450150	Extension Master Thesis in Geo-environmental Sciences	12	variable
450151	Extension Master Thesis in Hydrology	12	variable
450287	Field Course Applied Geology	6	Period 5
450152	Field Course Endogene Geology	6	Period 5
450153	Field Course Sedimentology/Structural Geology	6	Period 5
450304	Geobiology	6	Period 5

450132	Geomicrobiology / Groundwater Microbiology and Geochemistry	6	Period 1
450050	Geotechnics	6	Period 5
450148	Isotope Hydrology	3	Period 5
450155	Land Husbandry	3	Period 3
450167	Magmatic Processes Capita Selecta (Melt Inclusions)	3	Period 1 and 2
450158	Microstructures in Tectonites	6	Period 4
201796	Milieurecht (B3/M)	6	06 / 15
450161	Numerical Modelling in Tectonics	6	Period 5
450159	Ore Microscopy	3	Period 1
450162	Ore Petrology	3	Period 1
450054	Palaeo-ecology/Palynology	3	Period 3
450055	Petroleum Systems	2	Period 3
450164	Precambrian Geology	3	Period 3
450165	Remote Sensing in Hydrology	6	Period 4
450058	Sediment Petrography of Heavy Minerals	3	Period 3
450160	Spatial Variability and Multivariate Statistical Analyses	6	Period 2
470045	Toegepaste ecologie	6	01.11.2004 - 26.11.2004
450131	Transport Processes in Groundwater	6	Period 3
450286	Veldexcursie ecosystemen Ardennen	2	Periode 5
450061	Volcanism	3	Period 3

6 Environment and Resource Management

6.1 Introduction

6.1.1 The programme

The MSc Environment and Resource Management has a fixed programme which is followed by all students. Some degree of specialisation is offered by means of two profiles:
1. The research profile; effectuated by choosing (468017), Research Paper.
2. The societal profile; effectuated by choosing (468015), Traineeship

The programme is only available in a full time setting. The study load is 60 credit points (study points = stp.), making up one entire academic year. One credit point equals 28 hours of study (in conformity with the European Credit Transfer System, ECTS) and consists of actual participation in lectures and practical courses, preparation and other homework, and writing of reports, studying for interim examinations. The study load of each of the course modules is stated at the course descriptions in this guide.

Further online information with respect to the Environment and Resource Management programme and course module descriptions can be found at http://www.studiegids.vu.nl > Aard- en Levenswetenschappen > Environment and Resource Management.

6.1.2 Aim of the programme

The main aim of the programme is that the students acquire skills and techniques that allow them to apply their disciplinary knowledge on societal problems that relate to natural resources and the environment. Students will be trained to co-operate in multidisciplinary teams so that they can contribute to an integrated approach towards problem-analysis and problem solving in a variety of organisations dealing with natural resources and the environment: private and public, as well as national and international.

6.2 Admission

6.2.1 Admission requirements to ERM

Students with a Bachelor degree from the Vrije Universiteit and any other Dutch university can be admitted to the Master's programme in Environment and Resource Management.

Students who hold a certificate of higher vocational education (HBO) or an equivalent of a (Dutch) BSc degree obtained at an institution outside of the Netherlands may be admitted to the Master's programme in Environment and Resource Management on the basis of a decision to that effect taken by the examining board. The examining board will determine whether the qualification in question is sufficiently relevant to warrant admission. The examination board may make additional demands of the student before granting admission to the programme.

Participation in master courses without your BSc degree
The examination board may decide to admit the student to certain interim examinations of the MSc programme (specified in EER) even before he or she has successfully completed the BSc degree, provided that the student has accumulated at least 150 credit points within a BSc programme at the Vrije Universiteit.
The maximum period for which a student without a BSc degree can participate in components of the ERM master's programme is 6 months, calculated from the beginning of the academic year.

6.3 Final attainment levels

6.3.1 What should your learn?

An academic attitude

Acquiring an academic attitude towards environmental management is the key objective of the programme. A general academic attitude will have been built already during the Bachelor's phase, but it will be developed further during the Master's programme. Features of the desired academic attitude include:

- The will to explore and the capacity to investigate, to analyse problems and to independently solve such problems (i.e. a scientific attitude of curiosity and scepticism);

The intellectual skills to:

- read well (i.e. to be able to understand relevant scientific and policy papers),
- to write well,
- to calculate well,
- to reason logically,
- to distinguish truth from convention;
- To have a good level of disciplinary knowledge - in this case a discipline relevant for environmental management;
- To have enough knowledge of other relevant disciplines to assess the contribution of each individual discipline.

Professional skills

The study objectives do not only relate to an academic attitude, but also to the professional field in which most of the students will work after graduation. Features of such professional skills include:

- To recognise and acknowledge certain visions of relevant stakeholders on society and the environment;
- To be able to independently acquire relevant information on current environmental problems, by doing literature research, modelling and empirical research, and to critically analyse and evaluate both new and existing knowledge;
- To deal with environmental issues in co-operation with other experts;
- To write environmental reports and to critically evaluate such reports;
- To analyse and interpret environmental policy reports;
- To inform society on (potential) environmental problems, and on the uncertainties concerned;
- To argue which solutions are optimal for environmental problems, based on the information available (including the uncertainties involved);
- To communicate effectively (in writing and orally) with professionals, industry managers and employees, community groups, and the media.

Knowledge
'Knowledge' can be divided into four areas, namely facts, insight, application and problem solving. Since the students have already obtained a Bachelor's degree, they already carry a significant amount of knowledge with them, especially related to facts. Therefore, in our programme we will focus on methodologies and approaches for analysing and solving environmental problems. We discuss several 'typical' environmental problems in detail because they serve as case studies to which analysing tools can be applied and policy instruments can be evaluated.
Main objectives include:

- To understand the concept of sustainable development and to elaborate its principles in scientific, technological and socio-economic terms;
- To apply and interpret the scientific principles, guiding regulations, and to recommend practices for environmental management;
- To be able to understand and apply a range of relevant practical tools for investigating and assessing environmental problems, in particular impact assessment, life cycle analysis, (economic) valuation and policy evaluation, and to be aware of the value and the scope of these tools;
- To be able to examine the nature, effectiveness and the efficiency of solutions proposed for environmental problems.

6.4 Further study and career prospects

6.4.1 Orientation towards a career and the labour market

Spending part of your study in external traineeships and research projects is a good way to prepare for and familiarise yourself with the labour market. All programme components called 'Research project' and 'Master thesis' are subject to the Work placement and thesis regulations drawn up by the faculty. Please take note of these regulations and act accordingly.
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In addition, orientation towards the labour market is much helped by so-called 'bedrijvendagen' (businesses' days), organised by GeoVUsie, and by attending seminars given by people from trade and industry, that are organised throughout the year at the faculty.

The Education Inspection Committee is optimistic about labour market perspectives for professional and interdisciplinary educated environmental scientists:
Potential employers (research institutes, consultants, and NGO and governmental organisations) remarkably agree to prefer experts with a technical, scientific basis that is supported by a number of social science techniques such as decision support, regulation and public administration. Specific skills these potential employers consider to be important include:

- Ability to solve problems structurally;
- Good writing and presenting in Dutch and English;
- Project management;

- Sensitivity for policy;
- Co-operation.

Important developments they envisage are:

- Water quality and water management;
- Liveability linked to macro problems (climate change) and micro problems (quality of the neighbouring environment);
- Spatial issues.

IVM's management often receives requests for good candidates for job opportunities in ministries and other institutions.

6.4.2 Postgraduate degree programmes

After the doctoral or master degree programmes, there are opportunities to continue your educational career in a number of programmes at the Vrije Universiteit: PhD degree programmes (AIO- or OIO-opleiding), and a postgraduate programme in European Environmental Management.

PhD degree programmes

PhD-programmes are organised within a number of research schools:
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The PhD programme always consists of carrying out a research project, leading to a PhD thesis/dissertation, and of several compulsory or elective course modules. For more information on PhD-programmes and Research Schools please refer the internet: http://www.falw.vu.nl > onderzoeksinstituten.

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6.5 Environment and Resource Management, course modules

Programme components listed below make up the (compulsory) programme (60 stp.) of Environment and Resource Management. Some degree of specialisation is achieved by choosing either a societal profile (M) including a Traineeship, or a research profile (O) which includes a Research Paper.

Course code	***Course name***	***Stp.***	***Period***
468013	Analysis of Environmental Problems	3	Period 1 and 2
468004	Environmental Policy and Management	16	Period 3 and 4
468002	Environmental Problems: Case Studies	4	Period 1
468016	Portfolio	4	all

468017	Research Paper	18	Period 5 and 6
468011	Sustainability and Growth	6	Period 1
468015	Traineeship	18	Period 5 and 6

7 Programme components Earth Sciences, Hydrology, and Geo-environmental Sciences

subject **Advanced Geophysical Prospection**
code 450293
This course will probably not be organised before 2005-2006.
lecturers dr. G. Aalbersberg; drs. A. Kattenberg; drs.ing. S. Oonk
credits 3
period yet unknown
aim Improving knowledge of geophysical and geochemical prospection methods.
content This course builds on knowledge from the course "Geoarchaeological prospection techniques (450104)", and intends to provide a more thorough physical and chemical background to well-known and often-used techniques and novel methods. The techniques covered in the course are electrical resistance, IP, magnetometry, magnetic susceptibility, multi-element chemical prospection, conductivity and GPR. Soil properties are used as the key for understanding both the principle and the application of these geophysical and geochemical methods. Issues of sampling and scale are discussed in relation to the application of the techniques for the prospection of archaeological features, sites and landscapes.
form of tuition lectures, practical exercises, fieldwork, essays
mode of assessment essays, fieldwork report, written exam

subject **Advanced Paleo-Oceanography and Sea-level Change**
code 450044
lecturers prof.dr. D. Kroon; dr. G.M. Ganssen; dr. O. van de Plassche; dr. S.J.A. Jung; dr. H.B. Vonhof
credits 6
period period 4
aim To understand the role of the ocean in climate change, obtain knowledge of a wide range of research techniques (proxies), and discuss current states of the art.
content The course consists of a series of lectures, seminars and laboratory exercises. Lectures will focus on principles and on proxy development in paleoceanographic and sea-level research. Examples of the use of proxies in cores from the ocean, shelf, and coastal area will be presented from areas sensitive to climate change. The seminar series will address recent developments and current questions of climate-ocean variability in relation to the carbon-cycle.
form of tuition Lectures and laboratory work
mode of assessment Written essay on selected subject, oral presentation of results, written exam.

subject **Advanced Spatial Analysis Techniques**
code 450001
lecturers dr. M.A. Eleveld; dr. R.A.M. de Jeu; dr. S.W.M. Peters (and guest lecturers)
credits 6
period period 1
content This advanced course in GIS & RS consists of an introduction part and a specialisation part, depending on the master profile. In the introduction part,

spatial analysis techniques are explained (coupling GIS & RS, databases, MCA, visualisation), with emphasis on GIS. An introduction course to ArcView is included. In the specialisation part the student will elaborate on two case studies. Each case study consists of an introduction to the problem and additional theory and/or GIS or RS techniques followed by practical exercises and literature study. Each case study will be finished by a report on the exercises and literature and a presentation.

form of tuition 7-8 Lectures of 2 hours, 11 computer workshops of 4 hours, literature research, elaboration of workshops of 2 case studies and presentations.

literature Syllabus and other relevant literature will be presented on Blackboard.

mode of assessment Technical document on case studies, elaboration of one case study into a scientific paper and a final oral presentation.

remarks Basic knowledge of GIS and RS is essential, i.e. 450023- digitale ruimtelijke data.

naam **Algemene didactiek / pedagogiek 1 en 2**

code 990001

studiepunten 9

docent Diverse Docenten

periode 30.08.2004 - 31.08.2005

inhoud Bij algemene didactiek / pedagogiek spelen de *leservaringen* op school een belangrijke rol. Daarmee in samenhang komen bij de colleges algemene onderwijskundige en pedagogische inzichten onder andere via literatuurstudie aan de orde en wordt geoefend met en gereflecteerd op het begeleiden van leerprocessen. Het gaat daarbij om onderwerpen als orde, verschillen tussen leerlingen en leerstijlen. Reflectie op het eigen leerproces en dat van mede dio's via besprekingen van leerervaringen en het maken van een persoonlijk ontwikkelingsplan nemen een belangrijke plaats in. Het onderwijs wordt voor een belangrijk deel verzorgd door docenten van het cluster (alfa, bèta, gamma).
Er wordt gestreefd naar een samenhang tussen vakdidactische en algemeen didactische / pedagogische aspecten in het onderwijsaanbod.

literatuur Reader kan bij aanvang van de cursus aangeschaft worden.

onderwijs werkcollege (30.08.2004 - 31.08.2005)

toetsing opdracht
opdrachten worden opgenomen in het portfolio

blackboard Ja

subject **Analogue Modelling of Tectonic Processes**

code 450045

docent dr. D.A. Nieuwland

credits 2

period period 3

aim The main goal of the course is to familiarise the students with analogue modelling techniques, applications, advantages and limitations.

content In the course, the theory of analogue modelling is applied to the study of processes in tectonic faulting. It includes very large-scale processes, involving the complete lithosphere, and small-scale processes down to hand-specimen scale.

The course consists mostly of practical work during which the students will make their own models (3D and 4D) and apply various data acquisition and interpretation techniques.

form of tuition A one day introduction, followed by hands-on working in the lab.

literature A CD with pre-reading material will be provided.

remarks The students will work in small teams (3 persons max) each student will have to produce a report. The report will form the basis for the judicium given for the course.

subject **Applied Geophysical Analysis**

code 450142

lecturer prof.dr. J.F. Vandenberghe

credits 3

period variable

content Analysis of a series of (preferably) own geophysical measurements in the field of geoelectrics, borehole geophysics or electromagnetism. The geophysical measurements will be analysed with models and geologically interpreted. The course can be done at a time selected by student and supervisor. The results will be provided in the form of a report.

mode of assessment Written report

remarks Advice regarding previous courses taken: Applied Geophysics (450025), Field Course Netherlands (450126).

subject **Aquatic Ecology**

code 450137

lecturer dr.ir. J.E. Vermaat

credits 6

period 04.10.2004 - 29.10.2004

content Commonalities versus specific features of aquatic ecosystems: lakes, rivers, estuaries, the sea. Interactions between water body and surrounding land (catchment). A systems perspective: important processes and the role of biota: marginal or crucial? Interactions among biota in the foodweb (predation, competition) and otherwise (the role of engineers or keystone species, mutuality, mutualism). Aquatic biodiversity: what does it mean? Biota as indicators of water and sediment quality in rivers and lakes. Aquatic ecology for water quality and quantity management.

form of tuition Plenary lectures (5 x 4 = 20 hrs), comparative fieldwork: spatial gradient analysis of aquatic ecosystem: Nieuwe Meer, Amsterdamse Bos or Drinking Water Reservoir Loenderveen (8 hrs), excursion Water Board or NIOO-Centre for Limnology (8 hrs), student seminars (4 hrs), literature study.

literature Lecture notes (Vermaat -- Aquatic Ecology), chapters from Kalff J, 2002. Limnology, Prentice Hall., selected articles.

mode of assessment Written test, oral presentation (content and quality), fieldwork/fieldtrip report

subject **Archaeobotany**

code 450305

This course will probably not be organised before 2005-2006.

lecturers dr. G. Aalbersberg; dr H. van Haaster (BIAX); others

credits 3

period yet unknown

aim development of archaeobotanical identification skills
content The course will further develop specific archaeobotanical skills including the identification and analysis of (the subfossil remains of) cultural and occupation-related plant species. Attention will also be paid to degradation mechanisms and processes affecting preservation of archaeobotanical material in archaeological contexts.
form of tuition Lectures, practicals, literature research
mode of assessment Written exam

subject **Archaeometry III (Analytical Methods)**
code 450289
lecturers drs. E.A.J. Burke; dr. P.Z. Vroon; dr. J.R. Wijbrans; prof.dr. H. Kars
credits 6
period period 5
aim Providing insight in the use of modern inorganic analytical methods in archaeology and archaeometry
content The course consists of a series of lectures and laboratory exercises. Lectures will focus on the principles of a number of the most current analytical methods, on the understanding of the significance of numerical results obtained with these methods, and on their workable applications to archaeology and archaeometry. The laboratory exercises will give a hands-on training in different analytical methods (all aspects of sample handling and sample preparation, chemical analysis, electron/ion-beam techniques, mass spectrometry, data acquisition and interpretation).
form of tuition Lectures and laboratory work
literature Lecture notes and reader with selected papers/chapters
mode of assessment Written exam, laboratory results

subject **Archaeozoology**
code 450306
This course will probably not be organised before 2005-2006.
lecturer D.J. de Grooth (and others)
credits 3
period yet unknown
aim development of archaeozoological identification skills
content The course will develop specific archaeozoological skills including the identification and analysis of the remains of cultural and occupation-related animals, mainly vertebrate tetrapods. Attention will also be paid to degradation mechanisms and processes affecting preservation of archaeozoological material in archaeological contexts.
form of tuition Lectures, practicals, literature research
mode of assessment Written exam

subject **Biological Archaeometry**
code 450291
lecturer Prof. dr. M. Collins; drs. M.M.E. Jans
credits 6
period period 2
aim Providing an introduction to topics in biomolecular archaeology and the basic chemistry of key ancient biomolecules.

content The course consists of a series of lectures and practical laboratory exercises. Lectures will explore a range of themes within biomolecular archaeology, such as paleodiet, migration, and domestication; introduce the biochemistry of key biomolecules, for example DNA, lipids and proteins; and discuss the relevance of the results of biomolecular techniques for archaeological research. Also problems, like degradation of archaeological material and sample contamination, will be addressed.
The laboratory exercises will give a hands-on training in good laboratory practice, sample handling, and different analytical methods.
form of tuition Lectures and laboratory work
mode of assessment Written exam, written reports on laboratory results

subject **Capita Selecta Event Stratigraphy**
code 450134
docent prof.dr. J. Smit
credits 6
period period 2
aim Study of the role of catastrophic processes and events in earth history.
content The course aims to provide a better understanding of impact processes and their effects on the Earth System. Gain a better understanding of the influence of large catastrophic events (e.g. large meteorite impacts, large volcanic eruptions, plate-reorganisations) on the earth environment and biological and geological changes. How to recognize such events. Learn to take a holistic view of complex interrelated events.
form of tuition Lectures and practical research , literature.
Working Excursion (1 day) K/T boundary Limburg and/or Frasnian-Famennian boundary (Ardennes). The course will be managed through blackboard.
mode of assessment Blackboard based excercises

subject **Capita Selecta Geoarchaeology (Introduction Nikopolis)**
code 450294
lecturer dr. G. Aalbersberg (IGBA staff and guest lecturers)
credits 3
period period 3
aim Deepening and broadening knowledge of geoarchaeological topics
content The capita selecta will present topics from the entire spectrum of geoarchaeological science and be relevant to both the archaeometric and the landscape archaeological variants. It also includes an introduction to the Nikopolis project and other current research carried out by the institute, as well as short courses by guest lecturers.
form of tuition lectures, presentations, literature study, essays
mode of assessment essays, practical exercises

subject **Capita Selecta Structural Geology and Tectonics**
code 450144
lecturer dr. E. Willingshofer (lecturers of the Vrije Universiteit & guests)
credits 2
period period 4
aim To be able to link geological and geophysical data sets of various scales to

viable concepts in Earth Sciences, thereby conveying the understanding of processes which are involved in the deformation of the lithosphere.

content Students have to choose a topic for their self-study about which they have to hand in a written report and give a concise oral presentation. Topics are provided and cover certain aspects of a general theme, which may vary on a yearly basis. Themes may cover aspects which are important for the tectonic evolution of particular regions like the Alps or may cope with process-oriented issues like different modes of extension etc. The results of the self studies will be presented and discussed in the group. Relevant literature will be provided.

form of tuition Combined lecture and discussion meetings (~8 x 2hrs), self study, written and oral presentations.

mode of assessment Student paper and presentation 40%, written exam 60%
A kick-off meeting will take place during the first half of September and will be announced separately.

subject **Catchment Response Analysis**
code 450003
lecturers dr. A.A. van de Griend; dr.ir. E. Seyhan
credits 6
period period 1
content This course covers the fields of surface water hydraulics, hydrological concepts of hydrograph analysis, and catchment response modelling. The course includes channel hydraulics (with emphasis on theory and application of discharge measurement structures) and reservoir and river routing. The modelling part covers the spectrum from classical lumped models to distributed physically based models of various kinds.
form of tuition Lectures, practical desk exercises, and exercises with computer models such as RUNOFF and DUFLOW using real data collected from the fieldwork catchments of the department.
literature Lecture notes: Van de Griend: "Inleiding tot de Hydrodynamica en Hydraulica", VU-bookstore; Van de Griend: "Inleiding tot de Afvoerhydrologie", handout. Both lecture notes are available in English in digital form. Articles, book chapters, and handouts to be provided during the course.
mode of assessment Written exam

subject **Climate Modelling**
code 450004
lecturers dr. H. Renssen; prof.dr. A.J. Dolman; dr. M.J. Waterloo
credits 6
period period 1
content Geological archives show convincingly that the climate system experiences variability on a wide range of time-scales. For Quaternary studies, climate variations at the following time-scales are most important: glacials-interglacials, millennia and centuries-decades. This course focuses at the mechanisms behind these variations, thereby using climate models as a tool, i.e. numerical computer models in which the dynamics of the climate system is calculated. The combination of these models and geological data will be treated extensively. The course consists of lectures giving an overview of

climate models and their application (different types for different time-scales) and of discussion meetings, in which students discuss the recent literature in detail. In this way the course considers case studies for the different time-scales and deals with recent developments in climate modelling. The following two questions are central to the course:
1) What is the driving mechanism behind climate change at a particular time-scale?
2) How can we optimise the combination of climate models and geological data in order to increase our understanding of climate evolution?

form of tuition Lectures and discussion meetings

literature Lecture notes and selected papers (made available through Blackboard)

mode of assessment Compulsory participation in discussion meetings, oral presentation and written exam

naam **Communicatie en educatie via internet**

code 471027

docenten drs I. van Veen; J. Bruin

studiepunten 3

periode 15.11.2004 - 26.11.2004

doel Na afloop van de module hebben de studenten:
- inzicht in de theorie en praktijk van wetenschapscommunicatie via internet;
- inzicht in het planmatig inzetten van tekst, beelden, multimedia en *infographics*;
- ervaring met het produceren en bewerken van tekst, beelden, multimedia en *infographics.*

inhoud
- Doelgroepgerichte wetenschapscommunicatie via internet;
- *Content management* (voor statische en dynamische websites);
- Theorie en vraagstukken rond website *usability*;
- Content productie (tekst, beeld, multimedia, fotografie en *infographics*).

literatuur Boek in combinatie met artikelen. Wordt voor aanvang van de cursus nader bekend gemaakt.

toetsing Beoordeling aan de hand van individuele producten en het functioneren tijdens de practica en werkcolleges.

doelgroep Masterstudenten van de faculteiten Aard- en Levenswetenschappen en Exacte Wetenschappen.

werkwijze
- Zelfstudie;
- Interactieve responsie- en werkcolleges;
- Trainingssessies;
- Hoorcolleges.

voorkennis De cursus Wetenschapsjournalistiek dient met succes te zijn afgerond

naam **Communicatiewetenschappen**

code 471006

docent dr. C.M. Koolstra

studiepunten 6

periode 06.09.2004 - 01.10.2004

doel
- Kennismaken met basisbegrippen van de communicatiewetenschap;
- Kennismaken met communicatieprocessen vanuit een interpersoonlijk, organisatorisch en maatschappelijk perspectief;

