Alternative course guide

Earth Surface and Water

Last updated: 22-10-2014

Introduction

This is the course guide made by students of the committee for education of the U.A.V. It serves as an alternative for the official course guide. Here you can read the positive and negative experiences of students, stories of students that tell which course fitted in their track and which didn't, and all important points from the evaluations, for example the work load. The alternative course guide is updated every period by the committee for education of the U.A.V. It is not complete yet, but we hope you nevertheless can use it to make better choices for your master's program.

In this guide the four tracks of Earth Surface and Water can be found. For each track, at first a student that followed that track tells about his or her choices for courses and his or her experiences. Then the individual courses are discussed. Also the M-Profile *Earth and Sustainability* is discussed (for the M-Profile *GEO-Resources* see the course guide for Earth Life and Climate or Earth Structure and Dynamics).

The different tracks and different programs are partly overlapping. This means that one course can be part of more than one program. The students which evaluated the courses are part of only one track and therefore their experience might be slightly different than that of a student following the same course in a different track. Did you read something which is incomplete? Do not hesitate to contact us!

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1. Hydrology

For each track you have to chose at least 5 track courses, of which at least 3 from the top box.

Track: Hydrology
FG-Land surface hydrology*
AW-Principles of groundwater flow*
FG-Stochastic hydrology
FG-Unsaturated zone hydrology
AW-Hydrogeological transport phenomena
* obligated course
AW-Environmental hydrogeology
FG-Hydrology, climate change and fluvial systems
AW-Reactive transport in the hydrosphere

1.1 Inge's master track: Hydrology

Actually I just chose all eight hydrology courses. That is recommended if you don't know which part of hydrology you like most; if you do know, you can choose a smarter combination. Hydrology is a master track given by both AW (groundwater part) and FG (land surface part). If you do know what you like most, you can choose other courses. For example, groundwater can be perfectly combined with chemical courses such as Kinetic processes or the Geochemistry fieldwork. If you like more the land surface hydrology, you can opt for Earth surface modelling, Ecosystem modelling, the Excursion physical geography, some management courses or Remote Sensing or GIS.

1.2 Land surface hydrology

Overview

Period	1	Course code	GEO4-4404
Timeslot	B	Mean rating last year	7.6
Teacher	dr. R. van Beek	Mean workload last year	16 h
Contact	r.vanbeek@uu.nl Zon 1.10	Success rate last year	22 out of 28

Book: S. Dingman Physical Hydrology, 2nd Edition (ISBN: 978-1-57766-561-8). (Obligated) Principles of Groundwater flow (GEO4-1434) and Land Surface Hydrology are "obligated" for master students with the track Hydrology. One of them or both courses are often required for subsequent hydrology courses. Land Surface Hydrology is also part of the second year of the master Water Science and Management.

Acquired knowledge and skills

Knowledge: After an introduction of the global hydrological cycle, the course focuses on the hydrology within a catchment. Students learn several ways to describe the conversion of precipitation to runoff and storage. Ways to separate base flow from quick flow are discussed, as well as ways to describe the propagation of a flood wave (routing). Also there is a lecture on water management (interpret stream flow data for design purposes).
Skills: Students learn to analyze and interpret precipitation and runoff data. Also students learn ways to describe these data mathematically to make runoff forecasts. A small chapter is spent on errors and uncertainties. A lot of exercises are done with Excel, and some basic modeling with PC Raster.

Assessment, structure and work load
The course is well divided into different ways to obtain the knowledge. There are lectures, practicals (not graded) and computer practicals with Excel (not graded). One lecture students have to read two papers and discuss them. Students have to write a paper based on literature and a model report of a model they made themselves. Overall, the work load is evenly divided. Only the work load at the end of the course is high, because the deadline for the model report is close to the final exam. But the teacher is willingly to improve this.

Experiences
Students think the course is of high value for their track. The course evaluations state the teacher is very committed to help the students with the exercises or their model. This is good, because the modeling is independent and students have to find out how to make/adapt the model themselves, without some introduction lectures.
The reviews on the book are not very good. There is a lot of information, the main issues are hard to recognize. The reader is fine.
The feedback on the papers is late (after the final exam), but very specific. The final exam is of a high level, you really should practice old exams.

1.3 Principles of groundwater flow

Overview

Period	1	Course code	GEO4-1434
Timeslot	D	Mean rating last year	7.8
Teacher	prof. dr. R.J. Schotting	Mean workload last year	16-20 h
Contact	r.j.schotting@uu.nl AW W234	Success rate last year	-

Book: Charles R. Fitts, Groundwater science. Academic press, June 2002. ISBN 0-12-257855-4. (Obligated)
Principles of Groundwater flow and Land Surface Hydrology (GEO4-4404) are “obligated” for master students with the track Hydrology. One of them or both courses are often required for subsequent hydrology courses. Principles of Groundwater flow is also part of the master Water Science and Management.

Acquired knowledge and skills
Knowledge: The course gives a good overview of the basic principles to quantify flow of water through saturated porous media. All different subjects (porous media properties, flow equations, field tests etc.) are given on Osiris. A difference between Osiris and the actual course is that no attention is paid to solute transport and there is no excursion to a groundwater remediation site (this excursion is part of the course Hydrogeological Transport Phenomena GEO4-1433).
Many applications of the obtained knowledge are discussed. An introduction to the groundwater modeling program Modflow is given by Amir Raoof. Also an excursion to the drinking water company Oasen is part of the program.
Skills: The main skill you obtain is to set up and work out groundwater equations for different situations. Mathematics (differentials, super position principle etc.) is important during the whole course.

Assessment, structure and work load
Lectures cover the main part of the course. There are no practicals; students exercise by making their homework. Each part of the homework contributes to the final grade. Every homework exercise has

the same weighing, while the homework assignments in the end of the course definitely take more time than the first couple of homework assignments. The workload at the end of the course is therefore higher than in the first weeks of the course.
Next to the tutorials, there are some Modflow classes and an excursion to the drinking water company Oasen. No presentation, no papers to read or to write.
Students following Principles of Groundwater Flow have a very different background. Students who do the track Hydrology from the master Earth Surface and Water often have a bachelor Earth Sciences. They followed Water in GEO processes and Physical Hydrology, have a good background and know mathematics well. For them, the work load is quite low and the learning curve is slow