- Kennismaken met onderzoeksmethoden die vaak in de communicatiewetenschap worden gebruikt (survey, inhoudsanalyse, en experiment)
- Leren communicatieprocessen in wetenschappelijke termen te beschrijven met het doel theorieën toe te passen en elementaire voorspellingen te doen;

inhoud We leven in een communicatiemaatschappij. Volgens EU-schattingen houdt meer dan de helft van de beroepsbevolking zich bezig met een of andere vorm van communicatie. Men noemt hen ook wel communicatiewerkers. Om zinvol te kunnen functioneren in een communicatiemaatschappij heb je niet alleen communicatie-vaardigheden nodig (zoals schrijven, spreken en illustreren), maar moet je ook inzicht hebben in de wetmatigheden, ideeën en vooronderstellingen die daaraan ten grondslag liggen. Wat is communicatie? Welke media zijn belangrijk? Wat is een doelgroep? Wat is interactieve communicatie? Hoe effectief zijn publiekscampagnes?
Een inleiding in de communicatiewetenschap leidt je uiteraard niet op tot communicatiewetenschapper; daarvoor heb je een aantal jaren studie nodig. Maar basale kennis van en inzicht in de communicatie-wetenschap is noodzakelijk om op een adequaat niveau met communicatiewetenschappers te communiceren, bijvoorbeeld bij het opzetten van een campagne of het evalueren daarvan.

literatuur Boek: Severin, W. J. & Tankard, J. W. (2001). *Communication theories: Origins, methods, and uses in the mass media.* New York: Longman. [5th edition].
Een aantal wetenschappelijke artikelen (via Blackboard).

toetsing
- Participatie in de werkgroepen.
- Een groepswerkopdracht.
- Een schriftelijk tentamen, welke voor een deel uit meerkeuze vragen zal bestaan en voor een deel uit open vragen.

werkwijze Een combinatie van hoorcolleges, werkgroepbijeenkomsten en zelfstudie.

voorkennis Geen

subject **Contaminant Hydrogeology**

code 450133

lecturer dr. B.M. van Breukelen

credits 3

period period 5

aim To understand which processes and factors determine the spreading behaviour of various groups of anthropogenic pollutants during subsurface transport; to obtain a coherent view of useful methods to investigate contaminated sites; to understand the physical/chemical/biological principles of several remediation techniques and to evaluate their effectiveness in restoring the groundwater/soil quality.

content Properties of pollutants (sorption, volatilization, degradation); overview on processes and factors which determine the spreading of major pollutants such as: petroleum and chlorinated hydrocarbons, pesticides, PAHs, heavy metals, radionuclides, landfill leachate, and acid mine drainage. How to investigate contaminated sites? Available reactive transport models. Remediation methods: pump & treat, monitored natural attenuation and active bioremediation. Environmental policy on soil and groundwater pollution.

form of tuition Lecture, literature study, case study, group discussion
literature A syllabus with a compilation of (scientific) literature will be provided
mode of assessment Written report and presentation.
remarks Successful completion of Hydrochemistry (450052) and Transport processes in groundwater (450131) is advised.

subject **Ecohydrology**
code 450014
lecturers prof.dr. A.J. Dolman; dr. M.J. Waterloo; dr. L.A. Bruijnzeel
credits 6
period period 2
content The course will describe basic interactions between the vegetated land surface and the atmosphere and hydrosphere. Basic questions that are dealt with are: what determines the broad vegetation patterns of the world, and how do these in term determine the hydrological response of catchments. This requires understanding of primary hydrological processes of vegetation (interception, transpiration, soil moisture) and feedbacks of vegetation to the atmosphere. The hydrological structure of Dynamic Vegetation Models Tropical (DGVM's) will be discussed. Tropical and temperate deforestation and desertification processes are considered. The emphasis is on a combination of process understanding, interpretation of experimental results, and modeling.
form of tuition 12 lectures of 2 hours each and 8 half day workshops, showing numerical techniques and study and discussion of literature.
literature Relevant literature will be provided during the lectures (e.g. Baird, Wilby, Eco-hydrology; Woodward, Climate and plant distribution).
mode of assessment Written test on lecture notes and literature and attendance workshops.

subject **Environmental Management in River Basins and Coastal Lowlands**
code 450047
lecturers dr. J.C.J.H. Aerts; A.J. Gilbert; dr. J. Gupta; dr.ir. J.E. Vermaat
credits 6
period period 5
content River basins and coastal lowlands are generally intensely occupied by man and therefore show specific spatial conflicts among such economic activities as agriculture, nature management, recreation, infrastructure and housing. These activities are affected by important issues as climate change, political conflicts, water law, coastal protection, flood risks, soil and water pollution. Some of the effects are only noticed on a local scale. However, especially in large --trans boundary- river basins conflicts and problems in the upper part of a river basin are displaced downstream even into the coastal receiving zone.
Main goal of this course is to study a river basin as one entity, even though many river basins are shared between different countries. This course aims at analysing the subsequent impacts of the above-mentioned issues on economic activities, their implications for sustainable development and the role of spatial planning to resolve conflicts. For this, the course integrates expertise from technical fields, environmental management and socio economic studies. The course will discuss environmental policies, water law and politics in river basins but also presents a broad range of techniques, varying

from simple models and GIS to multi criteria analysis and multi disciplinary approaches. The course will present differences in issues and problems across river basins in developed and developing countries.

form of tuition The course consists of 14 meetings. Instructors are specialists form the university and external experts from private companies. After an introduction meeting, each instructor will introduce the meeting topic, followed by short presentations of the literature by students and a group discussion. The course includes a one day excursion.

literature Reader and literature research

mode of assessment Attendance of the meetings and excursions, presentation (skill and contents), final or partial exams on literature, completion of group assignment.

subject **Environmental Mineralogy**

code 450147

lecturer dr. M.A. Zakrzewski

credits 3

period period 2

aim To understand the role of minerals at or near the surface of the Earth.

content Environmental mineralogy is one of the most exciting, rapidly developing, socially and economically relevant areas of study and research in modern science. Both pure systems and those contaminated as a result of human activity are considered. These include problems with waste generated by mining of metals, industrial wastes, and those produced by the nuclear industry. The relationship between minerals and human health constitutes a special case.

form of tuition Lectures, literature study with written reports and oral presentation

literature A selection of published articles

mode of assessment Reports, written examination

naam **Evolutie van de mens**

code 470055

docenten prof.dr. N.M. van Straalen (cursusleider); prof.dr. G.J. Boekschoten

studiepunten 6

periode 10.01.2005 - 04.02.2005

doel Kennismaking met de discussies over de reconstructie van de humane evolutie. Verwerven van inzicht in de argumenten die vanuit verschillende disciplines gebruikt worden om zulke reconstructies te onderbouwen.
Eindtermen
De student is in staat:

- de huidige stand van zaken met betrekking tot de afstammingsgeschiedenis van Homo sapiens en andere homininen uiteen te zetten;
- bewijsmateriaal voor humane evolutie vanuit de moleculaire genetica, de palaeontologie, de vergelijkende ethologie en de biopsychologie op hun waarde te schatten;
- zich een oordeel te vormen over recente artikelen in Nature en Science waarin nieuwe palaeontologische vondsten en genetische gegevens gepresenteerd worden.

inhoud In de cursus worden de principes van de evolutieleer en de fylogenetische analyse geïllustreerd, gevolgd door een analyse van fossiele en genetische

gegevens en hun belang voor de reconstructie van de homininen-subfamilie. Achtereenvolgens komen aan de orde:

- Historische visies op de evolutie van mensen;
- Dateringsmethodes en tafonomie;
- Fylogenetische reconstructies;
- Bouwplannen van de primaten;
- Sociale structuren en sexueel gedrag bij apen en mensen;
- Anatomische overeenkomsten tussen mensapen en mensen;
- De oorsprong van de homininen;
- Evolutionaire verklaringen voor bipedalisme;
- De Australopithecus-soorten;
- Homo habilis en Homo erectus;
- Verschillende culturen van stenen werktuigen;
- Het raadsel van de neanderthalers;
- De oorsprong van Homo sapiens: in Afrika?;
- Evolutie van de hersenen, zelfbewustzijn en taal;
- Migraties van Homo sapiens;
- De landbouwrevolutie.

literatuur Verplicht studieboek: R. Lewin & R.A. Foley, Principles of Human Evolution, 2nd edition, Blackwell Science, Malden, ISBN 0 632 04704 6. Prijs ongeveer 50 euro.

toetsing Schriftelijk tentamen en een essay over een recent artikel.

doelgroep Keuzecursus voor biologen, biomedische wetenschappers, gezondheidswetenschappers, aardwetenschappers en voor studenten van andere faculteiten (bijv. antropologie, psychologie).

werkwijze Responsiecolleges (8 uur); hoorcolleges (17 uur); osteologisch practicum met humane botten en modellen van fossiele schedels (8 uur); onbegeleide zelfstudie (120 uur); tentamen (3 uur).

voorkennis Speciale voorkennis is niet vereist, maar een basiskennis van evolutiebiologie op het niveau van de eerstejaars cursus voor biologen (zie elders in de studiegids) wordt sterk aanbevolen.

subject **Exogene Isotope Geochemistry: Proxies and Tracers in the Sedimentary Record**

code 450005

lecturers dr. H.B. Vonhof; dr. C.J. Beets; dr. A.M. Immenhauser

credits 6

period period 1

aim Providing insight in the use of state of the art geochemical techniques, to be used in both the marine and terrestrial sedimentary record. This course aims at the use of "proxies and tracers"; dating techniques are taught in course 450048.

content The geochemical cycles of Carbon, Oxygen, Nitrogen and Hydrogen, with emphasis on the signatures of these elements in the sedimentary record (both in carbonates and organic matter). Various isotope-based proxies and tracers for paleotemperature, paleorainfall, paleosalinity and provenance studies are discussed and compared to proxies based on trace element ratios. Further, several radiogenic isotope proxies (Lead, Strontium and Neodymium) are dealt with for their application in paleoceanography sedimentology and paleoecology. Finally, we will carefully consider diagenetic processes that

affect geochemical signals in the sedimentary record.

form of tuition Lectures and practical work.

literature Reader.

mode of assessment Question paper on the subject matter, combined with an evaluation of the practical work.

subject **Exogene Isotope Geochemistry: Radiometric Dating Techniques**

code 450048

lecturers dr. T.J. Dunai; dr. C.J. Beets

credits 6

period period 4

aim Understanding concepts and methods for dating and determining rates of Earth Surface processes with isotope tools.

content Dating tools for quaternary sediments (e.g. radiocarbon dating, thermo-luminescence, U-Th dis-equilibrium dating). Determination of ages of geomophological surfaces (exposure age dating/cosmogenic nuclides) and of erosion rates (cosmogenic nuclides). Dating of topography (low-temperature (U-Th)/He dating). Concepts and methods are discussed at hand of practical examples.

form of tuition Lectures, literature, practicals

mode of assessment Seminars, exam

subject **Extension Master Thesis Archaeometry**

code 450302

lecturers prof.dr. H. Kars; dr. G. Aalbersberg; drs. E.A.J. Burke

credits 12

period variable

aim This subject provides the opportunity to extend the Master Thesis Archaeometry (450299 or 450300).

content Extension of the Master thesis research (O) or work placement (M) with a volume of 12 stp. (8weeks).

form of tuition Individual research or work placement (traineeship).

mode of assessment Written report integrated in master thesis. Grades are based on final Master Thesis report.

entry requirements Having been admitted to the accompanying Master Thesis.

remarks Extension of the master thesis is an optional subject and is part of the space for elective optional subjects in the degree programme. Extension of the master thesis is subject to the 'Work placement and thesis regulations'. As detailed written agreements between lecturer and student have been put forward already for the Master Thesis, an amendment with the nature of this extension will suffice and should be forwarded prior to the start of the extension to the examining board (maarten.bergwerff@falw.vu.nl).

subject **Extension Master Thesis Landscape Archaeology**

code 450301

lecturers prof.dr. H. Kars; dr. G. Aalbersberg; drs. E.A.J. Burke

credits 12

period variable

aim This subject provides the opportunity to extend the Master Thesis Landscape Archaeology (450297 or 450298).

content Extension of the Master thesis research (O) or work placement (M) with a volume of 12 stp. (8weeks).

form of tuition Individual research or work placement (traineeship).

mode of assessment Written report integrated in master thesis. Grades are based on final Master Thesis report.

entry requirements Having been admitted to the accompanying Master Thesis.

remarks Extension of the master thesis is an optional subject and is part of the space for elective optional subjects in the degree programme. Extension of the master thesis is subject to the 'Work placement and thesis regulations'. As detailed written agreements between lecturer and student have been put forward already for the Master Thesis, an amendment with the nature of this extension will suffice and should be forwarded prior to the start of the extension to the examining board (maarten.bergwerff@falw.vu.nl).

subject **Extension Master Thesis in Earth Sciences**

code 450149

lecturer various lecturers (of the departments of Petrology, Isotope geochemistry, Tectonics, Sedimentology, Quaternary geology & Geomorphology and Paleoecology & Paleoclimatology and Geoarchaeology that supervise Master thesis projects.)

credits 12

period variable

aim This subject provides the opportunity to extend the Master thesis research projects 450107 or 450111, 450118, 450120, 450xxx) or work placements (traineeships) (450108 or 450112, 450117, 450121, 450xxy).

content Extension of Master thesis research project or work placement (traineeship) with a volume of 12 stp. (8 weeks).

form of tuition Individual research or work placement (traineeship)

mode of assessment Written report integrated in master thesis -- grades are based on final Master thesis report.

remarks Having been admitted previously to the appropriate Master thesis for which this extension holds.
Extension of the master thesis is an optional subject and is part of the space for elective optional subjects in the teaching programme. Extension of the master thesis is subject to the `Work placement and thesis regulations' (stage- en scriptieregeling). As detailed written agreements between lecturer and student have been put forward already for the Master thesis, an amendment with the nature of this extension will suffice and should be forwarded prior to the start of the extension to the secretary to the examining board (maarten.bergwerff@falw.vu.nl). Information on Master thesis projects is provided by departmental lecturers and is made available on the departmental pages of the Faculty web-site:
Dutch page: http://www.geo.vu.nl/onderwijs/master/index-nl.html
English page: http://www.geo.vu.nl/onderwijs/afd/index-en.html

subject **Extension Master Thesis in Geo-environmental Sciences**

code 450150

credits 12

period variable

aim This subject provides the opportunity to extend the Master thesis research

project (450139) or work placement (traineeship), (450140).

content Extension of Master thesis research project or work placement (traineeship) with a volume of 12 stp. (8 weeks).

form of tuition Individual research or work placement (traineeship)

mode of assessment Written report integrated in master thesis -- grades are based on final Master thesis report.

entry requirements Having been admitted previously to the appropriate Master thesis for which this extension holds.

remarks Extension of the master thesis is an optional subject and is part of the space for elective optional subjects in the teaching programme. Extension of the master thesis is subject to the `Work placement and thesis regulations' (stage- en scriptieregeling). As detailed written agreements between lecturer and student have been put forward already for the Master thesis, an amendment with the nature of this extension will suffice and should be forwarded prior to the start of the extension to the secretary to the examining board (maarten.bergwerff@falw.vu.nl). Information on Master thesis projects is provided by departmental lecturers and is made available on the departmental pages of the Faculty web-site, or at:
Dutch page: http://www.geo.vu.nl/onderwijs/master/index-nl.html
English page: http://www.geo.vu.nl/onderwijs/afd/index-en.html

subject **Extension Master Thesis in Hydrology**

code 450151

credits 12

period variable

aim This subject provides the opportunity to extend the Master thesis research project (450122 or 450124) or work placement (traineeship), (450123 or 450125).

content Extension of Master thesis research project or work placement (traineeship) with a volume of 12 stp. (8 weeks).

form of tuition Individual research or work placement (traineeship)

mode of assessment Written report integrated in master thesis -- grades are based on final Master thesis report.

entry requirements Having been admitted previously to the appropriate Master thesis for which this extension holds.

remarks Extension of the master thesis is an optional subject and is part of the space for elective optional subjects in the teaching programme. Extension of the master thesis is subject to the `Work placement and thesis regulations' (stage- en scriptieregeling). As detailed written agreements between lecturer and student have been put forward already for the Master thesis, an amendment with the nature of this extension will suffice and should be forwarded prior to the start of the extension to the secretary to the examining board (maarten.bergwerff@falw.vu.nl). Information on Master thesis projects is provided by departmental lecturers and is made available on the departmental pages of the Faculty web-site, or at:
Dutch page: http://www.geo.vu.nl/onderwijs/master/index-nl.html
English page: http://www.geo.vu.nl/onderwijs/afd/index-en.html

subject **Field Course Algarve, Portugal**
code 450128
lecturers dr. H. Kooi; dr. J. Groen; dr. R.A.M. de Jeu
credits 3
period period 6
content The course is an exercise in (eco)hydrological field surveying. The objectives are to learn to make relevant hydrogeological and ecohydrological observations, to carry out field measurements and to make realistic, qualitative and/or quantitative interpretations regarding hydrological processes and conditions in the field as well as about their practical implications.
form of tuition The course starts with an excursion of three days devoted to (a) field observation and "hydrological system thinking", (b) field measurements and (c) the hydrological functioning of the Algarve region. This is followed by two short field surveys of about three days each, carried out by the students in small groups. Different assignments and field areas may be offered depending on the hydrogeological or ecohydrological specialization of the student.
literature Excursion guide + Report: Groundwater flow and geological structure of the Algarve, Portugal by J.J. de Vries and J. Schwan
mode of assessment Oral presentations of the field surveys.
entry requirements Admission to this field course is only granted to students with a BSc degree Earth Sciences and other students who have been admitted to the MSc degree programme by the examining board.

subject **Field Course Applied Geology**
code 450287
lecturer dr. M.A. Zakrzewski
credits 6
period period 5
aim The course provides insight in the work of geologists of various specialties as applied in the mineral deposit industry, particularly the mining and exploration geology.
content The course illustrates the theme: "Mineral Deposits and the Society". The student will learn the applications of almost all theoretical geologic disciplines in practice of a working mining industry along with the work of applied economic geology, mining geology, exploration, mineralogy, hydrology, structural and engineering geology, geophysics etc. A great deal of the field course will focus on environmental problems associated with the exploitation and utilisation of Earth's resources, as waste generated by mining particularly mining of metals, air pollution, disruption of soil and of the natural water resources.
form of tuition work excursion (3 stp.) to working and abandoned mines in Poland. Introduction lectures, literature study with oral presentation by students, take-home exercises (3 stp.).
literature 'Mineral Deposits of Poland' (book to be bought) and a selection of published articles.
mode of assessment Active participation, oral presentation, report of field exercises, written examination.
entry requirements Admission to this field course is only granted to students with a BSc degree

Earth Sciences (variant I or II) and other students who have been admitted to the MSc degree programme by the examining board.

subject **Field Course Endogene Geology**
code 450152
lecturers drs. F.F. Beunk; dr. R.A. Stephenson; dr. H. Stel
credits 6
period period 5
aim The objective of this course is to provide students with threedimensional scenes of geological structures on outcrop scale or in landscape views, and learn them the skills to link theoretical knowledge to real sight observations. The places of interest are geared to subjects from the specialisation "Lithosphere tectonics, Petrology and Isotope geochemistry".
content Visit to W. Scotland or Cyprus, or other locations in Europe.
form of tuition Work excursion (3 stp.), introductory lectures and literature study (3 stp.).
literature Articles and field guidebook.
mode of assessment Active participation, at site seminars, written examination.
entry requirements Admission to this field course is only granted to students with a BSc degree Earth Sciences (variant I) and other students who have been admitted to the MSc degree programme by the examining board.

subject **Field Course Netherlands (Measurements Techniques)**
code 450126
lecturers dr. M.J. Waterloo; drs. P.M.H. Smit; dr. J. Groen; drs. M.M.A. Groen
credits 3
period period 5
content Instruction in geophysical, geohydrological, meteorological and chemical measurement techniques for research on groundwater and surfacewater movement and quality.
form of tuition Field course of one week
mode of assessment Written report

subject **Field Course North Italy (hydrology)**
code 450127
lecturers dr. A.A. van de Griend; dr.ir. E. Seyhan
credits 9
period period 6
content Hydro(geo)logical reconnaissance study in alpine drainage basins with emphasis on geological en geomorphological characteristics on the one hand, and hydrological characteristics and phenomena on the other. The fieldwork is carried out in small groups (maximum 3 students). Each group will study a separate catchment in which a hydrological observation network will be installed with advanced hydrological measurement instruments. The fieldwork will be completed with an intensive programme of data analysis, modelling, and report writing.
form of tuition 5 weeks of fieldwork including several collective excursion days. Housing will be organised by the university. 1 week of preparation. Extended documentation material and excursion guide. Frequent evaluation during and after field visits.
mode of assessment Final written report and oral presentation at the end.

entry requirements	Admission to this field course is only granted to students with a BSc degree in Earth Sciences and other students who have been admitted to the MSc degree programme by the examination board.

subject	**Field Course Sedimentology/Structural Geology**
code	450153
lecturers	dr. G.V. Bertotti; dr. J.H. ten Veen (and others)
credits	6
period	period 5
aim	The objective of this course is to provide students with 3 dimensional scenes of geological structures on outcrop scale to seismic scale. Students will learn to link theoretical knowledge and real world observations to obtain a comprehensive understanding of tectono-sedimentary systems. The regions of interest are geared to subjects from the specialisation "Sedimentary and Structural geology, basin analysis and surface processes".
content	Eastern- or Southern Alps, Turkey or Pyrenees, or other locations in Europe
form of tuition	Work excursion (3 ects), introduction lectures and literature study (3 ects)
literature	Articles and fieldguide
mode of assessment	Active participation, at site seminars, written examination
entry requirements	Admission to this field course is only granted to students with a BSc degree Earth Sciences (variant I) (and to other students who have been admitted to the MSc degree programme by the examining board) AND who have at least completed 12 stp. of the compulsory/core optional part of MSc programmes *Lithosphere tectonics, petrology and isotope geochemistry*, or *Sedimentary and structural geology, basin analysis, and surface processes*.

subject	**Geo-ecological Environments**
code	450049
lecturers	prof.dr. J.F. Vandenberghe; dr. O. van de Plassche
credits	6
period	period 4
content	Fluvial environments: fluvial models in relation to climate, palaeohydrological reconstructions, periglacial fluvial systems, river rehabilitation, river flooding concepts, case studies and management. Periglacial environments: permafrost development and degradation, relations between periglacial landforms and structures and their climatic conditions, periglacial river systems theory and case studies. Coastal depositional environments: morphology, morphodynamics, facies distribution, and evolution of coastal sedimentary systems (deltas, estuaries, beaches, etc.) as a function of antecedent topography, sea-level change (with special attention to global variation in glacio- and hydro-isostatic effects), sediment supply and characteristics, energy regime, fresh-water supply, etc.; classifications of and links between various (sub-)environments.
form of tuition	Mainly practical exercises (presentations, discussions on studied literature), a two-days fieldtrip.
mode of assessment	Evaluation of verbal presentation of papers and input into discussions; written summary of discussions.
remarks	Successful completion of 450097 (Terrestrische milieus) is advised.

subject **Geobiology**
code 450304
lecturers dr. P. Ziveri; prof.dr. D. Kroon; dr. F.J.C. Peeters
credits 6
period period 5
aim To provide an overview of the most relevant aspects of the field of geobiology, to study various areas of microbiology, geology, geochemistry and evolution.
content The course will initiate contacts between scientific disciplines which are not usually combined and will open new insights onto the history of life on earth. Selected lectures by a variety of instructors will cover a broad range of topics. There will be lectures on the role of microbes as living chemical agents and their importance in global geochemical cycles, on the impact of marine biogeochemical fluxes on climate cnages, on the evolutionary theory and recent methods of determinign phylogenies of organisms, and on paleontology. The course includes independent research based on recent literature.
form of tuition Lectures, practical work, literature study
mode of assessment On the basis of a written essay

naam **Geobotanie (plantkunde)**
code 450094
docenten dr. S.J.P. Bohncke; dr. K.P. Boessenkool
studiepunten 6
periode periode 5
inhoud A. Colleges: evolutie en indeling van het plantenrijk; morfologie van bloemplanten; inleiding in de plantenecologie met speciale aandacht voor vocht, voedingsstoffen, verzuring, successie en natuurbeheer. Verder gaan we in op verschillende aspecten van de geobotanie, zoals de relaties tussen klimaat, bodem, plantengroei en vegetatietypen; plantengeografie van Europa en Nederland; beginselen van vegetatieanalyse.
B. Practica: Tijdens twee middagen practicum wordt de morfologie van een aantal geselecteerde plantenfamilies bestudeerd. Hierbij wordt eveneens het determineren van planten met behulp van een flora geoefend. Een derde practicummiddag wordt gebruikt voor de voorbereiding van excursies en veldwerk aan de hand van topografische en bodemkundige kaarten.
C. Excursies en veldwerk zijn erop gericht om planten en vegetatietypen in samenhang met milieu en landschap te bestuderen. De excursies bieden een overzicht van natuur- en cultuurlandschappen zoals vochtige beekdalen tot hoogveen en droge heides. Gedurende 1 dag wordt veldwerk uitgevoerd waarin vegetatieanalyse wordt gecombineerd met de bestudering van omgevingsfactoren zoals vocht en nutrientenbeschikbaarheid. Excursies en veldwerk vinden plaats in Twente en zuid Drente.
literatuur R. van der Meijden - Heukels' Flora van Nederland, 22e druk 1996 of eerste bijdruk.
toetsing Tentamen en een verslag over excursies en veldwerk
werkwijze 14 uur hoorcollege, 3 halve dagen practicum, 4 dagen excursies en veldwerk.

subject **Geomicrobiology / Groundwater Microbiology and Geochemistry**
code 450132
lecturers dr. W.F.M. Roling; dr. B.M. van Breukelen
credits 6
period period 1
aim At the end of this interdisciplinary course, students will be able to describe and explain:

- Aspects of the growth and cellular functioning of microorganisms.
- The dependency of microbial presence and activity on environmental conditions.
- The impact of microorganisms on groundwater quality and geochemistry.
- Important microbial processes in polluted and pristine groundwater ecosystems.
- Modern methods in microbial ecology and biogeochemistry

Students will also be able to apply this theoretical knowledge as well as practical experience with several modern methods in microbial ecology and biogeochemistry to simple geomicrobiological issues

content Theory will consist of:
Introduction to environmental microbiology: Types and diversity of micro-organisms in groundwater ecosystems. Microbial growth, gene-expression, metabolism, and enzyme-kinetics in relation to environmental conditions. Interactions between micro-organisms. Basics of molecular microbiology. Overview of modern techniques in microbial ecology and biogeochemistry.
Impact of microbiological processes on hydrochemistry: Presence of micro-organisms in the subsurface. Microbial contribution to important biogeochemical processes and nutrient cycles. Microbial mediated mineral dissolution and precipitation. Microbial processes in extreme environments (deep earth, early life, exobiology).
Degradation of organic contaminants in groundwater: Adaptation of micro-organisms to pollution. Biodegradation, bioremediation and "natural attenuation" of pollution.
Practical work will consist of:
Geomicrobiological researc: Groundwater sampling. Characterization of microbial communities in polluted groundwater and relating the presence of microorganisms to environmental conditions.

form of tuition 30 hours of work-lectures including performance of exercises, 60 hours of practicals (including two days of field-work), 70 hours study-pause
literature Madigan, M.T., Martinko, J.M. and Parker, J.M. (2002), Brock biology of microorganisms. Pearson Higher Education. ISBN: 0130491470 (75 euro), with syllabus with additional material and practicals (5 Euro).
mode of assessment Written exam about theory and practicals, testing both knowledge and insight.
remarks This module can be taken as an elective option by master students in Hydrology and Geo-environmental Sciences. In addition, this course is also open to students in the masters Biology and Earth Sciences.

subject **Geotechnics**
code 450050
lecturer guests (GeoDelft)
credits 6

period period 5

aim To obtain insight in soil mechanical processes and the interaction of soil and man made constructions. The introduction in geotechnics covers soil mechanics and foundation engineering and provides the earth scientist to cooperate in multi disciplinary projects in which geological, hydrological and geotechnical problems need to be considered simultaneously.

content The introduction in geotechnics gives an overview of soil mechanical processes and soil-construction interaction. Since geological, environmental and hydrological aspects form part of geotechnical processes, the different perception of these aspects in geotechnics is emphasized. Geotechnical processes and the influence of soil properties on these processes are illustrated by treatment of historical short term processes such as failures of dams, road constructions and collapse of buildings. Long terms processes such as settlement of roads, river dikes, and buildings are dealed with by means of examples from the Dutch engineering practice. The theoretical behaviour of soil induced by external loads and shear forces will be verified by performance of laboratory experiments and a field test.

form of tuition Lectures, laboratory experiments, field test (cone penetration test) and an excursion to the geocentrifuge

literature Syllabus `Geotechnics' and hand-outs

mode of assessment Written exam, report of laboratory experiments and field test

naam **Ges es: 3e j. wc: Natuur en vooruitgang 1500-2000**

code 520160

coördinator dr. P.J.E.M. van Dam

docenten dr. P.J.E.M. van Dam; dr. S.W. Verstegen; prof.dr. J.J. Boersema

studiepunten 10

contacturen 28 (28 werkcollege)

periode periode 4 en 5

doel Het leren uitvoeren van historisch onderzoek met literatuur en gedrukte bronnen naar ontwikkelingen in het denken over de natuur aan de hand van concrete case-studies, en daarover mondeling en schriftelijk rapporteren.

inhoud De moderne westerse mens kent de natuur vooral als een bedreigde en verdwijnende grootheid. Dat was vroeger anders. De natuur werd gezien als lelijk (ongeordend) gevaarlijk, nutteloos (economisch onrendabel) en uitgestrekt. Natuur diende plaats te maken voor cultuur. De zee werd getemd, woeste grond in cultuur gebracht, oerwoud gekapt en moeras drooggelegd. In dit college bestuderen we de ideologische omslag van 'beschaving is natuur ontginnen' naar 'beschaving is natuur behouden' en plaatsen die in de context van de langetermijn ontwikkeling van het denken over natuur, natuurbeheersing en maatschappelijke vooruitgang. Wanneer vond de omslag plaats en waarom? Wie hanteerde wanneer welke motieven ten aanzien van het beschaven of behouden van de natuur? We bestuderen de maatschappelijke discussies rond de grote inpolderingen in Nederland (Haarlemmermeer, Zuiderzee en Waddenzee) en trekken vergelijkingen met projecten elders in Europa en de V.S.

literatuur Syllabus

onderwijs werkcollege

toetsing Referaat en werkstuk

entreevoorwaarden Passieve kennis van het Nederlands is verplicht.

doelgroep Dit college kan dienen als invulling van één van de twee kernvakken in jaar 3 van de bacheloropleiding Geschiedenis.

opmerkingen
- Het is ook toegankelijk als bachelorbijvak voor studenten Biologie, Geologie, Taalwetenschappen, Communicatiewetenschappen, Antropologie, Filosofie, Theologie en Sociale Wetenschappen
- Inschrijven verplicht via TISVU

subject **Global Biogeochemical Cycles**
code 450051
lecturers prof.dr. A.J. Dolman; dr. J. van Huissteden
credits 6
period period 4
content An in depth analysis of the major global biogeochemical cycles and their natural and anthopogenic disturbances. Exchange of C, N, P and S between soil, water, atmosphere and biota on global and local scales in different climatic zones (tropics, temperate, boreal and arctic zone) and environments, e.g. forests, wetlands and marine environments. Interannual variability in uptake and exchange patters. Influence of biogeochemical cycles on the climate system, and relation with the hydrological cycle and of climate on the biogeochemistry. Examples of quantification of fluxes using different measurement techniques, inc. isotopic tracer applications and (inverse) modeling techniques.
form of tuition 24 hours of lectures + workshop attendance and preparation of literature review.
literature Parts of "Global Biogeochemical Cycles in the Climate System" by Ernst-Detlef Schulze (Editor), Martin Heimann (Editor), Sandy Harrison (Editor), Elisabeth Holland (Editor), Jonathan Lloyd, Iain Colin Prentice, David Schimel and literature made available during the course.
mode of assessment Test and literature review report.

subject **Groundwater Flow Modelling**
code 450008
lecturer dr. C.J. Hemker
credits 6
period period 2
content General introduction to programming with Matlab and to computer methods for the numerical modelling of saturated groundwater flow, including linear algebra, analytical algorithms, finite-difference and finite-element methods.
form of tuition Lectures; computer exercises using Matlab and several computer programs for modelling steady-state and transient groundwater flow, e.g. Flownet and MicroFEM
literature M. P. Anderson & W.W. Woessner, 1992, *Applied Groundwater Modelling: Simulation of Flow and Advective Transport,* Academic Press, Inc, 381p.
mode of assessment Oral presentation and written report on individual model exercise. Written examination
entry requirements Advice regarding previous courses taken: 450009: Groundwaterhydraulics

subject **Groundwater Hydraulics**
code 450009
lecturer dr. H. Kooi

credits 6
period period 1
aim To acquire knowledge of the theory of groundwater flow and its application to real-world problems and to develop practical skills in solving simple groundwater flow problems.
content Types of applications of groundwater hydraulics; the general approach. *Fundamentals of groundwater movement:* physics of Darcy's law, conservation of mass; partial differential equation of groundwater flow, specific storage, effective stress and anisotropy. *General behaviour and solution methods:* steady-state and non-steady-state (transient) problems, simplifying assumptions, graphical, analytical and numerical solution methods, diffusion behaviour, refraction, transients and Fourier series solutions. *Simple applications using analytical solutions:* topography-driven flow systems, flow in phreatic, confined and semi-confined aquifers and aquitards, well flow, land subsidence, hydraulic fracturing, residence times, macroscopic fluxes/balances. *Introduction to more complex flow problems:* variable-density flow, compaction.
form of tuition Lectures and exercises
literature Domenico, P.A. & F.W. Schwartz, 1998, *Physical and chemical hydrogeology*, 2nd edition, Wiley. + course notes (handouts)
mode of assessment Written exam
entry requirements Advice regarding previous courses taken: 450024: Inleiding hydrologie, 450073: Wis- en natuurkunde.

subject **Historical Geography**
code 450292
lecturer Prof. dr. G.J. Borger; dr. A.M.J. de Kraker
credits 6
period period 1
aim providing a basic knowledge of the historical geography of the Netherlands.
content The course provides knowledge of the evolution of the four main landscape types of the Netherlands and an understanding of the interaction between man and nature on a time scale of about 1,000 years. In particular the landscapes dominated by a mainly sandy soil, the polder (clay) areas and the peat areas, will be discussed. Students will independently study a fourth and alternative landscape type. Main issue is how these landscapes have continuously been changing and what have been the main forcing factors in this process of transformation. This implies knowledge of the social, political and economic systems that dominated particular periods of the recent millennium. This also implies knowledge of the natural processes that have had an impact over the recent millennium, such as rising mean sea level versus land reclamation/water management and coastal management; climate variability versus agricultural production and agricultural systems. The course finally aims at achieving a better understanding of our cultural heritage and how processes and decision making during and of the past still have an impact on present day landscapes and our environment as such.
Because this course provides knowledge and understanding of the interacting between spatial (geography) and temporal processes (history), it also deals with the main methods and instruments used by historical geographers, such as written records and old maps.

form of tuition lectures, practical exercises, two daily excursions
literature Relevant literature (e.g. reader) will be provided during the course.
mode of assessment exam based on written reports

subject **Hydrochemistry**
code 450052
lecturers dr. B.M. van Breukelen; drs. P.M.H. Smit
credits 6
period period 4
aim
- Obtain a quantitative insight in how biogeochemical processes and the geochemical composition of the subsurface determine and change the composition of (ground)water during flow.
- Get experience with the reactive transport model PHREEQC-2 and understand how this numerical model helps in solving hydrochemical problems.

content Hydro(geo)chemistry is essential for solving problems related with (ground)water quality and ecohydrology. The following topics are included: sampling and analysis of (ground)water; thermodynamics and kinetics of hydrogeochemical processes; reactive properties of hydrogeological systems; dissolution and precipitation of minerals; carbonate chemistry; cation exchange; surface complexation; weathering of silicates; redox-processes; effects of evaporation and mixing of different water types; principles and introduction to numerical geochemical modelling.
form of tuition Lectures; manual calculations; computer exercises; laboratorium experiments.
literature C.A.J. Appelo & D. Postma, 2004. *Geochemistry, groundwater and pollution. 2nd edition.*
mode of assessment Examination of lecture-subjects; evaluation of computer exercises; evaluation of laboratory experiments.
entry requirements Advice regarding previous courses taken: 450022: Inleiding in de anorganische geochemie (Bachelor's Earth Sciences).

naam **Information Representation/ Multimedia 1**
code 471015
docenten dr. G.C. van der Veer; dr. J.F. Hoorn; J. Smit
studiepunten 6
periode 10.01.2005 - 04.02.2004
inhoud In deze cursus wordt het begrip representatie systematisch behandeld, zowel vanuit de Psychologische kant van menselijke waarneming en informatieverwerking, als vanuit de kant van het ontwerpen van representaties met behulp van verschillende technieken. De cursus bevat theorie betreffende deze onderdelen met opgaven per onderdeel alsmede een ontwerpproject dat in groepen van ca. 3 personen zal worden uitgevoerd. Aanwezigheid is verplicht, en de cursus zal ca. 40 uur werk per week vereisen.
literatuur Zie http://www.cs.vu.nl/~gerrit/Communicatie-Afbeeldingen
toetsing De toetsing bestaat uit een combinatie van beoordelingen van:
- huiswerkopgaven
- presentatie eindproject
- documentatie eindproject

naam **Interpersoonlijke communicatie**
code 991000
studiepunten 3
periode 01-11-2004 / 12-11-2004
doel Ontwikkelen van:
- inzicht in interactieprocessen/het verloop van de communicatie in een groep;
- vaardigheden met betrekking tot het goed kunnen communiceren in een groep, in het bijzonder in een leidinggevende rol.

inhoud In deze module gaat het om het zicht krijgen op interactiepatronen die zich afspelen in een groep. Je eigen communicatieaandeel als groepslid en je mogelijkheden een 'leidersrol' te vervullen komen aan de orde.
Er wordt gewerkt aan de hand van het Model Interpersoonlijk Leraarsgedrag, dat wordt gebruikt in de lerarenopleiding maar dat ook bruikbaar is in andere situaties. Effecten die gedragingen van de 'leider' hebben op de leden van de groep worden geanalyseerd. Daarnaast wordt 'effectief' gedrag getraind.

literatuur
- F. Oomkes: communicatieleer, isbn 9053525378
- Artikelen die in de bijeenkomsten worden uitgereikt

toetsing Op basis opdracht (bijvoorbeeld via videofragment), waarvan de resultaten in het portfolio zichtbaar worden gemaakt.
werkwijze Werkcolleges/workshops waarin videobeelden worden geanalyseerd; herkennen van interactiepatronen; training/oefenen van gedragsvaardigheden.

subject **Isotope Hydrology**
code 450148
lecturer dr. J. Groen
credits 3
period period 5
aim After falling on the earth as precipitation, water distributes and redistributes itself repeatedly in vegetation, soil, groundwater, rivers, and seas, until it sooner or later returns to the atmosphere. During this earthly course water also continuously changes in solute content. The isotopes of water and its solutes are ideal tools for tracing various hydrological processes. As such isotope hydrology is applied in scientific studies to obtain more insight in these processes as well as for practical purposes like understanding runoff behaviour of rivers, effects of land-use and climate changes, groundwater exploration and managment, and assesment and monitoring of water pollution.
content Isotope hydrology, deals mainly with the light isotopes: 18O en 2H and 3H in water and 3He, 4He, 11B, 13C, 14C, 15N, 34S, 37Cl and 87Sr in solutes. These isotopes are diagnostic for many water and solute transport processes and hydrogeochemical reactions. The course discusses isotopic processes of mixing, fractionation and decay, which lead to endless variations of isotopic ratios in nature, both in space and time. These patterns enable us to determine the origin of waters and changes in climate and landscape. Students will carry out studies on the basis of data from earlier studies or from ongoing research of the Department of Hydrogeology and Geo-environmental Sciences.
form of tuition Oral courses, excursion to isotope laboratories, study of research data with an oral presentation.

literature Syllabus with exercises, printout of overhead sheets, summarized version of the IAEA report "Environmental isotopes in the hydrological cycle", old exam questions

mode of assessment Written examination, presentations and reports of case studies

remarks Advice regarding previous courses taken: Inleiding hydrologie (bachelor course) 450024 Geochemie voor aardwetenschappers 450068 (bachelor course) and Hydrochemistry 450052 (master course hydrology).

naam **Keuzemodulen**

code 990004

studiepunten 4

docent Diverse Docenten

inhoud Het Onderwijscentrum VU biedt keuzemodulen aan. Eén van de mogelijkheden is één of meer van de door het instituut aangeboden keuzemodulen te volgen. De dio kan er echter ook voor kiezen om een bepaald aspect van een schoolvak of een aspect van het leerproces van leerlingen of van het coachen van leerlingen nader te bestuderen. Door het Onderwijscentrum VU worden onder andere de volgende keuzemodulen aangeboden:

- Docent in Europa
- Lesgeven in het HBO
- Excursie Gent
- Petje af
- Lesgeven in het VMBO

Binnen de clusters en vakken worden keuzemodulen aangeboden als:

- Veldwerkweek
- Klassieke Culturele Vorming (KCV)
- Culturele en Kunstzinnige Vorming (CKV)

literatuur Wordt bij aanvang van de cursus bekend gemaakt.

onderwijs werkcollege
werkcolleges vinden plaats op maandag

toetsing opdracht

opmerkingen In het voorjaar worden het definitieve aanbod van keuzemodulen bekend gemaakt. De inschrijving voor de modulen vindt dan plaats.

subject **Land Husbandry**

code 450155

lecturer dr. W.R.S. Critchley (staff members CIS (Centre for International Cooperation VU) see for further information CIS: http://130.37.129.100/cdcs/)

credits 3

period period 3

aim The course main focus is on `what can be done about the 'problems' of erosion and degradation. It spans a wide range of topics, including environmental problems, history of approaches, concepts of rural development, conservation technologies in the field, working with local people, and consultancy skills in R+D projects in the development tropics.

content Environmental degradation and rural poverty: processes and impact. History of conservation: from failed approaches to new concepts in rural development and principles of Land Husbandry. Conservation technologies:

humid areas/dry areas. International environmental protocols and their impact on rural development programmes. Socio-economic factors: population/ land tenure/ gender/ incentives/ participation etc., Indigenous knowledge and local innovation, Participatory learning and action (PRA/ PTD/ PM&E etc). Case studies of projects and programmes from Africa and Asia. Project design, monitoring, evaluation and technical backstopping.

form of tuition 8 x 3 hour presentations/ seminars plus an assignment and end exam, One topic would be chosen by each student for an assignment of 3,000 -- 5,000 words based on further reading

mode of assessment Written exam

subject **Magmatic Processes**

code 450011

lecturers dr. G.R. Davies; dr. P.Z. Vroon; drs. F.F. Beunk

credits 6

period period 2

aim *Knowledge:* understanding of melts, melting processes and melt transport in the principal crustal and mantle reservoirs as related to specific geodynamic environments; exchange of matter between the principal reservoirs, and the development of these reservoirs with time.
Skills: geochemical modelling practice; scientific writing and oral presentation.

content Distribution of major and trace elements between solid and liquid phases; geochemical modelling of magmatic differentiation processes. Radiogenic and stable isotopes as tracers of magmatic processes; geochemical and temporal evolution of crust and mantle.
The physics of magmatic processes: source, transport, emplacement/eruption. Characteristics of principal geodynamic environments; their effects on magmatic processes.

form of tuition Home work, tutorial seminars, practicals; student paper and its oral presentation.

literature Selection from chapters of text-books and review papers. Handouts.

mode of assessment Practicals (20%), paper and its presentation (40%), written exam (40%).

remarks Recommended prior courses: Petrology I (450076), Petrology of System Earth (450083), Isotope geochemistry (450028)

subject **Magmatic Processes Capita Selecta (Melt Inclusions)**

code 450167

lecturer dr. I. Nikogosian

credits 3

period period 1 and 2

aim The course provides a theoretical and practical introduction to a relatively new method of study of melting processes in the crust and mantle. Melt inclusions are tiny drops of melt enclosed inside crystals of magmatic minerals. Melt inclusions are trapped during crystal growth. Physically separated from the magmatic environment outside the host crystal, melt inclusions are protected from the many complicated processes which may attend the bulk system - mixing, crystal fractionation, degassing and contamination. Thus, melt inclusions reveal the compositional variations of individual primary melts and conditions of their origin. The methodology of

melt inclusion studies involves micro-thermometric experiments on a high-temperature heating stage. Melt inclusions are homogenised (remelted) in equilibrium with their host minerals, allowing determination of crystallisation temperature. Homogenised melts are quenched into glass and, subsequently, analysed by electron and ion/laser microprobe for major and trace element and isotopic compositions. These data can be used in numerical modeling of melting processes and primary magma evolution (compositions, pressure, temperature, fugacity and volatiles).

content *Lectures* will address *(1)* general information about magmatic inclusions, their types and classification, and methodologies of melt inclusions study, and *(2)* the derivation of main petrological characteristics of primary magmas: their chemical composition, oxygen fugacity and volatile content, liquidus mineral assemblages, and temperature and pressure of crystallization.
Practicals: High-temperature experiments with melt inclusions to determine magma crystallisation temperature, using a heating/quenching stage (up to 1500oC) installed at the VU (Department of Petrology). Additional heating/cooling experiments with fluid inclusions to determine crystallisation pressure and volatile contents in melts. The student will also practise with `PETROLOG', a petrological software package for the numerical modeling of magmatic evolution.

literature A selection of published articles

mode of assessment Reports of lab work, written theoretical examination.

remarks Recommended prior course: Magmatic Processes (450011)

subject **Marine Geology**

code 450012

lecturer vacancy (course may not be taught in 2004-2005)

credits 6

period period 2

aim To obtain a good overview of the important elements of the geology of the ocean basins, how they are studied, and the relationship between the methods, the resulting data, and how they are interpreted. The participant should be able at the end of the course to properly assess data obtained at sea, specify methods for addressing scientific problems related to marine geology and research at sea, and better understand rocks in the geological record which originated through marine processes.

content This course focuses on marine research techniques (geophysical methods, navigation, cartography, sampling methods, and the technology of marine investigations) and their application to the study of marine geology in practice.
The *main themes* are modern processes in the ocean basins and a comparison of their products there with what we observe in the geological record, methods and observations of these processes and products, and an examination of some typical data from such observations.
The *scope* includes the development of modern ocean basins, from mid-ocean ridges to the margins and coast, with consideration given to multidisciplinary aspects such as hydrothermal systems of mid-ocean ridges and microbiologically mediated diagenetic processes in gassy sediments on margins.

form of tuition There will be roughly 24 hours of lectures and 16 hours practical work
literature Jones, E.J.W. (1999) Marine Geophysics, John Wiley and Sons.
mode of assessment Written examination and exercises from practicals.
remarks Those following this course are recommended to have a basic understanding of general geophysical methods (e.g. from a first course in exploration geophysics).

subject **Master Thesis Archaeometry (M-variant)**
code 450299
lecturers prof.dr. H. Kars; dr. G. Aalbersberg; drs. E.A.J. Burke
credits 27
period variable
aim improvement of scientific research skills, reporting results
content As in the Research Project, the student will be enabled to independently perform scientific research, either at the Institute or at another university. Alternatively, the Master Thesis can be used as an apprenticeship with a company in the field of geoarchaeology as an introduction into commercial archaeology.
form of tuition fieldwork, laboratory work, apprenticeship
mode of assessment written report
remarks The Master thesis is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the Master thesis work placement (M-variant) or research project (O-variant). This agreement should be put forward to the examining board (Dr. Ir. M. Bergwerff) before the start of the work placement or research project.
The master thesis work placement or research project may be extended by a volume of 12 stp. using the optional subject 'Extension Master Thesis Archaeometry' (450302).
Admission to the Master Thesis is only granted to master students (students without a bachelor degree are therefore excluded). Admission requirements are checked by the examining board. Participants should register in time (preferably 2-3 months in advance) with the staff member/department in question and by TISVU/TIS.

subject **Master Thesis Archaeometry (O-variant)**
code 450300
lecturers prof.dr. H. Kars; dr. G. Aalbersberg; drs. E.A.J. Burke
credits 27
period variable
aim improvement of scientific research skills, reporting results
content As in the Research Project, the student will be enabled to independently perform scientific research, either at the Institute or at another university. Alternatively, the Master Thesis can be used as an apprenticeship with a company in the field of geoarchaeology as an introduction into commercial archaeology.
form of tuition fieldwork, laboratory work, apprenticeship
mode of assessment written report
remarks The Master thesis is subject to the school's Work placement and thesis

regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the Master thesis work placement (M-variant) or research project (O-variant). This agreement should be put forward to the examining board (Dr. Ir. M. Bergwerff) before the start of the work placement or research project.
The master thesis work placement or research project may be extended by a volume of 12 stp. using the optional subject 'Extension Master Thesis Archaeometry' (450302).
Admission to the Master Thesis is only granted to master students (students without a bachelor degree are therefore excluded). Admission requirements are checked by the examining board. Participants should register in time (preferably 2-3 months in advance) with the staff member/department in question and by TISVU/TIS.

subject **Master Thesis Ecohydrology (M-variant)**
code 450125
credits 27
period variable
aim Work placement (traineeship; stage) in the master specialisation Ecohydrology of the master programme in Hydrology.
content Work placement (traineeship; stage) with a volume of 27 stp. (18 weeks) and related master thesis report
form of tuition Work placement (traineeship; stage)
mode of assessment Written report
entry requirements Bachelor exam Earth Sciences VU variant I, II or III, and at least 36 stp. of the programme of the master specialisation concerned should be registered by the student administration. Otherwise, admission only when granted by the examining board.
remarks The Master thesis is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the Master thesis work placement (M-variant) or research project (O-variant). This agreement should be put forward to the examining board (Dr. Ir. M. Bergwerff) before the start of the work placement or research project.
The master thesis work placement or research project may be extended by a volume of 12 stp. using the optional subject `Extension of master thesis in hydrology' (450151).
Information on Master thesis projects is provided by departmental members of staff and is made available on the departmental pages of the faculty web-site, or at:
Dutch page: http://www.geo.vu.nl/onderwijs/master/index-nl.html
English page: http://www.geo.vu.nl/onderwijs/afd/index-en.html

subject **Master Thesis Ecohydrology (O-variant)**
code 450124
credits 27
period variable
aim Research project in the master specialisation Ecohydrology of the master

programme in Hydrology.

content Research project with a volume of 27 stp. (18 weeks) and related master thesis report

form of tuition Research project

mode of assessment Written report

entry requirements Bachelor exam Earth Sciences VU variant I, II or III, and at least 36 stp. of the programme of the master specialisation concerned should be registered by the student administration. Otherwise, admission only when granted by the examining board.

remarks The Master thesis is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the Master thesis work placement (M-variant) or research project (O-variant). This agreement should be put forward to the examining board (Dr. Ir. M. Bergwerff) before the start of the work placement or research project.
The master thesis work placement or research project may be extended by a volume of 12 stp. using the optional subject `Extension of master thesis in hydrology' (450151)
Information on Master thesis projects is provided by departmental staff members and is made available on the departmental pages of the faculty web-site, or at:
Dutch page: http://www.geo.vu.nl/onderwijs/master/index-nl.html
English page: http://www.geo.vu.nl/onderwijs/afd/index-en.html

subject **Master Thesis Geo-ecosystems and Climate (M-variant)**

code 450140

credits 27

period variable

aim Work placement (traineeship; stage) in the master specialisation Geo-ecosystems and climate of the master programme in Geo-environmental Sciences.

content Work placement (traineeship; stage) with a volume of 27 stp. (18 weeks) and related master thesis report.

form of tuition Work placement (traineeship; stage).

mode of assessment Written report.

entry requirements Bachelor exam Earth Sciences VU variant II or III, and at least 36 stp. of the programme of the master specialisation concerned should be registered by the student administration. Otherwise, admission only when granted by the examining board.

remarks The Master thesis is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the Master thesis work placement (M-variant) or research project (O-variant). This agreement should be put forward to the examining board (Dr. Ir. M. Bergwerff) before the start of the work placement or research project.
The master thesis work placement or research project may be extended by a volume of 12 stp. using the optional subject `Extension of master thesis in geo-environmental sciences' (450150).

Information on Master thesis projects is provided by departmental staff members and is made available on the departmental pages of the Faculty web-site, or at:
Dutch page: http://www.geo.vu.nl/onderwijs/master/index-nl.html
English page: http://www.geo.vu.nl/onderwijs/afd/index-en.html

subject **Master Thesis Geo-ecosystems and Climate (O-variant)**
code 450139
credits 27
period variable
aim Research project in the master specialisation Geo-ecosystems and climate of the master programme in Geo-environmental Sciences.
content Research project with a volume of 27 stp. (18 weeks) and related master thesis report.
form of tuition Research project.
mode of assessment Written report.
entry requirements Bachelor exam Earth Sciences VU variant II or III, and at least 36 stp. of the programme of the master specialisation concerned should be registered by the student administration. Otherwise, admission only when granted by the examining board.
remarks The Master thesis is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the Master thesis work placement (M-variant) or research project (O-variant). This agreement should be put forward to the examining board (Dr. Ir. M. Bergwerff) before the start of the work placement or research project.
The master thesis work placement or research project may be extended by a volume of 12 stp. using the optional subject `Extension of master thesis in geo-environmental sciences' (450150).
Information on Master thesis projects is provided by departmental staff members and is made available on the departmental pages of the faculty web-site, or at:
Dutch page: http://www.geo.vu.nl/onderwijs/master/index-nl.html
English page: http://www.geo.vu.nl/onderwijs/afd/index-en.html

subject **Master Thesis Hydrogeology (M-variant)**
code 450123
credits 27
period variable
aim Work placement (traineeship; stage) in the master specialisation Hydrogeology of the master programme in Hydrology
content Work placement (traineeship; stage) with a volume of 27 stp. (18 weeks) and related master thesis report
form of tuition Work placement (traineeship; stage)
mode of assessment Written report
entry requirements Bachelor exam Earth Sciences VU variant I, II or III, and at least 36 stp. of the programme of the master specialisation concerned should be registered by the student administration. Otherwise, admission only when granted by the examining board.

remarks The Master thesis is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the Master thesis work placement (M-variant) or research project (O-variant). This agreement should be put forward to the examining board (Dr. Ir. M. Bergwerff) before the start of the work placement or research project.
The master thesis work placement or research project may be extended by a volume of 12 stp. using the optional subject `Extension of master thesis in hydrology' (450151)
Information on Master thesis projects is provided by departmental staff members and is made available on the departmental pages of the faculty web-site, or at:
Dutch page: http://www.geo.vu.nl/onderwijs/master/index-nl.html
English page: http://www.geo.vu.nl/onderwijs/afd/index-en.html

subject **Master Thesis Hydrogeology (O-variant)**
code 450122
credits 27
period variable
aim Research project in the master specialisation Hydrogeology of the master programme in Hydrology.
content Research project with a volume of 27 stp. (18 weeks) and related master thesis report
form of tuition Research project
mode of assessment Written report
entry requirements Bachelor exam Earth Sciences VU variant I, II or III, and at least 36 stp. of the programme of the master specialisation concerned should be registered by the student administration. Otherwise, admission only when granted by the examining board.
remarks The Master thesis is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the Master thesis work placement (M-variant) or research project (O-variant). This agreement should be put forward to the examining board (Dr. Ir. M. Bergwerff) before the start of the work placement or research project.
The master thesis work placement or research project may be extended by a volume of 12 stp. using the optional subject `Extension of master thesis in hydrology' (450151)
Information on Master thesis projects is provided by departmental staff members and is made available on the departmental pages of the Faculty web-site, or at:
Dutch page: http://www.geo.vu.nl/onderwijs/master/index-nl.html
English page: http://www.geo.vu.nl/onderwijs/afd/index-en.html

subject **Master Thesis Landscape Archaeology (M-variant)**
code 450297
lecturers prof.dr. H. Kars; dr. G. Aalbersberg; drs. E.A.J. Burke
credits 27

period variable
aim improvement of scientific research skills, reporting results
content As in the Research Project, the student will be enabled to independently perform scientific research, either at the Institute or at another university. Alternatively, the Master Thesis can be used as an apprenticeship with a company in the field of geoarchaeology as an introduction into commercial archaeology.
form of tuition fieldwork, laboratory work, apprenticeship
mode of assessment written report
remarks The Master thesis is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the Master thesis work placement (M-variant) or research project (O-variant). This agreement should be put forward to the examining board (Dr. Ir. M. Bergwerff) before the start of the work placement or research project.
The master thesis work placement or research project may be extended by a volume of 12 stp. using the optional subject 'Extension Master Thesis Landscape Archaeology' (450301).
Admission to the Master Thesis is only granted to master students (students without a bachelor degree are therefore excluded). Admission requirements are checked by the examining board. Participants should register in time (preferably 2-3 months in advance) with the staff member/department in question and by TISVU/TIS.

subject **Master Thesis Landscape Archaeology (O-variant)**
code 450298
lecturers prof.dr. H. Kars; dr. G. Aalbersberg; drs. E.A.J. Burke
credits 27
period variable
aim improvement of scientific research skills, reporting results
content As in the Research Project, the student will be enabled to independently perform scientific research, either at the Institute or at another university. Alternatively, the Master Thesis can be used as an apprenticeship with a company in the field of geoarchaeology as an introduction into commercial archaeology.
form of tuition fieldwork, laboratory work, apprenticeship
mode of assessment written report
remarks The Master thesis is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the Master thesis work placement (M-variant) or research project (O-variant). This agreement should be put forward to the examining board (Dr. Ir. M. Bergwerff) before the start of the work placement or research project.
The master thesis work placement or research project may be extended by a volume of 12 stp. using the optional subject 'Extension Master Thesis Landscape Archaeology' (450301).
Admission to the Master Thesis is only granted to master students (students without a bachelor degree are therefore excluded). Admission requirements

are checked by the examining board. Participants should register in time (preferably 2-3 months in advance) with the staff member/department in question and by TISVU/TIS.

subject **Master Thesis Lithosphere Tectonics, Petrology, and Isotope Geochemistry (M-variant)**
code 450108
credits 27
period variable
aim Work placement (traineeship; stage) in the master specialisation Lithosphere tectonics, petrology and isotope geochemistry of the master programme in Earth Sciences.
content Work placement (traineeship; stage) with a volume of 27 stp. (18 weeks) and related master thesis report
form of tuition Work placement (traineeship; stage)
mode of assessment Written report
entry requirements Bachelor exam Earth Sciences VU variant I, and at least 36 stp. of the programme of the master specialisation concerned should be registered by the student administration. Otherwise, admission only when granted by the examining board.
remarks The Master thesis is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the Master thesis work placement (M-variant) or research project (O-variant). This agreement should be put forward to the examining board (Dr. Ir. M. Bergwerff) before the start of the work placement or research project.
The master thesis work placement or research project may be extended by a volume of 12 stp. using the optional subject 'Extension of master thesis in earth sciences' (450149).
Information on Master thesis projects is provided by departmental staff members and is made available on the departmental pages of the faculty web-site, or at:
Dutch page: http://www.geo.vu.nl/onderwijs/master/index-nl.html
English page: http://www.geo.vu.nl/onderwijs/afd/index-en.html

subject **Master Thesis Lithosphere Tectonics, Petrology, and Isotope Geochemistry (O-variant)**
code 450107
credits 27
period variable
aim Research project in the master specialisation Lithosphere tectonics, petrology and isotope geochemistry of the master programme in Earth Sciences.
content Research project with a volume of 27 stp. (18 weeks) and related master thesis report
form of tuition Research project. Integrated in this subject is a course on analytical techniques taught by members of the departments of Petrology and Isotope Geochemistry. The course consists of eight mornings, or afternoons, and will cover all aspects of sample handling from sampling techniques in the field, preparation of thin sections, preparation of samples required for analysis, to

the basic theory of analytical techniques available in the faculty, data acquisition and interpretation. For practicals that are part of this course students will make use of materials sampled for their own projects.

mode of assessment Written report

entry requirements Bachelor exam Earth Sciences VU variant I, and at least 36 stp. of the programme of the master specialisation concerned should be registered by the student administration. Otherwise, admission only when granted by the examining board.

remarks The Master thesis is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the Master thesis work placement (M-variant) or research project (O-variant). This agreement should be put forward to the examining board (Dr. Ir. M. Bergwerff) before the start of the work placement or research project.
The master thesis work placement or research project may be extended by a volume of 12 stp. using the optional subject 'Extension of master thesis in earth sciences' (450149).
Information on Master thesis projects is provided by departmental lecturers and is made available on the departmental pages of the Faculty web-site, or at:
Dutch page: http://www.geo.vu.nl/onderwijs/master/index-nl.html
English page: http://www.geo.vu.nl/onderwijs/afd/index-en.html

subject **Master Thesis Paleoclimatology/Paleo-ecology/Paleo-oceanography (M-variant)**

code 450118

credits 27

period variable

aim Work placement (traineeship; stage) in the master specialisation Paleoclimatology/Paleo-ecology/Paleo-oceanography of the master programme in Earth Sciences.

content Work placement (traineeship; stage) with a volume of 27 stp. (18 weeks) and related master thesis report

form of tuition Work placement (traineeship; stage)

mode of assessment Written report

entry requirements Bachelor exam Earth Sciences VU variant I, II or III, and at least 36 stp. of the programme of the master specialisation concerned should be registered by the student administration. Otherwise, admission only when granted by the examining board.

remarks The Master thesis is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the Master thesis work placement (M-variant) or research project (O-variant). This agreement should be put forward to the examining board (Dr. Ir. M. Bergwerff) before the start of the work placement or research project.
The master thesis work placement or research project may be extended by a volume of 12 stp. using the optional subject 'Extension of master thesis in earth sciences' (450149).

Information on Master thesis projects is provided by departmental supervisors and is made available on the departmental pages of the Faculty web-site, or at:
Dutch page: http://www.geo.vu.nl/onderwijs/master/index-nl.html
English page: http://www.geo.vu.nl/onderwijs/afd/index-en.html

subject **Master Thesis Paleoclimatology/Paleo-ecology/Paleo-oceanography (O-variant)**
code 450117
credits 27
period variable
aim Research project in the master specialisation Paleoclimatology/Paleo-ecology/Paleo-oceanography of the master programme in Earth Sciences.
content Research project with a volume of 27 stp. (18 weeks) and related master thesis report
form of tuition Research project
mode of assessment Written report
entry requirements Bachelor exam Earth Sciences VU variant I, II or III, and at least 36 stp. of the programme of the master specialisation concerned should be registered by the student administration. Otherwise, admission only when granted by the examining board.
remarks The Master thesis is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the Master thesis work placement (M-variant) or research project (O-variant). This agreement should be put forward to the examining board (Dr. Ir. M. Bergwerff) before the start of the work placement or research project.
The master thesis work placement or research project may be extended by a volume of 12 stp. using the optional subject 'Extension of master thesis in earth sciences' (450149).
Information on Master thesis projects is provided by departmental supervisors and is made available on the departmental pages of the faculty web-site, or at:
Dutch page: http://www.geo.vu.nl/onderwijs/master/index-nl.html
English page: http://www.geo.vu.nl/onderwijs/afd/index-en.html

subject **Master Thesis Quaternary Geology/ Geo-ecology (M-variant)**
code 450121
credits 27
period variable
aim Work placement (traineeship; stage) in the master specialisation Quaternary geology/geo-ecology of the master programme in Earth Sciences.
content Work placement (traineeship; stage) with a volume of 27 stp. (18 weeks) and related master thesis report
form of tuition Work placement (traineeship; stage)
mode of assessment Written report
entry requirements Bachelor exam Earth Sciences VU variant II, and at least 36 stp. of the programme of the master specialisation concerned should be registered by the student administration. Otherwise, admission only when granted by the

examining board.

remarks The Master thesis is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the Master thesis work placement (M-variant) or research project (O-variant). This agreement should be put forward to the examining board (Dr. Ir. M. Bergwerff) before the start of the work placement or research project.
The master thesis work placement or research project may be extended by a volume of 12 stp. using the optional subject 'Extension of master thesis in earth sciences' (450149).
Information on Master thesis projects is provided by departmental lecturers and is made available on the departmental pages of the Faculty web-site, or at:
Dutch page: http://www.geo.vu.nl/onderwijs/master/index-nl.html
English page: http://www.geo.vu.nl/onderwijs/afd/index-en.html

subject **Master Thesis Quaternary Geology/ Geo-ecology (O-variant)**
code 450120
credits 27
period variable
aim Research project in the master specialisation Quaternary geology/geo-ecology of the master programme in Earth Sciences
content Research project with a volume of 27 stp. (18 weeks) and related master thesis report
form of tuition Research project
mode of assessment Written report
entry requirements Bachelor exam Earth Sciences VU variant II, and at least 36 stp. of the programme of the master specialisation concerned should be registered by the student administration. Otherwise, admission only when granted by the examining board.
remarks The Master thesis is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the Master thesis work placement (M-variant) or research project (O-variant). This agreement should be put forward to the examining board (Dr. Ir. M. Bergwerff) before the start of the work placement or research project.
The master thesis work placement or research project may be extended by a volume of 12 stp. using the optional subject 'Extension of master thesis in earth sciences' (450149).
Information on Master thesis projects is provided by departmental lecturers and is made available on the departmental pages of the Faculty web-site or at:
Dutch page: http://www.geo.vu.nl/onderwijs/master/index-nl.html
English page: http://www.geo.vu.nl/onderwijs/afd/index-en.html

subject **Master Thesis Sedimentary and Structural Geology, Basin Analysis, and Surface Processes (M-variant)**
code 450112
credits 27

period	variable
aim	Work placement (traineeship; stage) in the master specialisation Sedimentary and structural geology, basin analysis, and surface processes of the master programme in Earth Sciences.
content	Work placement (traineeship; stage) with a volume of 27 stp. (18 weeks) and related master thesis report
form of tuition	Work placement (traineeship; stage)
mode of assessment	Written report
entry requirements	Bachelor exam Earth Sciences VU variant I, and at least 36 stp. of the programme of the master specialisation concerned should be registered by the student administration. Otherwise, admission only when granted by the examining board.
remarks	The Master thesis is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the Master thesis work placement (M-variant) or research project (O-variant). This agreement should be put forward to the examining board (Dr. Ir. M. Bergwerff) before the start of the work placement or research project. The master thesis work placement or research project may be extended by a volume of 12 stp. using the optional subject 'Extension of master thesis in earth sciences' (450149). Information on Master thesis projects is provided by departmental lecturers and is made available on the departmental pages of the faculty web-site, or at: Dutch page: http://www.geo.vu.nl/onderwijs/master/index-nl.html English page: http://www.geo.vu.nl/onderwijs/afd/index-en.html

subject	**Master Thesis Sedimentary and Structural Geology, Basin Analysis, and Surface Processes (O-variant)**
code	450111
credits	27
period	variable
aim	Research project in the master specialisation Sedimentary and structural geology, basin analysis and surface processes of the master programme in Earth Sciences.
content	Research project with a volume of 27 stp. (18 weeks) and related master thesis report
form of tuition	Research project
mode of assessment	Written report
entry requirements	Bachelor exam Earth Sciences VU variant I, and at least 36 stp. of the programme of the master specialisation concerned should be registered by the student administration. Otherwise, admission only when granted by the examining board.
remarks	The Master thesis is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the Master thesis work placement (M-variant) or research project (O-variant). This agreement should be put forward to the examining board (Dr. Ir. M. Bergwerff) before the start of the work placement or research project.

The master thesis work placement or research project may be extended by a volume of 12 stp. using the optional subject 'Extension of master thesis in earth sciences' (450149).
Information on Master thesis projects is provided by departmental staff members and is made available on the departmental pages of the faculty web-site, or at:
Dutch page: http://www.geo.vu.nl/onderwijs/master/index-nl.html
English page: http://www.geo.vu.nl/onderwijs/afd/index-en.html

subject **Metamorphism**
code 450013
lecturer vacancy
credits 6
period period 2
aim *Knowledge:* the student acquires sufficient understanding of the theoretical basis of metamorphism (i.e. chemical thermodynamics) for the calculation of phase equilibria in open and closed systems for common non-metamorphic protoliths.
Skills: the theoretical background will allow the student to recognize critical metamorphic assemblages and stable parageneses. From these, he will be able to derive PT-paths by thermobarometric calculations.
content Metamorphic phase equilibria, their variance and calculation; theoretical (chemographic) analysis of assemblages and reactions; element distribution between minerals; recognition of stable assemblages and of reactions in rocks. Role of fluid phases.
Metamorphism of pelitic sediments, carbonate rocks and mafic (igneous) rocks. Geothermobarometry and PT-paths. Relation between PT-paths and geodynamic processes.
form of tuition Home work and tutorial seminars. Practicals: microscopy, chemographic analysis, calculation of phase equilibria, geothermobarometric calculations. Writing of a student paper on a selected subject and its oral presentation.
literature Selection from chapters of text-books and review papers. Handouts.
mode of assessment Practicals (20%), paper and its presentation (40%), written exam (40%).
remarks Recommended prior courses: Petrology (450076), Petrology of System Earth (450083).

subject **Microstructures in Tectonites**
code 450158
lecturer dr. H. Stel (Dr. H.L.M. van Roermund)
credits 6
period period 4
content During the course, the main mechanism of deformation of minerals and rocks will be discussed and it will be shown by practical work how these mechanisms left their imprint on mesoscopic and microscopic scale. Topics of interest are a.o.: pressure solution, dislocation glide and climb; recovery recrystallization and the formation of mylonites. Information that is derived from microscopic observations will be compared with general models of rock deformation such as derived from experimental work. Special attention will be given to microstructures that yield information between deformation-induced foliations and the growth of metamorphic minerals.

The second part of the course will be dedicated to the analysis of deformation induced defect structures in minerals with the aid of Transmission Electron Microscopy (TEM).

literature Literature: C.W. Passchier and R.A.J. Trouw: Microtectonics. Springer Verlag 1996

naam **Milieurecht (B3/M)**

code 201796

studiepunten 6

docent dr. L.A.J. Spaans (kamer 6A-10, tel. (020) 44 46262)

periode week 6 - 15

doel Beoogd wordt de student vertrouwd te maken met de hoofdlijnen van het nationale milieurecht. De student wordt geacht na afronding van de collegecyclus de studiestof te kunnen toepassen in concrete gevallen.

inhoud Milieurecht is dat deel van het recht waarmee de 'fysieke omgeving' wordt beschermd en beheerd. Het milieurecht is in die zin bijzonder, omdat het als een rode draad door allerlei min of meer traditionele rechtsgebieden loopt. Daar komt bij dat de inhoud van het nationale milieurecht in hoge mate wordt bepaald door internationaal recht. Binnen de collegecyclus wordt niet alleen aandacht besteed aan de nationale milieurechtelijke regelgeving, maar ook aan die rechtsgebieden die een raakvlak met die regelgeving vertonen en, in beperkte mate, aan de internationale regelgeving ter zake.

literatuur

- F.C.M.A. Michiels, *De Wet Milieubeheer*, Deventer, Kluwer meest recente druk (wetbundel) ;
- Specifieke Milieurechtwetbundel;
- Syllabus *Milieurecht* verkrijgbaar in de VU-boekhandel.

onderwijs algemeen (week 6 - 15)

toetsing Schriftelijk tentamen en schriftelijke opdracht.

opmerkingen De colleges worden ondersteund via een site op de digitale leeromgeving blackboard.

werkwijze Gecombineerde hoor- en discussiecolleges waarbij een actieve deelname van de studenten wordt verwacht. Om het inzicht in de grote hoeveelheid regelingen te vergroten is gekozen voor een opdeling van de collegecyclus in een blok "hoofdlijnen nationale milieuwetgeving en een blok" `capita selecta'. In het eerste blok wordt de student vertrouwd gemaakt met het systeem van het nationale milieurecht, waarbij de Wet milieubeheer en de daarop betrekking hebbende jurisprudentie centraal staan. Het tweede blok van de collegecyclus betreft een verdieping, waarbij onder meer wordt ingegaan op het raakvlak tussen het milieu- en ruimtelijke ordeningsrecht en tussen het milieu- en natuurbeschermingsrecht.

voorkennisvakken 200211: Bestuursrecht I (BN2)
200353: Bestuursrecht II (B3) (Dit vak wordt sterk aanbevolen.)

naam **Museologie en buitenschoolse educatie**

code 471026

docenten drs I. van Veen; drs. B.J. Regeer; dr. P.J.A. van Mensch

studiepunten 6

periode 29.11.2004 - 24.12.2004

doel *Eindtermen*
na afloop van de module hebben de studenten:

- inzicht in de rol die musea, bezoekerscentra en tentoonstellingen (kunnen) spelen bij het populariseren van wetenschappelijke informatie, zowel nationaal als internationaal;
- inzicht in de rol die musea kunnen spelen bij het maatschappelijk debat over natuurwetenschappen.
- kennis van theorie en praktijk van educatie naast educatie op school; zoals bijvoorbeeld educatie in musea, op televisie, via de radio, debatteren, spellen of gedrukte informatie, maar ook volwasseneneducatie.

na afloop van de module kennen de studenten:

- de globale geschiedenis en ontwikkeling van musea in de 20e en 21e eeuw.

na afloop van de module kunnen de studenten:

- natuurwetenschappelijke musea, bezoekerscentra en tentoonstellingen kritisch beoordelen;
- een bezoekersonderzoek opzetten, uitvoeren en beoordelen;
- een tentoonstellingsplan maken en beoordelen.

literatuur
- Reader wordt bij college verstrekt;
- Museumjaarkaarten voor de studenten (zelf aanschaffen).

toetsing Aan de hand van praktijkopdrachten

werkwijze Hoor- en werkcolleges, excursies.

subject **Numerical Modelling in Tectonics**

code 450161

lecturer dr. R.A. Stephenson

credits 6

period period 5

aim The purpose of this course is to strengthen the student's understanding of the quantitative concepts behind numerical modelling techniques used in structural analysis and tectonic modelling.

content The mathematical principles of continuum mechanics are reviewed as necessary to link with a quantitative description of how the finite element method is used to solve problems of mechanical equilibrium typical for tectonics problems, in parallel with practical (computer-assisted) application of same. The student is also familiarised with the fundamentals of the finite difference method, as they are applied to problems of thermal structure of the lithosphere and other tectonics-related problems.

- Mathematical formulation of models: solutions to (partial) differential equations and application to simple geologically-relevant models
- Continuum mechanics: background principles, dimensional and tensorial homogeneity, Lagrangian and Eulerian frame of reference, index notation and matrices
- Stress and strain tensors, Cauchy's formula and representation of stress, constitutive equations, equations of equilibrium and motion
- Finite difference method: implicit and explicit methods
- Finite element method: variational principles, displacement approach, shape functions, stiffness matrix, singularity and boundary conditions, convergence criteria

form of tuition Colleges, historical and current literature study and report, finite difference method exercises, practical/project constructing, solving and interpretation of

elasto-static finite element models

mode of assessment Approx. 45% participation and (take-home) examination, 35% practical/project, 20% literature study and other exercises

naam **Ontwikkelingsvraagstukken (interfacultair)**

code 60000010
Basiscursus: 6 studiepunten
Vervolgtraject: 3 - 12 studiepunten (facultatief)

studiepunten 6

periode periode 1, 2, 3 en 4

docent onbekend (Diverse docenten, afkomstig van de VU, andere Nederlandse Universiteiten en ontwikkelingsorganisaties)

periode Basiscursus: 1e en 2e periode (september - december)Vervolgtraject: 2e, 3e en 4e periode (vanaf begin november - eind maart)

inhoud Dit interfacultaire keuzevak bestaat uit een basiscursus en een vervolgtraject. De basiscursus omvat een serie van 14 hoorcolleges, waarin vanuit verschillende disciplines informatie geboden wordt over ontwikkelingsvraagstukken en het thema 'Overheden, bedrijven en NGO. Partners in een globaliserende wereld'. De eerste 6 colleges bieden basisinformatie, terwijl in de laatste 8 bijeenkomsten het thema meer centraal zal staan. Het vervolgtraject kan worden ingevuld met een studiereis naar Suriname, het deelnemen aan het simulatiespel 'Africulture', of met het schrijven van een werkstuk over een onderwerp naar keuze.

literatuur
- Handboek Ontwikkelingsvraagstukke
- Reader Keuzevak Ontwikkelingsvraagstukken 2004-2005
- Themabundel Ontwikkelingsproblematiek

onderwijs hoorcollege
Een informatieboekje met nadere beschrijvingen van de basiscursus en vervolgtrajecten is aan te vragen bij: Afdeling Ontwikkelingseconomie Faculteit der Economische Wetenschappen en Bedrijfskunde, de Boelelaan 1105, 1081 HV Amsterdam, kamer 4A-33, tel. 020-4446140, e-mail: iko@feweb.vu.nl

toetsing schriftelijk tentamen
(75%) en opdracht (25%) in basiscursus.

opmerkingen Een informatieboekje met nadere beschrijvingen van de basiscursus en vervolgtrajecten is aan te vragen bij: Afdeling Ontwikkelingseconomie Faculteit der Economische Wetenschappen en Bedrijfskunde, de Boelelaan 1105, 1081 HV Amsterdam, kamer 4A-33, tel. 020-4446140, e-mail: iko@feweb.vu.nl . Zie ook de website: http://www.feweb.vu.nl/iko

subject **Ore Microscopy**

code 450159

lecturer dr. M.A. Zakrzewski

credits 3

period period 1

aim The course provides a base for microscopic techniques in reflected light.

content The ore microscope, mineral properties, sample preparation, identification of about 20 most important ore minerals and most common accessory opaque minerals in rocks, indentation hardness and reflectance (quantitative

measurement), textures of the ore minerals, parageneses.
form of tuition The course consists mainly of practical work.
literature Spry, P.G.& Gedlinske, B.L. (1987) Tables for the determination of common opaque minerals. The Economic Geology Publ. Co.
mode of assessment Microscopic determination of ore minerals.

subject **Ore Petrology**
code 450162
lecturer dr. M.A. Zakrzewski
credits 3
period period 1
aim The course provides a link between the economic mineral deposits and petrological associations and with their global tectonic settings.
content Lectures will consider some most important associations: mafic and ultramafic association, felsic association, iron ores of sedimentary affiliation, marine-volcanic sulfide association, the limestone Zn-Pb association, and ore deposits of metamorphic affiliation.
Practicals: macroscopic determination of ore minerals, studying of typical ore assemblages and their (micro)textures.
form of tuition Lectures and exercises
literature A selection of published articles
mode of assessment Reports of practicals, written examination
remarks Advised BSc-course on mineral deposits (450084)

subject **Orogenesis**
code 450053
lecturers dr. J.R. Wijbrans; dr. M. ter Voorde; dr. R.A. Stephenson; dr. H. Stel
credits 6
period period 4
aim *knowledge:* to obtain an understanding of orogenesis as a dynamic process in space and time. The course applies skills obtained in MSc course Metamorphism and Structural Geology II (BSc) to integrate the thermal and mechanical development of continental crust in various orogenic settings (convergent margin, continent-continent collision, core complex). Timescales of orogenic processes, and testing of concepts and models in numerical experiments.
skills: the ability develop and assess PTtd paths for continental orogenic rocks. to judge the timescales involved in orogenic processes. to evaluate and report in oral and written reports on scientific papers.
content A. The structure of recent and older orogens, windows on continental margin and deep continental processes, from mega to mesoscale; natural cases and (analogue) models, application of knowledge acquired in MSc course `Metamorphism'.
B. Rheology of the continental lithosphere.
C. Isotopic dating methods; dating prograde and retrograde P-T paths, open and closed system behaviour, thermochronology.
D. P-T-t-d paths of metamorphic rocks in orogens: deciphering subsidence/exhumation paths from thermobarometry and thermochronology, and testing and validation by numerical experiments.
form of tuition Home work, tutorial seminars, modelling practicals, student paper and its oral

presentation.

literature -Faure G. (1986), Principles of Isotope Geochemistry. John Wiley and Sons. chapters 6, 7, 8 and 18.
-Keary P., Vine, FJ. (1996) Global tectonics, Blackwell Science. chapters 2, 5, 8 and 8.
-Spear FS. (1993), Metamorphic phase equilibria and Pressure Temperature time paths. MSA. chapter 3, 20 and 21.
-Stuewe K. (2002), Geodynamics of the lithosphere. Springer. chapters 1, 2, 3, 5, 6 and 7. Books are available through the library.

mode of assessment Practicals (20%); paper and its presentation (40%); written examination (40%).

remarks Recommended prior courses: Petrology of System Earth (450083), Structural Geology II (450081), Metamorphism (450013).

subject **Palaeo-ecology/Palynology**

code 450054

lecturer dr. S.J.P. Bohncke

credits 3

period period 3

content The basal principles of palynology and applications in Quaternary Geology such as climate reconstructions and paleoenvironmental reconstructions.

form of tuition *Lectures*: on pollen dispersion, deposition and preservation. How to construct a pollen diagram. How to interpret a pollen diagram, the local and regional signal. The relation between pollen assemblage and paleovegetation.
Quaternary vegetation- and climate history of NW Europe.
Palynological characteristics of glacial, interglacial and interstadial pollenrecords, biostrigraphy. Anthropogenic impact as recorded in pollen diagrams. Landscape reconstructions applying pollen en macrobotanical data.
Raised bogs as paleoclimatic archieves in the Holocene.
Literature study: on specific articles concerning the application of palynology in Quaternary studies.
Practical: the study of pollen morphological features using a microscope, the practical collection and the digital photo database.
Different fossil pollen assemblages will be studied ranging from glacial to interglacial. Together the students work on pollen slides from one specific core and will make and interpret a pollen diagram.

mode of assessment Written examination on theory; essay on the practical part.

subject **Paleo-ecological Environments**

code 450015

lecturers dr. H.B. Vonhof; dr. S.J.P. Bohncke; dr. M.A. Prins

credits 6

period period 2

aim The goal of this course is to recognize patterns in sediment properties and microfaunal/floral composition in marine and terrestrial cores and to relate these to climatic and environmental development.

content The course consists of a series of lectures, laboratory work (core description, corescanner, grainsize analyses, CaCO3/Corg determination, stable O/C isotopes, geochemistry) and microscope work on the microflora (pollen, macro-remains) and -fauna (foraminifera, ostracods) and sedimentological

parameters.
The observed patterns across glacial/interglacial transitions in the cores will be interpreted in terms of climatic and environmental change. Differences in response of the marine and terrestrial realm and correlation between the two records will be discussed.

form of tuition Lectures, laboratory/microscope work, reading of selected papers.

mode of assessment Written essay, oral presentation of results.

subject **Petroleum Systems**

code 450055

lecturer prof.dr. H. Doust

credits 2

period period 3

aim To provide students with;

- A good, all-round idea of what hydrocarbon (oil and gas) exploration and production means to science and society, and to provide an insight into how, why and where accumulations occur
- To review some of the world's main petroleum systems and to pick out the main lessons they provide, linking geology to subsurface understanding
- To review the concepts of petroleum systems and plays and see how they can be applied to future subsurface analysis and energy supply prediction

content The course reviews a number of issues, technical and otherwise, that have impact on exploration for hydrocarbons worldwide. Emphasis is placed on the need to be able to study subsurface issues at different scales, from the most regional to the most local and to integrate data and concepts from all sorts of different disciplines: Hydrocarbon exploration involves the use of all sorts of subsurface skills, with the objective of predicting where hydrocarbons might be found and what sort of volumes may be expected. Topics covered in the course include: What hydrocarbons are, what they are used for, what the current supply and demand for hydrocarbons is, what the essential parameters are that are needed for a hydrocarbon accumulation to form -- these (source rocks, reservoirs, seals, traps and "plumbing") are dealt with in some detail. Following this is an extensive review of the concepts of sedimentary basin, petroleum system and "play", illustrated by examples from round the world, with special emphasis being placed on the Middle East, North Sea, Far East and Latin America. Other issues discussed include technologies applied in exploration, how exploration is carried out in practice (including legal aspects) and some perspectives on the future of this highly important, but also controversial industry.

form of tuition Lectures, practical examples worked by students, videos (if time)

literature Syllabus can be obtained from the lecturer (cost Euro 5.50) Powerpoint presentation material is posted on Blackboard.

mode of assessment Question paper on the subject matter, including practical examples of analysis of plays and petroleum systems

remarks Students are carried on a roller-coaster of integrated geologic concepts and swept in a short time from place to place across the globe to look at the local geology from an explorers' perspective. Mental alertness and the flexibility to follow these rapid changes are therefore essential to gaining maximum benefit from the course!

subject **Polyphase Deformation in Orogens and Forelands**
code 450016
lecturers dr. G.V. Bertotti; dr. E. Willingshofer; dr. H. Stel
credits 6
period period 2
aim Learning to interpret structures their mutual time/space relations and their implications for larger scale tectonics.
content The course focuses on deformations taking place in the orogens and in their forelands and has a "hand-on" approach with students working actively on data sets provided by the lecturers. The course is composed of three blocks.
Block 1 concentrates on brittle deformation taking place in the foreland adjacent to the orogen and in its most external sectors. Structures such as joints, breccias and upper crustal shear zones are examined in detail in specific case studies.
Block II is devoted to rocks and regions being deformed at the middle to lower crustal depths of orogenic zones. As such these rocks record deformations related to their burial- as well as to their exhumation history. Back at the Earth's surface these rocks form the axial zone of most orogens such as in the Alps.
Block III is dedicated to the analysis and understanding of shear zones both at high and low temperatures. These are zones accommodating large deformations and are therefore of major importance for the understanding of tectonic systems.
form of tuition Analysis of case studies carried out by students and coached by the lecturers , lectures and excercises.
literature B.A. van der Pluijm and S. Marshalk -- Earth structure, An introduction to structural geology and tectonics. McGraw-Hill, 493 p.
mode of assessment Written exam and reports
reqd. subjects 450077: Structurele geologie I, inclusief veldpracticum (Advice regarding previous course taken)
450081: Structurele geologie II (Advice regarding previous course taken)

naam **Popular Science Writing**
code 471025
docent Docent Taalcentrum VU
studiepunten 3
periode 07.02.2005 - 8.02.2005
doel Na afloop van de module hebben de studenten:
- inzicht in de specifieke aard van Engelse bètawetenschappelijke teksten;
- inzicht in interculturele aspecten bij het gebruik van de Engelse taal.

Na afloop van de module kennen de studenten:
- de opbouw van een Engelstalige tekst en de verschillende stijlkenmerken van Engelse teksten;
- de verschillen tussen de Nederlandse en de Engelse schrijftaalconventies.

Na afloop van de module kunnen de studenten:
- korte pakkende stukjes in het Engels schrijven over bètawetenschappelijke onderwerpen en daarbij jargon vermijden;
- een Engelstalig persbericht, samenvatting of brochure schrijven en redigeren

- een Engelstalige sollicitatiebrief schrijven.

inhoud De cursus is opgebouwd uit verschillende blokken. Elk blok wordt afgesloten met een schrijfopdracht. In deze blokken komen o.a. aan bod:
- algemene tekstopbouw: wat is de *functie* van de tekst, welke boodschap wil je overbrengen?
- Popular science writing versus Academic writing: wat zijn de verschillen?
- Taalvariatie en taalvergelijking: wat zijn de verschillen tussen een Nederlandse en Engelse tekst. En ook: behandeling van de diverse valkuilen als het gaat om het schrijven van een Engelse tekst.
- Interculturele verschillen: schrijven voor een internationale doelgroep: schrijven voor *native* en *non-native speakers;* taalverschillen binnen Europa.

literatuur De syllabus die behoort bij deze cursus is af te halen bij het Taalcentrum-VU, in de week voorafgaand aan de cursus.

toetsing Ten minste 4 schrijfopdrachten

werkwijze De werkwijze is wisselend: theorie en praktijk wisselen elkaar af. De werkcolleges worden zoveel mogelijk verzorgd in het computerlab van de faculteit Letteren. De daar geïnstalleerde software biedt bijvoorbeeld de mogelijkheid voor 2 studenten om samen aan een tekst te werken. Tijdens de werkcolleges werkt men in groepen van maximaal 12-15 studenten.

voorkennis Deelnemers moeten de cursus Wetenschapsjournalistiek hebben gevolgd.

naam **Praktijk 1 en 2**

code 990002

studiepunten 30

contacturen Op school geeft de docent in opleiding minimaal 120 lessen en maakt minimaal 250 klassencontacturen. Minimaal 40 lesuren worden gegeven in bovenbouwklassen havo/vwo.

periode 30.08.2004 - 31.08.2005

doel Praktijkervaring opdoen op school vormt de kern van de opleiding.

inhoud In overleg met de begeleider op school en op de opleiding voert de docent in opleiding stageopdrachten op school uit en verwerkt deze in het portfolio.

onderwijs stage (30.08.2004 - 31.08.2005)
De praktijkervaring wordt opgedaan op een school voor Voortgezet Onderwijs.

toetsing stageverslag
De praktijkervaring wordt door de schoolbegeleider en door de instituutsbegeleider beoordeeld.
Opdrachten in het kader van praktijkervaring worden opgenomen in het portfolio.

docenten Er zijn twee begeleiders: één vanuit de school en één vanuit de opleiding.

naam **Praktijkonderzoek**

code 990003

studiepunten 8

contacturen Ongeveer 15

docent Diverse docenten

doel
- Zicht krijgen hoe door systematisch onderzoeken van onderwijssituaties inzicht verkregen kan worden leerprocessen van leerlingen.
- Opdoen van ervaring met het voorbereiden uitvoeren en rapporteren van

onderzoek van onderwijssituaties.

inhoud Bij het praktijkonderzoek diept de dio één of meer vraagstukken uit de (eigen) onderwijspraktijk uit. Hij doet dat door het opzetten, uitvoeren en evalueren van een op de onderwijspraktijk gericht onderzoek waarbij op één of enkele scholen empirisch materiaal wordt verzameld rond de meesterproef. Elke dio maakt in het kader van vakdidactiek een meesterproef. In het praktijkonderzoek wordt het leereffect (van een of meer aspecten) van de meesterproef onderzocht.
Dit onderzoek mondt uit in een (voor)onderzoekverslag, een peer review en een onderzoeksartikel. Op de onderwijsresearchdag van het Onderwijscentrum VU worden enkele praktijkonderzoeken van dio's gepresenteerd en bediscussieerd.

literatuur
- Baarda, D.B. et al. (1998) Kwalitatief onderzoek. Basisboek. Houten: EPN. ISBN: 90-207-2485-1.
- Oost, H. & Markenhof, A. (2002) Een onderzoek voorbereiden. Baarn: HB. ISBN: 90-5574-376-3.
- Oost, H. (2002) Een onderzoek uitvoeren. Baarn: HB. ISBN: 90-5574-373-9.
- Oost, H. (2002) Een onderzoek rapporteren. Baarn: HB. ISBN: 90-5574-374-7.

toetsing
- (Voor)onderzoeksverslag
- Peer review over (voor)onderzoeksverslag
- onderzoeksartikel voor vaktijdschrift voor leraren

opmerkingen Het onderzoek wordt uitgevoerd rond de meesterproef en bevat een vooronderzoek en een hoofdonderzoek

werkwijze Aan het begin van de opleiding worden doel, planning en beoordeling van het praktijkonderzoek uitgelegd en ontvangen de dio's een handleiding met daarin onder meer een beoordelingschecklist en literatuursuggesties op het gebied van methoden en technieken van onderzoek.
Er worden drie werkcolleges georganiseerd ter ondersteuning.
Dio's worden uitgedaagd met hun praktijkonderzoek aan te sluiten bij onderzoek dat wordt verricht door medewerkers van het Onderwijscentrum VU en zoveel mogelijk gemeenschappelijke thema¿s op te pakken.
Literatuurverkenning, probleemstelling, onderzoeksvraag en onderzoeksdesign dienen door de instituutsbegeleiders goedgekeurd te worden alvorens de dio verder kan gaan met de dataverzamelingsfase en de data verwerkingsfase. Gedurende deze fasen zijn de instituutsbegeleiders beschikbaar voor individuele hulp.
Aan de hand van concepten van het onderzoeksverslag reflecteert de dio met zijn instituutsbegeleider op de analyse van de onderzoeksgegevens in het licht van de literatuur. Vervolgens wordt het definitieve onderzoeksartikel geschreven.

subject **Precambrian Geology**
code 450164
lecturer prof.dr. C.W. Passchier
credits 3
period period 3
aim The Precambrian (Archean and Proterozic) comprises the immensely long time periods between the initial formation of the planet Earth and the earliest

Paleozoic radiation of life forms with endo- or extra-skeletons. This course intends to summarise the Precambrian Geology in a general and interdisciplinary manner covering the evolution of the lithosphere, the hydrosphere, the atmosphere and the biosphere.

content The course covers four main fields of Precambrian Geology: A) Earliest Precambrian planetary evolution; B) Evolution of the Precambrian lithosphere (genesis, petrology, tectonics and geochemistry); C) Evolution of the Precambrian atmosphere (e.g., evidence for free oxygen in the atmosphere); D) Surface processes (early sediments, earliest life forms).

form of tuition This course will be given combining teaching and self study elements. Students are expected to read and review key publications and to present main findings in small groups.

literature Key publications and information provided via the world wide web.

mode of assessment Summaries and presentations.

subject **Regional Basin Geology**

code 450056

lecturers dr. B.P. Zoetemeijer; dr. G.V. Bertotti; prof.dr. H. Doust; dr. J.H. ten Veen

credits 6

period period 4

aim The goal of the course is to teach students to build a consistent scheme for the dynamic evolution of a sedimentary basin from a geological and geophysical dataset. We focus on the ability to extrapolate local data to a regional scale interpretation in space and time.

content The course is built around case studies (regional basin settings in different tectonic regimes). Data from various sources (seismic, wells, gravity, sedimentology and structural geology) are presented and students work in small groups to interpret and to derive the dynamic evolution of the basin.

form of tuition Lectures and exercises in small groups

mode of assessment Written reports (60%), presentation case studies (20%) and attitude (20%) In case of frequent absence during contact hours the result of the course will be insufficient. More details are listed in the Course Guide or BlackBoard site.

subject **Regional Hydrogeology and Groundwater Management**

code 450057

lecturers prof.dr. J.J. de Vries; dr. J. Groen

credits 6

period period 4

content Concepts porosity and permeability in connection with rock lithology and structure; occurrence of groundwater reserves and their recharge, discharge and dynamics in relation to geological, geomorhological and climatic conditions; exploration and resources assessment by application of water balance studies, geophysics, chemical, and isotope tracers. Groundwater exploitation and management. Regional case-studies from various areas.

form of tuition Course work, practical exercises and study of literature, excursions.

literature Syllabi

mode of assessment Written account on exercises and questions.

entry requirements Advice regarding previous courses taken: 450024: inleiding hydrologie.

subject **Remote Sensing in Hydrology**
code 450165
lecturers dr. A.A. van de Griend; dr.ir. E. Seyhan
credits 6
period period 4
aim This course deals with different portions of the E-M spectrum that are relevant for hydrological research and applications at different spatial scales. After a broad introduction, including basic theory of radiative transfer, the lectures will concentrate on three portions of the spectrum, i.e.: Visible/NIR, thermal-infrared, and microwaves. These portions will be used to demonstrate their potential for vegetation monitoring (biomass), energy-balance modelling (evapotranspiration and soil moisture), and radiative transfer modelling (biomass and soil-moisture), respectively. Special attention will be given to the problem of atmospheric correction using MODTRAN.
The course includes a series of practical exercises, varying form atmospheric corrections (visible/NIR and thermal), geometrical correction for synergistic analysis of images from different satellites, and application of simple energy-balance and radiative transfer models using multi-temporal thermal and microwave observations from space. Large-scale analysis will be done by the spatial analysis software packages IDRISI and MATLAB. Several sessions will be used to learn the basics of MATLAB.
form of tuition 16 hours of lectures, 24 hours of practical (computer) exercises and literature study.
literature Lecture notes, articles and handouts
mode of assessment Written exam.

subject **Research Project Archaeometry**
code 450296
lecturers prof.dr. H. Kars; dr. G. Aalbersberg; drs. E.A.J. Burke
credits 27
period period 6
aim development, planning and carrying out of scientific research and reporting results
content The geoarchaeological research projects will allow students to develop their own scientific questions into small-scale research projects within the framework of larger existing research projects. These projects will include the usual stages of planning and preliminary literature research (2 weeks), the research itself (8 weeks) and reporting the results (8 weeks). The research topic can be in any of the geoarchaeological disciplines and include fieldwork and laboratory analyses.
form of tuition fieldwork, laboratory work
mode of assessment written report
remarks The Research Project is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the research project. This agreement should be put forward to the examining board (Dr. Ir. M. Bergwerff) before the start of the project. Admission to the Research Project is only granted to master students (students without a bachelor degree are therefore excluded). Admission

requirements are checked by the examining board on April 15th. Participants should register in time (preferably before March 1st) with the staff member/department in question and by TISVU/TIS.

subject **Research Project Endogene Geology**
code 450110
credits 27
period period 6
content 2 weeks preparation, 8 weeks research, 8 weeks report
form of tuition Fieldwork or lab analysis or stage. Following field or lab research or stage, the student must present and document his/her results in a report.
mode of assessment Written report - Grading is based on report.
remarks Admission to this Research project is only granted to students with a BSc degree Earth Sciences and other students who have been admitted to the MSc degree programme by the examining board. Admission requirements are checked by the examining board on April 15th. Participants should register in time (preferably before March 1st) with the staff member/department in question and by TIS.

subject **Research Project Geo-ecosystems and Climate**
code 450138
credits 27
period period 6
content 2 weeks preparation, 8 weeks research, 8 weeks report
form of tuition Fieldwork or lab analysis or stage. Following field or lab research or stage, the student must present and document his/her results in a report.
mode of assessment Written report - Grading is based on report.
remarks Admission to this Research project is only granted to students with a BSc degree Earth Sciences and other students who have been admitted to the MSc degree programme by the examining board. Admission requirements are checked by the examining board on April 15th. Participants should register in time (preferably before March 1st) with the staff member/department in question and by TIS.

subject **Research Project Landscape Archaeology**
code 450295
lecturers prof.dr. H. Kars; dr. G. Aalbersberg; drs. E.A.J. Burke
credits 27
period period 6
aim development, planning and carrying out of scientific research and reporting results
content The geoarchaeological research projects will allow students to develop their own scientific questions into small-scale research projects within the framework of larger existing research projects. These projects will include the usual stages of planning and preliminary literature research (2 weeks), the research itself (8 weeks) and reporting the results (8 weeks). The research topic can be in any of the geoarchaeological disciplines and include fieldwork and laboratory analyses.
form of tuition fieldwork, laboratory work
mode of assessment written report

remarks The Research Project is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the research project. This agreement should be put forward to the examining board (Dr. Ir. M. Bergwerff) before the start of the project. Admission to the Research Project is only granted to master students (students without a bachelor degree are therefore excluded). Admission requirements are checked by the examining board on April 15th. Participants should register in time (preferably before March 1st) with the staff member/department in question and by TISVU/TIS.

subject **Research Project Marine Geology**
code 450115
credits 27
period period 6
content 2 weeks preparation, 8 weeks research, 8 weeks report
form of tuition Fieldwork or lab analysis or stage. Following field or lab research or stage, the student must present and document his/her results in a report.
mode of assessment Written report - Grading is based on report.
remarks Admission to this Research project is only granted to students with a BSc degree Earth Sciences and other students who have been admitted to the MSc degree programme by the examining board. Admission requirements are checked by the examining board on April 15th. Participants should register in time (preferably before March 1st) with the staff member/department in question and by TIS.

subject **Research Project Paleo-climatology/Paleo-ecology/Paleo-oceanography**
code 450116
credits 27
period period 6
content 2 weeks preparation, 8 weeks research, 8 weeks report
form of tuition Fieldwork or lab analysis or stage. Following field or lab research or stage, the student must present and document his/her results in a report.
mode of assessment Written report - Grading is based on report.
remarks Admission to this Research project is only granted to students with a BSc degree Earth Sciences and other students who have been admitted to the MSc degree programme by the examining board. Admission requirements are checked by the examining board on April 15th. Participants should register in time (preferably before March 1st) with the staff member/department in question and by TIS.

subject **Research Project Petrology and Isotope Geochemistry**
code 450109
credits 27
period period 6
content 2 weeks preparation, 8 weeks research, 8 weeks report
form of tuition Fieldwork or lab analysis or stage. Following field or lab research or stage, the student must present and document his/her results in a report.
mode of assessment Written report - Grading is based on report.
remarks Admission to this Research project is only granted to students with a BSc

degree Earth Sciences and other students who have been admitted to the MSc degree programme by the examining board. Admission requirements are checked by the examining board on April 15th. Participants should register in time (preferably before March 1st) with the staff member/department in question and by TIS.

subject **Research Project Quaternary Geology/Geo-ecology**
code 450119
credits 27
period period 6
content 2 weeks preparation, 8 weeks research, 8 weeks report
form of tuition Fieldwork or lab analysis or stage. Following field or lab research or stage, the student must present and document his/her results in a report.
mode of assessment Written report - Grading is based on report.
remarks Admission to this Research project is only granted to students with a BSc degree Earth Sciences and other students who have been admitted to the MSc degree programme by the examining board. Admission requirements are checked by the examining board on April 15th. Participants should register in time (preferably before March 1st) with the staff member/department in question and by TIS.

subject **Research Project Sedimentology**
code 450114
credits 27
period period 6
content 2 weeks preparation, 8 weeks research, 8 weeks report
form of tuition Fieldwork or lab analysis or stage. Following field or lab research or stage, the student must present and document his/her results in a report.
mode of assessment Written report - Grading is based on report.
remarks Admission to this Research project is only granted to students with a BSc degree Earth Sciences and other students who have been admitted to the MSc degree programme by the examining board. Admission requirements are checked by the examining board on April 15th. Participants should register in time (preferably before March 1st) with the staff member/department in question and by TIS.

subject **Research Project Structural Geology and Tectonics**
code 450113
credits 27
period period 6
content 2 weeks preparation, 8 weeks research, 8 weeks report
form of tuition Fieldwork or lab analysis or stage. Following field or lab research or stage, the student must present and document his/her results in a report.
mode of assessment Written report - Grading is based on report.
remarks Admission to this Research project is only granted to students with a BSc degree Earth Sciences and other students who have been admitted to the MSc degree programme by the examining board. Admission requirements are checked by the examining board on April 15th. Participants should register in time (preferably before March 1st) with the staff member/department in question and by TIS.

subject **Sediment Petrography of Heavy Minerals**
code 450058
lecturer dr. C. Kasse
credits 3
period period 3
content The study of optical characteristics of heavy minerals under the microscope. The study of the heavy mineral characteristics (relief, color, pleochroism, etc.) in slides from the mono-mineral collection. Recognition and determination of heavy minerals from unconsolidated deposits. Construction of heavy mineral diagrams and interpretation of the heavy mineral assemblages regarding the provenance of the sediment and the Quaternary lithostratigraphy of the Netherlands.
form of tuition Lectures and practical courses
mode of assessment Independent determination of a heavy mineral sample by the student.

subject **Sedimentology for Masters**
code 450017
lecturer dr. A.M. Immenhauser
credits 6
period period 2
aim This course is focussed on students with a specialisation in sedimentology, structural geology and paleo-climatology. The participant is expected to gain an understanding of a number of important topics that have not yet been (or insufficiently) covered by previous courses. The main modules are: I.) sequence stratigraphy (2 stp.), II.) global-scale paleoceanography (2 stp.), and III.) thin-section petrography of siliciclastic and carbonate rocks (2 stp). Although these are three different topics, they have common links as climate and paleoceanography are the main motor behind the sequence stratigraphic organisation of sediment packages and similarly, climate controls the erosion of crystalline basement rocks and therefore the deposition of siliciclastic sandstones.
content (1) The participant will be introduced in the technique of sequence stratigraphic interpretation of sediment bodies. Special attention will be on the recognition and interpretation of the key elements of sequence stratigraphic interpretation (i.e. sequence boundaries, maximum flooding intervals, etc.).
(2) The second module will cover the main large-scale elements of the interaction between atmosphere and hydrosphere.
(3) The third module will focus on the thin section analysis of (i) siliciclastic rocks using Palaeozoic and Mesozoic samples from a transect across portions of the Himalayan Mountains and (ii) Cretaceous carbonate rocks from the Arabian platform.
form of tuition The methodology used includes teaching, little projects, self-study of publications and course materials and practical work at the microscopes.
mode of assessment Grading will take place based on delivered reports and the work during the practical module (siliciclastics and carbonates).
remarks A detailed description of the course organisation as well as digital handouts are available on the students homepage of the section sedimentology: http://www.geo.vu.nl/users/sedimar/index.html

subject **Simple and Applied Reflection Seismics**
code 450059
lecturers dr. J.A.M. Kenter; dr. W.W.W. Beekman; prof.dr. H. Doust
credits 6
period period 4
aim The participant is expected to build sufficient understanding of the fundamentals and the limitations of the applications of reflection seismics as a tool to predict the structure and geology in the shallow to deeper (100's to several 1000's of meters) subsurface.
content Assuming a basic knowledge of the principles of reflection seismics. Modular program that provides the student with handson experience of interpreting and integrating data from well logs, reflection seismics and geology. Special attention will be paid to pitfalls in data acquisition, processing and interpretation. The following modules will be studied:
1. Seismic Acquisition and Logging
2. Petrophysics and Geology
3. Processing and Workstation Skills
4. Seismic Interpretation: Stratigraphy (A) and Structure (B)
5. Integration of Seismic, Outcrop and Well data

form of tuition The course will concentrate on hands-on experience with industry level software packages and exercises for seismic interpretation, physical properties and log analysis. Emphasis is on short modular (see above) tasks centered on one or two data sets that participants will accomplish in small groups using digital data sets and processing. Each module will be introduced by a series of presentations. The course materials will be available through Blackboard; similarly, results should be submitted to Blackboard as well. Course materials, assignements and answers are available on Blackboard (http://www.bb.vu.nl/).
mode of assessment Theoretical written exam and results (Blackboard) of modules.
remarks A one day applied field course that includes all modules is planned, pending number of participants and weather, at the end of the course.

naam **Sociale geografie II**
code 450168
docent dr. J.A. van der Schee
studiepunten 12
periode Ter eigen keuze
doel Het verdiepen van kennis en vaardigheden op het gebied van sociale geografie voor wie docent aardrijkskunde wil worden.
inhoud In deze cursus vindt een verdieping en uitbouw plaats van wat in de cursus sociale geografie I in het bachelorprogramma wordt aangeboden.
Het programma kent twee onderdelen:
- Sociale geografie van wereldregio's
- Sociale geografie van Nederland

Bij beide onderdelen gaat het om het verwerven van inzicht in hoe economische, politieke en sociaal-culturele ontwikkelingen leiden tot veranderingen in de positie en het profiel van regio's.
literatuur Cloke, P. et al. (1999) Introducing Human Geographies. London: Arnold. Hieruit: The City en The Country, pp. 246-267.

Blij, H. de & P.O. Muller (2002) Geography. New York: Wiley. Hieruit: Hoofdstukken 2, 4, 6 en 10.
Pater, B. de et al. (2002) Denken over regio's. Muiden: Coutinho. Hieruit: Hoofstuk 7 pp. 151- 182.
Dicken, P. 1998) Global Shift. London: Cha[man. Hieruit: Hoofdstuk 2: pp.24-72.
Haggett, P. (2001) Geography, a global synthesis. New York: Prentice Hall. Hieruit: hoofdstuk 7, pp. 202-231
Musterd, S. & B. de Pater (1992) Randstad Holland. Assen Van Gorcum, 175 pp.

toetsing Ontwerp van een regionaal-geografische studie van een wereldregio plus een excursiemap voor een regionaal-geografische excursie in Nederland.

opmerkingen Deze cursus is verplicht voor wie de eerstegraads lerarenopleiding aardrijkskunde wil volgen.

werkwijze Werkbesprekingen en opdrachten m.b.t. het vervaardigen van een regionaal-geografische studie over een regio buiten Nederland en het vervaardigen van een geografische excursie in Nederland.

subject **Soil Vegetation Atmosphere Exchange**

code 450060

lecturers dr. M.J. Waterloo; prof.dr. A.J. Dolman

credits 6

period period 4

aim The main goal of this course is to teach the students micrometeorology. The course also aims to teach the student how to apply this knowledge of micrometerorological processes, in combination with prior knowledge on soil physical and plant physiological processes, to simulate impacts of changes in climate, land use and soil properties on the hydrological cycle using computer models.

content Soil vegetation atmosphere exchange deals with the micrometeorological processes that determine the basic exchange of water, energy and nutrients from the soil and vegetation to the atmosphere. The first part of the course deals with fundamental micrometeorological theory: radiation exchange, energy balance, soil heat flux, flux-profile relationships, K-theory and coupling to the planetary boundary layer. The second part deals with measurement techniques for fluxes of heat, water, momentum and CO2, and other trace gasses. The final part of the course teaches primary principles of Soil Vegetation Atmosphere Transfer Schemes (SVAT). A series of computer workshops accompanies the latter part to achieve hands-on experience of SVAT modeling.

literature Course reader and all other relevant documents are available on Blackboard.

mode of assessment Written examination, attendance of workshops and submission of exercises

remarks Follows-up on the Eco-hydrology (450014) and Unsaturated zone and near-surface hydrological processes (450021) courses.

subject **Spatial Variability and Multivariate Statistical Analyses**

code 450160

lecturer dr.ir. E. Seyhan

credits 6

period period 2

content Continuous and discreet data frequency distribution, nonparametric methodology, linear and non-linear multiple regression analyses, multivariate statistical analyses (cluster, factor and discriminate analyses), geostatistical analyses, trend surface analyses. Software: SPSS 11, SYSTAT 10, SURFER 7, GEO-EAS

form of tuition Lectures, practical desk exercises, and exercises with computer models

literature E. Seyhan, Introduction to multivariate statistical analysis in hydrology;
E. Seyhan, The practice of multivariate statistics;
E. Seyhan, Exercises on geostatistical analysis

mode of assessment Written exam

subject **Tectonics and Global Geophysics**

code 450018

lecturer dr. R.A. Stephenson

credits 6

period period 1

aim The purpose of this course is to provide a deeper understanding of the geophysical properties of the Earth as a whole, but emphasising the lithosphere-upper mantle system, that govern the large-scale tectonic processes that shape the geology of the lithosphere. In so doing, the student receives an overview of the geophysical techniques used to image the interior of the Earth, from the scale of the Earth as a whole (global seismology and shape of the Earth) to the scale of the crustal lithosphere (deep near-vertical and wide-angle seismic and magneto-telluric studies).

content

- Structure of the Earth's interior: identification and interpretation of teleseismic (earthquake) phases; core-mantle boundary structure; seismological definition of mantle discontinuities
- Mantle tomography: methodological principles and interpretation of results
- Shape of the Earth: geoid and its spherical harmonic representation; Chandler wobble and nutations
- Thermal structure of the mantle: convection, thermal instabilities and mantle plumes; "small-scale" convection
- Geophysical images of the lithosphere: passive seismology (receiver functions); acquisition of and interpretation of velocity structure from regional refraction/wide-angle seismic; acquisition of and interpretation of large-scale acoustic impedance geometries from deep near-vertical reflection seismic; electrical structure from magneto-tellurics and allied methodologies; gravity anomalies and density structure, isostatic admittance characteristics of continental lithosphere

form of tuition Lectures, historical and current literature study and report, project/practical involving integrated modelling and interpretation of seismic and (at least) one other kind of geophysical data at the crustal scale.

mode of assessment Approx. 50% participation and (take-home) examination, 30% practical, 20% literature study and other exercises.

subject **Tectonomorphology**

code 450019

lecturers prof.dr. P.A.M. Andriessen; dr. M. ter Voorde (staff department of Tectonics)

credits 6

period period 1

aim The course aims to familiarize students with
- chronological techniques that can be used as time-control in studies of landscape-evolution , and
- key physical phenomena that shape the landscape (i.e. tectonic events, surface processes, and their mutual interaction.

content The course will focus on tectonic mechanisms that change the landscape, dating techniques and the quantification of vertical motion using modern thermochronological tools, and the genetic link and feedback mechanisms between orogenesis, and denudation. Numerical modeling of topography development, resulting from a combination of tectonic- and surface processes, will be carried out.

form of tuition Lectures, literature study, computer-practicals, discussions.

subject **Thematic Research Project Ecohydrology**

code 450135

lecturer staff members (of the department of Hydrology and Geo-environmental Sciences)

credits 12

content Literature study, possibly with a short fieldwork or lab research

form of tuition Individual research and report writing

mode of assessment Written report

entry requirements Admission to this research project is only granted to students with a BSc degree Earth Sciences and other students who have been admitted to the MSc degree programme by the examining board.

subject **Thematic Research Project Hydrology**

code 450129

lecturer staff members (of the department of Hydrology and Geo-environmental Sciences.)

credits 12

content Literature study, possibly with a short fieldwork or lab research

form of tuition Individual research and report writing

mode of assessment Written report

entry requirements Admission to this research project is only granted to students with a BSc degree Earth Sciences and other students who have been admitted to the MSc degree programme by the examining board.

naam **Toegepaste ecologie**

code 470045

docenten prof.dr. J. Rozema (cursuscoördinator); prof.dr. M.A.P.A. Aerts; Gastdocenten (de gastdocenten zijn werkzaam bij verschillende ministeries, instituten en bedrijven)

studiepunten 6

periode 01.11.2004 - 26.11.2004

doel Oriëntatie op en verdieping in het het brede veld van toepassingen van de oecologie, mede als ondersteuning bij de keuze van studenten voor M.Sc. stagemogelijkheden. Training in het opzetten en opstellen van een rapport. Verder vergroot de cursus het perspectief van beroepsmogelijkheden van de afgestudeerde oecoloog. De toegepaste oecoloog werkt vaak in

multidisciplinaire samenwerkingsverbanden. Er wordt inzicht verkregen in de vraag hoe oecologisch onderzoek bijdraagt in het oplossen van milieuproblemen en hoe milieubeleid tot stand komt. Natuurbeheer vormt een belangrijk onderdeel van het veld van de toegepaste oecologie

Eindtermen:

De student:

- kent de aangeboden leerstof en collegestof over hoe oecologische principes milieuproblemen kunnen helpen oplossen, zoals de Ecologische Hoofd Structuur, en het sluiten van kringlopen;
- kent de principes die ten grondslag liggen aan natuurbeheer en milieubeheer en weet deze in de praktijk te brengen;
- heeft inzicht in de samenhang van milieuproblematiek en milieubeleid en de relatie met oecologisch onderzoek;
- heeft een overzicht van de brede beroepsmogelijkheden van de afgestudeerde oecoloog;
- heeft kennisgemaakt met multidisciplinaire samenwerking;
- is in staat in korte tijd een vraagstelling en een plan van aanpak m.b.t. een milieuprobleem te formuleren en uit te werken tot een rapport.

inhoud Kennismaking met de omgeving van de beroepspraktijk van de afgestudeerde oecoloog. Vaak spelen milieuproblemen en milieubeleid hierbij een grote rol, en wordt van oecologen een brede inzetbaarheid gevraagd. Hieraan wordt in een 15-tal hoor- en interactieve colleges aandacht besteed.

Daarnaast schrijft en presenteert de cursist een rapport (werkstuk) over een project naar eigen keuze en met een zelf geformuleerde vraag- of doelstelling.

In de cursus komen de volgende onderwerpen aan de orde:

Natuurbeheer

Natuurbeheer en onderzoek in het Noord-Hollands duinreservaat; vernatting van duinvalleien; toegepast ecologisch onderzoek in de Zeeuwse delta: De ontwikkeling van oevervegetatie in het Volkerak- Zoommeer; ecological engineering, natuurtechniek en waterstaatswerken.

Milieubeheer en milieubeleid

Vermesting, biodiversiteit en bodem-oecosystemen; inrichting van het Waddengebied; het RIVM en normen voor toxiciteit in de bodem; advisering bij bodembeschermingsbeleid; bestrijdingsmiddelen, landbouw en milieu; onderzoek naar bestrijding van parasitaire onkruiden; duurzame landbouw op brakke en zoute grond;

Mondiaal milieu en klimaatverandering

Emissie van broeikasgassen in wetlands; ecologisch onderzoek en advisering klimaatverandering- gevolgen voor van het gat in de ozonlaag en broeikaseffect voor ecosystemen.

literatuur Leerboek Toegepaste Oecologie. J.Rozema en H.A. Verhoef. Bijdragen van de toegepaste oeocologie in de analyse en het oplossen van milieuproblemen. 1997. VU Uitgeverij, Amsterdam.

Collegestof door (gast)docenten.

toetsing Tentamen over de leerstof en behandelde collegestof (1/2), mondelinge presentatie (1/4) van werkstuk (1/4). Zonder voltooiing van deze laatste twee onderdelen kan geen eindcijfer worden verkregen.

doelgroep Biologen, milieuwetenschappers en aardwetenschappers.

werkwijze In de ochtenden of middagen van week 1, 2 en 3 interactieve werkcolleges

door (gast)docenten over de beroepspraktijk van de toegepaste ecoloog. Tijdens het andere dagdeel wordt door de cursist aan de het rapport(werkstuk) gewerkt.

subject **Transport Processes in Groundwater**
code 450131
lecturer dr. H. Kooi
credits 6
period period 3
aim The objectives of the course are: (1) basic understanding of heat and solute transport in groundwater systems (2) being able to do transport calculations for simple problems (3) basic understanding of numerical solution of transport equations and (4) have some experience with modelling of (relatively complicated) transport problems using computer software.
content Hydrogeology is to a large extent concerned with flow of water in the subsurface (courses *Groundwater Hydraulics* and *Groundwater Flow Modelling*). However, that is not all there is to it. Many practical and academic applications of groundwater hydrology involve transport of solutes (dissolved chemical species) or heat in groundwater systems, rather than the flow of groundwater itself. Examples are contaminant hydrogeology, tracer hydrogeology, sea-water intrusion, the evolution of fresh-salt groundwater in coastal areas, heat/cold storage in groundwater, and inversion of information on groundwater flow and climate from borehole temperature measurements. To be able to work in this important segment of groundwater hydrology, the student should acquire new knowledge and skills .
Topics that will be addressed in the course are:
Fundamental transport processes: advection, diffusion, dispersion and first-order reaction (sorption and retardation) in 1-, 2- and 3-dimensions. Basic behaviour of the individual and combined processes. Numerical approaches, methods and codes. The role of uncertainty in process parameters. Implications of discrepancies in scale of measurement and process scale.
form of tuition Lectures, desk exercises, exercises with computer codes and case studies. a modelling assignment.
literature Lecture notes and articles from the literature Domenico, P.A. & F.W. Schwartz, 1998, *Physical and chemical hydrogeology*, 2nd edition, Wiley. + Course notes
mode of assessment Written exam + assignments during the course
remarks Successful completion of Groundwater Hydraulics (450009) and Groundwater Flow Modelling (450008) is strongly recommended. Having participated in Hydrochemistry (450052) is advised.

subject **Unsaturated Zone and Near Surface Hydrological Processes**
code 450021
lecturers dr. L.A. Bruijnzeel; dr. J. Schellekens; dr. R.A.M. de Jeu
credits 6
period period 2
aim The objective of this combined course is to provide basic insight into the hydrological processes operating within the unsaturated zone as a whole and near the surface in particular.
content Part I (unsaturated zone): introductory concepts; hydraulic potential theory;

soil water retention aspects; measurement techniques for soil water content and matric potential; stationary and non-stationary unsaturated flow (hydraulics); infiltration during conditions of ponding, concepts and basic modelling; determining saturated and unsaturated soil hydraulic conductivities; macropore vs. matrix flow; Rijtema -- De Laat approach to modelling unsaturated flow under conditions of high water table (MUST); SVAT model theory (SOAP model); Van Genuchten approach to soil water retention curve modelling.
Part II (near-surface processes): hillslope hydrological patterns in relation to climate, soil type and slope morphology; mechanisms of runoff generation (infiltration-excess overland flow, subsurface stormflow, saturation overland flow); surficial erosion processes (splash, wash and rill erosion) and governing factors; gully erosion; mass wastage; the concept of sediment delivery; temporal and spatial variability in runoff and sediment delivery at various scales; quantifying surface runoff, erosion and sediment delivery; simple erosion prediction models (RUSLE); process-based modelling of runoff and sediment transport (GUEST); soil conservation techniques (including videos).

form of tuition A series of 12 lectures of 2 hours each plus 2 practicals of 4 hours each.

literature Koorevaar, P., Menelik, G. & Dirksen, C., 1983. Chapters 1-5 in *Elements of soil physics. Developments in Soil Science* no. 13, Elsevier. chapter 6 in Ward, R.C. & M. Robinson, 2000. *Principles of hydrology (4th ed.)*, McGraw-Hill.
Morgan, R.P.C., 1995. *Soil erosion and conservation* (2nd ed.). Longman.
Plus materials to be handed out during the course

mode of assessment Written examination.

entry requirements Participants are advised to follow the course on Groundwater Hydraulics (450009) first.

naam **Vakdidactiek 1 en 2**

code 990000

studiepunten 9

docent Diverse docenten

periode 30.08.2004 - 31.08.2005

inhoud De vakdidactiek houdt zich bezig met de inhoud van het schoolvak en met het lesgeven in het schoolvak. Er is aandacht voor vakspecifieke kennis, vaardigheden en inzichten en voor het schoolvak relevante ICT-toepassingen. In het vakdidactiekprogramma vindt eveneens een vertaling plaats van algemeen didactische thema's naar het vak. Een belangrijk onderdeel van de vakdidactiek is de *meesterproef:* in de derde fase ontwerpt de docent in opleiding als meesterproef onderwijsmateriaal volgens een aantal richtlijnen. Een meesterproef kan bestaan uit praktische opdrachten, trainingsmodules, een speciaal lessenpakket, een plan voor een excursie, etc.
De docent in opleiding laat hiermee zien dat hij zelfstandig vanuit zijn eigen kennis en inzicht t.a.v. onderwijs, vak en maatschappij een uitgewerkt plan kan ontwerpen dat leerlingen in staat stelt op een bepaald gebied leerervaring op te doen. De meesterproef wordt uitgetest in de onderwijspraktijk en geëvalueerd. De vakdidacticus beoordeelt de meesterproef in het kader van het portfolio.

literatuur Reader kan bij aanvang van de cursus aangeschaft worden.

onderwijs	werkcollege (30.08.2004 - 31.08.2005) op maandag
toetsing	opdracht opdrachten worden opgenomen in het portfolio
blackboard	Ja

naam	**Veldexcursie ecosystemen Ardennen**
code	450286
docenten	prof.dr. J. Rozema; dr. N.D. de With; dr. H. Hillebrand
studiepunten	2
periode	periode 5
doel	-Kennismaking met planten en diersoorten van Midden Europese ecosystemen: bossen op kalkbodem, bronbossen, hoogvenen, kalkgraslanden, puinhellingen, zware metaalweiden en snelstromende wateren. -Kennis van flora en fauna van ecosystemen, ook in relatie tot biogeografie. -Het leren gebruiken van Flora van Heukels en andere determinatiewerken -Het leren maken van vegetatieopnamen en het berekenen van een diversiteitsindex. -Het leren karakteriseren van belangrijke abiotische en biotische omstandigheden: pH bodemwater, bodemprofiel, moedermateriaal -Inzicht in de samenhang van onderdelen van ecosystemen: samenhang door trofische structuur, en de daarmee verbonden stofkringlopen. -Inzicht in factoren die de biodiversiteit van ecosystemen beinvloeden. -Inzicht in het beheer van bezochte ecosystemen. Aanwijzingen hiervoor (karakterisering, samenhang, biodiversiteit, beheer) worden met een vragen en opdrachtlijst gegeven.
inhoud	Excursieduur van 1 week: Nederlandse en Latijnse Plantennamen. Nederlandse en Latijnse Dierennamen. Kenmerkende eigenschappen van bezochte ecosystemen: hoogveen, kalkloofbos, moerasbos, kalkgrasland, puinhelling, zware metaalweide, snelstromende rivier. Vegetatieopnamen en het berekenen van diversiteitsindex. Karakteriseren van belangrijke abiotische omstandigheden: pH bodemwater, bodemprofiel, moedermateriaal.
toetsing	-Kort deelverslag, en ingevulde vragen en opdrachtenlijst. -Toets over herkenning planten en dieren in hun ecosysteem. en over structuur (soortensamenstelling, trofische structuur) en processen (successie, decompositie, nutrientenkringlopen) van de ecosystemen in de excursiegebieden.
opmerkingen	De eigenbijdrage voor de reis- en verblijfskosten voor deze excursieweek bedraagt per student ongeveer Euro 100.00. Je verblijft met een aantal medecursisten in een huisje. Aan het eind van elke excursiedag wordt bij een Delhaize supermarkt gestopt om eten in te kopen. Dit komt voor rekening van de studenten. De excrusie maakt deel uit van de bachelorstage voor Biologie-studenten, maar kan als losse keuzecursus ook door studenten in de Aardwetenschappen worden gevolgd. Benodigdheden en literatuur: Handleiding excursiehandleiding Ardennen. Prijs Euro 5.65 Heukels Flora van Nederland, Wolters Noordhoff, laatste editie Goede loep (Euro 25)

Natuurgidsen voor herkenning diersoorten.
Vroegtijdige opgave is noodzakelijk in verband met de reservering van huisvesting in de Ardennen. Verdere informatie en opgave bij jrozema@bio.vu.nl

werkwijze Voorcollege flora en fauna excursiegebieden Ecosystemen Ardennen
Voorcollege geologie Ardennen Gast docent
Dia's flora en fauna ecosystem Ardennen
Excursies naar: hoogveen, kalkloofbos, kalkgrasland, puinhelling, zware metaalweide, snelstromende rivier.
Uitvoeren van opdracht: metingen aan abiotische factoren, bodemprofiel, moedermateriaal, maken vegetatieopname, determinaties planten en diergroepen.
Maken van een verslag over de uitgevoerde opdracht.

subject **Volcanism**
code 450061
lecturer dr. P.Z. Vroon
credits 3
period period 3
content Introduction to modern quantitative volcanology. Types of eruption and volcanic deposits. Role of volatiles and crystal growth.
form of tuition Lectures; computational exercises (magma viscosity, density, eruption dynamics, heat discharge). Practicals (fluid dynamics, electron microscopy of volcanic glasses).
literature Selected chapters from; R.V. Fisher & H.-U. Schmincke(1984), *Pyroclastic rocks*. Springer Verlag;
R.S.J. Sparks et al. (1997), *Volcanic plumes*. J. Wiley & Sons.
mode of assessment Practicals (50%), written exam (50%).

naam **Wetenschapsjournalistiek**
code 471014
docenten dr. J.T.J.M. Willems; drs. L. Linsen
studiepunten 6
periode 04.10.2004 - 29.10.2004
doel
- Inzicht verwerven in het proces van het populariseren van de beta-wetenschappen, met name het begrijpelijk en toegankelijk maken van wetenschappelijke informatie via de journalistiek;
- Trainen in het zelf populair wetenschappelijk schrijven voor dag- en weekbladen;
- Trainen in het schrijven van enkele bijzondere genres zoals interviews, boekrecensies en opinie-artikelen.

inhoud Deze module bestaat uit ochtenden waarin de diverse praktische en theoretische aspecten van het journalistiek schrijven over wetenschap (en technologie) aan de orde komen. Dat zijn bij voorbeeld schrijftechniek, interviewen en illustreren resp. de werking van de media, ethische aspecten en communicatiebarrières tussen onderzoekers en journalisten.
Deze aspecten worden besproken tijdens werkcolleges (na zelfstudie), aan de hand van casussen (pgo) en met gastsprekers.
De middagen zijn gereserveerd voor het schrijven van tenminste zes populair-wetenschappelijke artikelen. Dat doe je in groepjes van twee (of

	eventueel drie) studenten. De werkstukken (persberichten, artikelen en interviews) worden in de groep besproken. Het laatste artikel dient in principe geschikt te zijn voor publicatie in een dag- of weekblad (zoals Trouw of Natuurwetenschap & Techniek)
literatuur	Journalistiek schrijven, Donkers, H en J. Willems (red.), Coutinho, Bussum, 2002 (tweede druk).
toetsing	Je wordt beoordeeld op basis van je laatste werkstuk: een populair-wetenschappelijk artikel voor een dagblad of tijdschrift.
opmerkingen	Deze module omvat veel huiswerk. Een deel daarvan past in de tijd van het studieprogramma, maar waarschijnlijk zul je ook daarbuiten tijd en energie moet zoeken om de geplande artikelen te schrijven.
werkwijze	(Werk-)colleges over de theorie en over de praktijk van de schrijvende journalistiek, vaardigheidstrainingen en huiswerk (in groepjes), zowel op het terrein van het zelf schrijven als op het beoordelen van andermans artikelen.

8 Programme components Environment and Resource Management

subject **Analysis of Environmental Problems**
code 468013
lecturers dr. R. Janssen; A.J. Gilbert; dr. M. van Herwijnen; dr. P.J.H. van Beukering (and others)
credits 3
period period 1 and 2
aim This module gives an overview of the more technical tools for analysing environmental problems. First the module clarifies the scope of each analytical tool. Then for each tool an introduction will be given, followed by a seminar or tutorial in which the tool is actually used. The students must apply the tool to a (simplified) problem and write a short report on the outcomes. The Vechtstreek, case treated in Module 468002 will reappear in some parts of this module.
content Specific topics include:

- Introduction: description of the 5 problems
- Systems analysis and simulation: use of simulation software (STELLA);
- Spatial analysis and spatial evaluation; use of Geographic Information Systems (GIS)(ARCVIEW);
- Multicriteria analysis (MCA) and the use of decision support software (DEFINITE);
- Life cycle analysis (LCA)
- Valuation and cost-benefit analysis (CBA); the use of CBA software (DEFINITE);
- Stakeholder analysis and participation; the use of interview techniques
- Spatial negotiation and mediation.

Systems analysis
Systems analysis refers to methods supporting system management by exploring alternative futures. Systems analysis provides a formal procedure by which different management actions can be tested and, in particular, compared, to derive insight as to which action(s) are more likely to yield the desired future. STELLA is computer software that supports systems thinking and permits systems analysis.

Spatial analysis and spatial evaluation
Spatial planning involves physical and socio-economic data that have a spatial component. These data can be point data collected during field studies, or area covering data from satellite images (Remote Sensing). Before these data can be used in spatial planning, these data must be analysed and published either in maps, tables or charts. Creating an area-covered map of point observations involves interpretation of points in the field from where no observations were taken.. The spatial analysis techniques are usually performed within a Geographical Information System (GIS). This part of the course will focus on the following technical aspects: basic GIS and Remote sensing theory, data formats, data import/export, visualisation, overlay, mathematical GIS functions, map types, creating maps and meaningful

legends, Multicriteria analysis and GIS. A main part of this topic is devoted to exercises with the GIS package ARCVIEW.

Multicriteria analysis
Comparing alternative options for dealing with environmental problems usually involves a large amount of information. Because using this amount of information effectively is an impossible task, methods are developed to support decision makers. Examples are multicriteria methods, visualisation methods and cost-benefit analysis. Weighted summation is a very popular multicriteria method. Important aspects include: aggregation of incomparable information, integration of the opinion of stakeholders and presentation of information and results. Weighted summation are applied on a case study using the decision support software DEFINITE. Life cycle analysis can be seen as a dedicated application of MCA for comparing the environmental impacts of products.

Valuation and cost-benefit analysis
Economics is about making choices. Making choices about the environment is more complex than making choices in the context of purely 'private' goods and services. In the environmental context, what needs to be compared is one priced good (the private good) and one un-priced one (the public good, typically an environmental good or service). In this choice context it is necessary to impute a value for the environmental good or service. The discipline of environmental economics has developed techniques whereby such values can be estimated (e.g. hedonic pricing) and evaluated (e.g. cost-benefit analysis). The module on environmental economics explains these techniques, and demonstrates its application in various case studies. Also, different computerised valuation techniques will be practised and students will be sent out in the field to gain experience in surveying techniques.

Stakeholder analysis and participation
When environmental problems are analysed, it becomes soon clear that such problems cannot be objectively defined. They are social constructs and people give these problems their own definition and they have their own understanding of the kinds of solutions that are likely to work in addressing the problem. We will focus on the qualitative participative methodologies that are generally used in the social sciences for the purpose of research. These social science methods include discourse analysis, interview techniques, stakeholder research and participation, and participatory integrated assessment, etc. In particular, the course will focus on training the students in interview techniques and stakeholder analysis within the context of undertaking case studies.

Spatial negotiation and mediation
A workshop combines a broad range of disciplines and methods. The workshop uses elements of stakeholder analysis and participation, spatial analysis, multi-criteria analysis, scenario analysis and cost-benefit analysis. To support a negotiation and mediation process, a GIS-based exercise was developed. The students are divided into stakeholder groups and with the use of the spatial mediation and negotiation support tool they are given the

assignment to develop a spatial plan. The workshop contains 3 phases. The first phase is devoted to identifying stakeholder preferences and constructing a 'value map'. In the second phase, the groups will develop sectoral plans for the area, and these plans will be confronted with the value maps of the other stakeholder groups to identify conflicts and possible compromises. In the third and final phase, the groups will negotiate on a possible compromise.

literature Reader 'Analysis of environmental problems' Kahn, J.R. (1998). The Economic Approach to Environmental and Natural Resources South-Western publishers. Chapters 1, 2 and 4.

mode of assessment At the end of this module there will be an open book examination on the topics treated mentioned above. The students have the option to write a group or individual report on the application of one of the methods discussed, or on the application of one of the methods discussed. The exam weighs two thirds and the report one third. Students must pass both (5.5 or higher).

subject **Environmental Policy and Management**

code 468004

lecturers prof.dr. J.C.J.M. van den Bergh (co-ordinator); dr. D. Huitema (co-ordinator); dr. J. Gupta; dr. M.A. van Drunen (and others)

credits 16

period period 3 and 4

aim The purpose of this module is to give an overview of policy instruments and institutional arrangements for managing environmental problems from an interdisciplinary perspective, involving economics, policy analysis, law, the management sciences and anthropology.
The root cause of environmental problems is that not all costs falling on economic agents are borne by those responsible for generating them. The problem will be conceptualised in this module through the notion of externalities. There are various instruments and institutional arrangements for addressing such externalities. Criteria for their selection and evaluation will be discussed. Applications of environmental policies to the Netherlands, as well as to global problems will be discussed.
At the end of this module the students are able to judge how well certain policy instruments and institutional arrangements perform in terms of effectiveness, efficiency and the distribution of welfare in society.

content *Block A: Introduction and policy science approach to environmental issues*
In the first class an overview of this module will be given, mainly highlighting the social science approach to environmental issues. Important from this perspective is the separation between the societal and natural systems. The natural system fulfils important functions for human societies and thereby affects human welfare and development. However, in turn, humans affect the natural system. Whether or not an environmental problem exists depends both on the state of the natural system and on the perception and views of people.
Having introduced the basics of this module, this block continues with a focus on what governments do or can do to address environmental problems. The learning objectives are to gain insight into the following questions:
1. How do environmental themes come to the attention of governments in the first place?
2. What is a policy, and when do we speak of a government policy? How is

policy made?
3. How are policies implemented and enforced?
4. How can policy be evaluated?

Block B: Economic theory of environmental policy

In Block B the economic approach to the analysis of environmental policy will be presented. The central notion is externalities, which in the case of environmental problems take the form of external costs. Furthermore, many environmental problems are characterised by public goods instead of private goods. Before moving on to public or governmental policy, endogenous or self-organised solutions to environmental problems will be examined. In this context the Coase theorem is relevant.

Economists tend to focus on efficiency and cost-effectiveness, but considerations relating to equity, effectiveness in the face of uncertainty, social-political feasibility, enforceability, and sustainability also play an important role in the public debate. Therefore, the role of efficiency and potential conflict with other criteria will be carefully analysed.

Next, a typology of instrument or policy selection will be offered. A broad and widely used categorisation is into market-based instruments, command-and-control, and moral and information instruments. Subsequently, specific instruments are analysed in detail, such as taxes and levies, quantity and technology standards, tradable permits, deposit-refund systems and environmental tax revision.

After this standard theory, advanced topics are introduced. These include: the implication of alternative assumptions regarding the behaviour of firms and consumers; dealing with irreversibility and uncertainty; distribution and equity; voluntary approaches; a comparison of advised (normative) and realised (positive) policy; and the role of technological innovation. The block closes with applications.

Block C: The international context of environmental policy

Current environmental law build on earlier agreements between states on how to share natural resources such as international water. Furthermore, various international organisations (World Bank, UN, OECD, EU) pursue international environmental policies, in the absence of a World Environment Organization. It should also be noted that various non-state actors are increasingly relevant to global environmental governance including industry, science, civil society and specific environmental NGOs, thus giving rise to multi-level and multilayered governance. Key conflicts concern North-South relations in global environmental governance.

In the second part of this block a number of social mechanisms will be reviewed that are especially relevant to environmental issues in the South. We will elaborate the interactions between southern and northern social mechanisms that operate as sources of environmental problems and form the basis for solutions to these.

Block D: Transformation

Solving complex environmental problems requires a major transformation (or transition) of the current systems of production, consumption and incentive structure to more sustainable combinations of technology and organisational structure. In this block, attention is given to three dimensions: (1) transition and transformation processes, (2) industrial ecology and (3) environmental regulation from a corporate governance perspective.

First, processes of transformation and systems change with the aim to reach sustainability are examined. A transition can be understood as a gradual process of system change (25 years or more) and includes a technological, societal and economic dimension. In working groups, the students gain experience with exploring possibilities for stimulation of long-term transition processes by using the backcasting methodology.
Second, industrial ecology examines the impact of industry and technology and associated changes in society and the economy on the biophysical environment. It focuses on the potential role of industry in reducing environmental burdens throughout the product life cycle. Two issues are investigated in detail: waste treatment in the Netherlands and eco-industrial parks, focusing on the famous case of Kalundborg in Denmark.
Third, the corporate governance perspective is discussed. Sustainable business demands more than complying regulations: a broadening of environmental perspectives (resource use, product policies), integration of environmental, economic and social strategies (Planet, Profit, People) and capabilities for self-governance to stay ahead of government regulation. Instruments to assist companies in this endeavour towards Corporate Social Responsibility are discussed.

literature
- J.R. Kahn (1998). The Economic Approach to Environmental and Natural Resources. 2nd edition. The Dryden Press, Harcourt Brace College Publishers, Fort Worth, USA, Chapters 3, 5, 6, 8, 9, 14, 17.
- Anderson, J.E., Public policy making, New York, 2003 (Houghton Mifflin).
- Reader 'Policy and management' (about 700 pages).

mode of assessment
- After the four blocks, a long paper must be written on a specific topic.
- The module ends with a comprehensive open book exam,
- The exam weighs two third and the paper one third. Students must pass both (5.5 or higher).

remarks Students are strongly recommended to have followed Module 3: Analysis of environmental problems (code 468013)

subject **Environmental Problems: Case Studies**
code 468002
lecturers dr.ir. J.E. Vermaat; dr. J.C.J.H. Aerts (and others)
credits 4
contact Dr. ir. Jan Vermaat, jan.vermaat@ivm.vu.nl, +31-20-4449596, room A-543.
period period 1

aim
- The development of a common, multi-dimensional perspective of present-day, complex environmental problems;
- The development of a framework-for-analysis, to describe, analyse and address such environmental problems;
- The development of an insight in the inter-relatedness of societal, biogeochemical and spatial aspects of complex environmental problems.

content Two present-day, practical but complex environmental issues will be used as cases:
- Spatial planning in the Vecht area: water management and nature development
- Climate change and development

These cases have been selected to address an increase in spatial scale,

because of their need of multidisciplinary inputs, and because they cover important policy themes that feature in national and European policy texts. They serve as an introduction to Modules 3 and 4 (4680013 and 468004).
The first case will highlight contrasting interests among stakeholders in a complex spatial planning context. The Vecht area is a well-studied landscape where urban development, recreation, agriculture, and nature conservation require a balanced planning. Future needs in terms of water quantity and quality interfere with these needs.
In the second case, the effects of climate change in developing countries will be presented. Beyond the physically apparent changes, i.e. sea level rise and altered regional precipitation patterns, socio-economic consequences and international dependencies will be addressed.

form of tuition Lectures, workshops and an excursion. Workshops will include skills training in paper reviewing and oral presentations.

literature Reader composed of scientific papers selected by the lecturers

mode of assessment Students must write a comparative literature review of two papers. The review is based on a provided format and can be written by students individually or in pairs.

subject **Portfolio**

code 468016

lecturers dr. M.A. van Drunen; drs. M.I. Tromp Meesters; drs. F.H. Oosterhuis

credits 4

contact Dr. Michiel van Drunen, michiel.van.drunen@ivm.vu.nl, +31-20-4449534, room A645.

period all

aim The objective of this module is that the students reflect on their personal development and more specifically their development related to the *competences*: to be able to read and interpret scientific papers in their own discipline; to be able to write clearly and to contribute to scientific papers and reports; to be able to interpret data sets; to reason logically i.e. to draw motivated conclusions based on empirical evidence; to distinguish main issues from less important issues and to distinguish truth from convention.

content A portfolio is a purposeful collection of student work that exhibits the student's efforts, progress and achievements in one or more areas. In the Environment and Resource Management programme the students will be responsible for their own portfolio. This will include an electronic archive with multimedia files (documents, models, presentations, pictures, videos). From this archive, several selections can be made public on internet (a showcase), or be made available for tutors and fellow students (for feedback), and for assessors (for grading).
Central in this module is the personal development plan that is written at the very beginning of the programme. It will be adapted by the students during the year if necessary. In the plan, each student writes what competences he wants to acquire. This will depend strongly on his educational and professional background. He must add files to his portfolio to describe his current competences (e.g. by adding a copy of his Bachelor's diploma, websites, reports, essays, presentations, etc.). The student evaluates his development by self reflection and by discussions with his tutor (portfolio assessment).

mode of assessment During the year, the student will add many new products to his portfolio, such as reports, essays, presentations, feedback he has received from peers, feedback he has given to peers, and test results. For the performance assessment, some of these products will be obligatory:

- A personal development plan,
- One essay,
- One individual or one group report,
- A feedback report on an individual report or a feedback report on a group report,
- A feedback report on the activities of other group members,
- Feedback reports of three other group members on your activities in the group,
- Feedback reports of two different students on two of the products in the portfolio,
- The module five group report, and
- Three oral or poster presentations.
- A self reflection report..

remarks This module is relevant only for students following Modules 1-5 (468011, 468002, 468013, 468004, and 468015 or 468017) in the MSc programme Environment and Resource Management.

subject **Research Paper**
code 468017
lecturer drs. M.I. Tromp Meesters (coordinator)
credits 18
period period 5 and 6
aim Objectives of this module are:

- To become acquainted with environmental research in practice;
- To develop and apply the theoretical frameworks elaborated in the former modules in a specific context;
- To apply the disciplinary knowledge and skills, obtained in the bachelor study and in the former modules of the ERM to a real life research question.

content Based on the interest of the students and the supervisors. The product will be a scientific paper. The students carry out an environmental research project that is related to their disciplinary background, at the Vrije Universiteit.
form of tuition Individual literature research (on internet and in the library) and oral and written reporting are some of the methods. Meeting and reporting skills will be taught. The research subject will be of a more fundamental scientific nature, meant to prepare the student for a scientific career.
literature Is highly dependant on the subject and the option chosen. For the skills mentioned above an additional reader will be used.
mode of assessment The product of this module will be a scientific paper. The report or paper may include a computer model, a website or another multimedia product. The specific subject and approaches to be used will be chosen based on the learning objectives of the student and consultation with his tutor. The paper contributes 70% to the final grade and the research activities 30%.
remarks Students are strongly recommended to have followed Module 4: Environmental policy and management (code: 468004)

subject **Sustainability and Growth**

code 468011

lecturers prof.dr. J.J. Boersema; dr. P.E. van der Werff; prof.dr. A.J. Dolman; dr. A.M. van Dommelen (and others)

credits 6

contact Prof.dr. Jan Boersema, mailto:(j.boersema@dienst.vu.nl, +31-20-4445675) or dr. Peter van der Werff, peter.van.der.werff@ivm.vu.nl, +31-20-4449542, room A646.

period period 1

aim The first module offers a historical and conceptual framework. It touches briefly on several subjects that are elaborated later on. Its objectives are:

- To understand concept of sustainable development and to elaborate its principles in scientific, technological and socio-economic terms.
- To define 'environmental problems'.
- To understand important mechanisms that relate to environmental problems including worldviews, (economic) growth and thermodynamics.

Key concepts: Evolution; sustainability; quality; diversity; future-oriented policy; culture- nature interface.

content 1. General perspective.
Starting this module we examine the evolution of humans, their lives as hunters and gatherers and their eventual adoption of agriculture and further transformation into industrialized societies and even beyond that. Highly developed modern societies are often considered to be or become unsustainable. Sustainability has become a major societal and political goal and sustainable development the road to be taken. What do we learn from the past? The history of Easter Island seems a perfect example and warning.
2. The natural science perspective.
The idea of the Earth as a system that is regulated as a thermostat, with strong coupling between solar irradiance, chemical composition that shape the preconditions of life (Gaia) will form the basis of this part. Past variations in both irradiance and chemical composition in the earth will related to climatic changes and indicate how sensitive the earth system is to changes. Two central questions will be addressed:
Is the concept of growth at odds with the laws of thermodynamics? Does the concept of sustainability ill befit the idea of evolution?
3. The social science perspective.
Human beings live in a number of social entities, such as groups, organizations and societies. In a social entity people have to a certain extent similar patterns of thinking and acting. Especially during childhood patterns of thought are internalized at a subconscious level, which makes it difficult to change them. Environmental management aimed at redirecting such patterns faces thorough problems. Interactions between societal systems that affect the physical environment provide even larger challenges. Environmental management, the redirection of societal complexity for the benefit of the environment, requires a thorough understanding of such complexity.
4. The economic perspective.
Since several decades people worry about the influence of continuing economic growth on nature, environment and supplies of natural resources, and feedback to growth. The various optimistic and pessimistic viewpoints are referred to as the "growth debate". This debate can best be explained on

the basis of three core questions: Does economic growth increase social welfare? Is growth feasible? And can we control or steer growth? Based on answers to these questions, one can identify five perspectives in the debate. These are evaluated from both theoretical and empirical angles.
5. The Philosophical perspective.
Environmental philosophy deals with fundamental questions concerning the 'nature' of mankind and his place in nature. In ancient philosophy thoughts on this subject are often referred to as cosmologies. As positions taken have a bearing on ethics the relevance of reliable knowledge is obvious. Does science provide such knowledge? What if uncertainty appears to be a typical feature of the world we live in? How can science play his part in, or underpin decision--making and future oriented policies?

form of tuition Lectures and workshops.

literature Reader composed of papers selected by the lecturers

mode of assessment At the end of this module there will be an open book examination based on the literature mentioned above. In addition, an individual essay based on a selection of the issues discussed in this module and on the learning objectives needs to be prepared as well.The exam weighs two third and the essay one third. Students must pass both (5.5 or higher).

subject **Traineeship**

code 468015

lecturer drs. M.I. Tromp Meesters

credits 18

period period 5 and 6

aim Objectives of this module are:

- To become acquainted with environmental research and policy in practice;
- To apply the theoretical frameworks elaborated in the former modules in a specific context;
- To apply the disciplinary knowledge and skills, obtained in the bachelor degree programme and in the former modules of ERM to a real life problem.

content For his/her master's thesis the student has two options:

- *Internal environmental report.* Four to seven students jointly carry out a research project in a multidisciplinary setting, supervised by an experienced researcher at the VU. In this option specific attention will also be given to conferring techniques and project management.
- *External environmental report.* An individual internship externally, e.g. at a company or an (international) governmental organisation. The Institute for Environmental Studies (IVM), as an internationally oriented research organisation, has a large network of outstanding environmental institutes and (non) governmental organisations that can supervise interns.

form of tuition Dependent on the choice of the student, the method will be working in a research project group (1), in which skills as project management and meeting techniques will be taught. Literature research (on internet and in the library) and oral and written reporting are some of the methods. During the individual internship (2) meeting and reporting skills will be taught.

literature Is highly dependant on the subject and the option chosen. For the skills mentioned in (1) an additional reader will be used.

mode of assessment	The product of this module will be either a group report, or an individual report. The report may include a computer model, a website or another multimedia product. The specific subject and approaches to be used will be chosen based on the learning objectives of the student and consultation with his tutor. The report contributes 70% to the final grade and the research activities 30%.
remarks	Students are strongly recommended to have followed Module 4: Environmental policy and management (code: 468004)

9 Subjects listed by course code

Course code	*Course name*	*Stp.*	*Period*
201796	Milieurecht (B3/M)	6	week 6 - 15
450001	Advanced Spatial Analysis Techniques	6	Period 1
450003	Catchment Response Analysis	6	Period 1
450004	Climate Modelling	6	Period 1
450005	Exogene Isotope Geochemistry: Proxies and Tracers in the Sedimentary Record	6	Period 1
450008	Groundwater Flow Modelling	6	Period 2
450009	Groundwater Hydraulics	6	Period 1
450011	Magmatic Processes	6	Period 2
450012	Marine Geology	6	Period 2
450013	Metamorphism	6	Period 2
450014	Ecohydrology	6	Period 2
450015	Paleo-ecological Environments	6	Period 2
450016	Polyphase Deformation in Orogens and Forelands	6	Period 2
450017	Sedimentology for Masters	6	Period 2
450018	Tectonics and Global Geophysics	6	Period 1
450019	Tectonomorphology	6	Period 1
450021	Unsaturated Zone and Near Surface Hydrological Processes	6	Period 2
450044	Advanced Paleo-Oceanography and Sea-level Change	6	Period 4
450045	Analogue Modelling of Tectonic Processes	2	Period 3
450047	Environmental Management in River Basins and Coastal Lowlands	6	Period 5
450048	Exogene Isotope Geochemistry: Radiometric Dating Techniques	6	Period 4
450049	Geo-ecological Environments	6	Period 4
450050	Geotechnics	6	Period 5
450051	Global Biogeochemical Cycles	6	Period 4
450052	Hydrochemistry	6	Period 4
450053	Orogenesis	6	Period 4
450054	Palaeo-ecology/Palynology	3	Period 3
450055	Petroleum Systems	2	Period 3
450056	Regional Basin Geology	6	Period 4
450057	Regional Hydrogeology and Groundwater Management	6	Period 4
450058	Sediment Petrography of Heavy Minerals	3	Period 3
450059	Simple and Applied Reflection Seismics	6	Period 4
450060	Soil Vegetation Atmosphere Exchange	6	Period 4
450061	Volcanism	3	Period 3
450094	Geobotanie (plantkunde)	6	Periode 5
450107	Master Thesis Lithosphere Tectonics, Petrology, and Isotope Geochemistry (O-variant)	27	variable
450108	Master Thesis Lithosphere Tectonics, Petrology, and Isotope Geochemistry (M-variant)	27	variable
450109	Research Project Petrology and Isotope Geochemistry	27	Period 6
450110	Research Project Endogene Geology	27	Period 6
450111	Master Thesis Sedimentary and Structural	27	variable

	Geology, Basin Analysis, and Surface Processes (O-variant)		
450112	Master Thesis Sedimentary and Structural Geology, Basin Analysis, and Surface Processes (M-variant)	27	variable
450113	Research Project Structural Geology and Tectonics	27	Period 6
450114	Research Project Sedimentology	27	Period 6
450115	Research Project Marine Geology	27	Period 6
450116	Research Project Paleo-climatology/Paleo-ecology/Paleo-oceanography	27	Period 6
450117	Master Thesis Paleoclimatology/Paleo-ecology/Paleo-oceanography (O-variant)	27	variable
450118	Master Thesis Paleoclimatology/Paleo-ecology/Paleo-oceanography (M-variant)	27	variable
450119	Research Project Quaternary Geology/Geo-ecology	27	Period 6
450120	Master Thesis Quaternary Geology/ Geo-ecology (O-variant)	27	variable
450121	Master Thesis Quaternary Geology/ Geo-ecology (M-variant)	27	variable
450122	Master Thesis Hydrogeology (O-variant)	27	variable
450123	Master Thesis Hydrogeology (M-variant)	27	variable
450124	Master Thesis Ecohydrology (O-variant)	27	variable
450125	Master Thesis Ecohydrology (M-variant)	27	variable
450126	Field Course Netherlands (Measurements Techniques)	3	Period 5
450127	Field Course North Italy (hydrology)	9	Period 6
450128	Field Course Algarve, Portugal	3	Period 6
450129	Thematic Research Project Hydrology	12	variable
450132	Geomicrobiology / Groundwater Microbiology and Geochemistry	6	Period 1
450133	Contaminant Hydrogeology	3	Period 5
450134	Capita Selecta Event Stratigraphy	6	Period 2
450135	Thematic Research Project Ecohydrology	12	variabe
450137	Aquatic Ecology	6	04.10.2004 - 29.10.2004
450138	Research Project Geo-ecosystems and Climate	27	Period 6
450139	Master Thesis Geo-ecosystems and Climate (O-variant)	27	variable
450140	Master Thesis Geo-ecosystems and Climate (M-variant)	27	variable
450142	Applied Geophysical Analysis	3	variable
450144	Capita Selecta Structural Geology and Tectonics	2	Period 4
450147	Environmental Mineralogy	3	Period 2
450148	Isotope Hydrology	3	Period 5
450149	Extension Master Thesis in Earth Sciences	12	variable
450150	Extension Master Thesis in Geo-environmental Sciences	12	variable
450151	Extension Master Thesis in Hydrology	12	variable
450152	Field Course Endogene Geology	6	Period 5
450153	Field Course Sedimentology/Structural Geology	6	Period 5
450155	Land Husbandry	3	Period 3
450158	Microstructures in Tectonites	6	Period 4
450159	Ore Microscopy	3	Period 1

450160	Spatial Variability and Multivariate Statistical Analyses	6	Period 2
450161	Numerical Modelling in Tectonics	6	Period 5
450162	Ore Petrology	3	Period 1
450164	Precambrian Geology	3	Period 3
450165	Remote Sensing in Hydrology	6	Period 4
450167	Magmatic Processes Capita Selecta (Melt Inclusions)	3	Period 1 and 2
450168	Sociale geografie II	12	Ter eigen keuze
450286	Veldexcursie ecosystemen Ardennen	2	Periode 5
450287	Field Course Applied Geology	6	Period 5
450289	Archaeometry III (Analytical Methods)	6	Period 5
450291	Biological Archaeometry	6	Period 2
450292	Historical Geography	6	Period 1
450293	Advanced Geophysical Prospection	3	yet unknown
450294	Capita Selecta Geoarchaeology (Introduction Nikopolis)	3	Period 3
450295	Research Project Landscape Archaeology	27	Period 6
450296	Research Project Archaeometry	27	Period 6
450297	Master Thesis Landscape Archaeology (M-variant)	27	variable
450298	Master Thesis Landscape Archaeology (O-variant)	27	variable
450299	Master Thesis Archaeometry (M-variant)	27	variable
450300	Master Thesis Archaeometry (O-variant)	27	variable
450301	Extension Master Thesis Landscape Archaeology	12	variable
450302	Extension Master Thesis Archaeometry	12	variable
450304	Geobiology	6	Period 5
450305	Archaeobotany	3	yet unknown
450306	Archaeozoology	3	yet unknown
468002	Environmental Problems: Case Studies	4	Period 1
468004	Environmental Policy and Management	16	Period 3 and 4
468011	Sustainability and Growth	6	Period 1
468013	Analysis of Environmental Problems	12	Period 1 and 2
468015	Traineeship	18	Period 5 and 6
468016	Portfolio	4	all
468017	Research Paper	18	Period 5 and 6
470045	Toegepaste ecologie	6	01.11.2004 - 26.11.2004
470055	Evolutie van de mens	6	10.01.2005 - 04.02.2005
471006	Communicatiewetenschappen	6	06.09.2004 - 01.10.2004
471014	Wetenschapsjournalistiek	6	04.10.2004 - 29.10.2004
471015	Information Representation/ Multimedia 1	6	10.01.2005 - 04.02.2004
471025	Popular Science Writing	3	07.02.2005 - 8.02.2005
471026	Museologie en buitenschoolse educatie	6	29.11.2004 - 24.12.2004
471027	Communicatie en educatie via internet	3	15.11.2004 - 26.11.2004
520160	Ges es: 3e j. wc: Natuur en vooruitgang 1500-2000	10	Periode 4 en 5
60000010	Ontwikkelingsvraagstukken (interfacultair)	6	Periode 1, 2, 3 en 4
990000	Vakdidactiek 1 en 2	9	30-08-2004 / 31-08-2005
990001	Algemene didactiek / pedagogiek 1 en 2	9	30-08-2004 / 31-08-2005
990002	Praktijk 1 en 2	30	30-08-2004 / 31-08-2005
990003	Praktijkonderzoek	8	
990004	Keuzemodulen	4	
991000	Interpersoonlijke communicatie	3	01-11-2004 / 12-11-2004

10 Appendices

10.1 Lecturers

10.1.1 Faculty of Earth and Life Sciences

phone	name	e-mail (@falw.vu.nl)	room
47355	dr. G. Aalbersberg	gerard.aalbersberg	O-450
47340	prof.dr. P.A.M. Andriessen	paul.andriessen	H-325
47324	dr. R.T. van Balen	ronald.van.balen	F-430
49801	dr. W.W.W. Beekman	fred.beekman	C-220
47357	dr. C.J. Beets	kay.beets	F-438
47288	dr. G. Bertotti	giovanni.bertotti	E-251
47371	drs. F.F. Beunk	frank.beunk	F-348
47260	dr. C. Biermann	cees.biermann	E-152
47326	dr. K.P. Boessenkool	karin.boessenkool	H-343
47348	dr. S.J.P. Bohncke	sjoerd.bohncke	M-428
47393	drs. B.M. van Breukelen	boris.van.breukelen	C-428
47294	dr. L.A. Bruijnzeel	sampurno.bruijnzeel	M-446
47345	drs. E.A.J. Burke	ernst.burke	F-338
47341	prof.dr. S.A.P.L. Cloetingh	sierd.cloetingh	E-160
47287	dr. O. van Dam	oscar.van.dam	F-464
47329	dr. G.R. Davies	gareth.davies	F-032
47358	prof.dr. A.J. Dolman	han.dolman	M-438
49806	prof.dr. H. Doust	harry.doust	E-154
47398	dr. T. Dunai	tibor.dunai	H-351
	prof.dr.ir. J.T. Fokkema	jan.fokkema	
47351	dr. A.R. Fortuin	anne.fortuin	E-237
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47012	dr. H. Hillebrand	herman.hillebrand	A-043
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47363	dr. A.M. Immenhauser	adrian.immenhauser	E-247
47295	drs. M.M.E. Jans	miranda.jans	O-425
47321	dr. R.A.M de Jeu	richard.de.jeu	H-320
47424	dr. S.J.A. Jung	simon.jung	E-353
47364	prof.dr. H. Kars	henk.kars	O-439
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47422	dr. D.A. Nieuwland	dick.nieuwland	C-214
47373	dr. I. Nikogosian	igor.nikogosian	H-359
47258	drs.ing. S. Oonk	stijn.oonk	O-441

47419	dr. F.J.C. Peeters	frank.peeters	E-336
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47327	dr. M.A. Prins	maarten.prins	E-322
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47307	dr.ir. E. Seyhan	ersin.seyhan	O-449
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47273	drs. P.M.H. Smit	paul.smit	O-442
47376	dr. H. Renssen	hans.renssen	C-408
47262	dr. H. Stel	harry.stel	E-127
47347	dr. R.A. Stephenson	randell.stephenson	E-137
47292	dr. S.R. Troelstra	simon.troelstra	E-319
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47404	dr. P.Z. Vroon	pieter.vroon	M452
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47325	dr. P. Ziveri	patrizia.ziveri	E-328
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46371	dr. G.J.L.M. Burgers	gjl.burgers	08A/23
46434	dr. P.J.E.M. van Dam	pjem.van.dam	10A/22
46369	prof.dr. N. Roymans	ngam.roymans	08A/21
46255	dr. S.W. Verstegen	sw.verstegen	12A/28
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10.3 Programme components subject to Work placement and thesis regulations

Course code	***Subject***	***Stp.***
450107	Master Thesis Lithosphere Tectonics, Petrology, and Isotope Geochemistry (O-variant)	27
450108	Master Thesis Lithosphere Tectonics, Petrology, and Isotope Geochemistry (M-variant)	27
450109	Research Project Petrology and Isotope Geochemistry	27
450110	Research Project Endogene Geology	27
450111	Master Thesis Sedimentary and Structural Geology, Basin Analysis, and Surface Processes (O-variant)	27
450112	Master Thesis Sedimentary and Structural Geology, Basin Analysis, and Surface Processes (M-variant)	27
450113	Research Project Structural Geology and Tectonics	27
450114	Research Project Sedimentology	27
450115	Research Project Marine Geology	27
450116	Research Project Paleo-climatology/Paleo-ecology/Paleo-oceanography	27
450117	Master Thesis Paleoclimatology/Paleo-ecology/Paleo-oceanography (O-variant)	27
450118	Master Thesis Paleoclimatology/Paleo-ecology/Paleo-oceanography (M-variant)	27
450119	Research Project Quaternary Geology/Geo-ecology	27
450120	Master Thesis Quaternary Geology/ Geo-ecology (O-variant)	27
450121	Master Thesis Quaternary Geology/ Geo-ecology (M-variant)	27
450122	Master Thesis Hydrogeology (O-variant)	27
450123	Master Thesis Hydrogeology (M-variant)	27
450124	Master Thesis Ecohydrology (O-variant)	27
450125	Master Thesis Ecohydrology (M-variant)	27
450129	Thematic Research Project Hydrology	12
450135	Thematic Research Project Ecohydrology	12
450138	Research Project Geo-ecosystems and Climate	27
450139	Master Thesis Geo-ecosystems and Climate (O-variant)	27
450140	Master Thesis Geo-ecosystems and Climate (M-variant)	27
450149	Extension Master Thesis in Earth Sciences	12
450150	Extension Master Thesis in Geo-environmental Sciences	12
450151	Extension Master Thesis in Hydrology	12
450295	Research Project Landscape Archaeology	27
450296	Research Project Archaeometry	27
450297	Master Thesis Landscape Archaeology (M-variant)	27
450298	Master Thesis Landscape Archaeology (O-variant)	27
450299	Master Thesis Archaeometry (M-variant)	27
450300	Master Thesis Archaeometry (O-variant)	27
450301	Extension Master Thesis Landscape Archaeology	12
450302	Extension Master Thesis Archaeometry	12
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468017	Research Paper	18

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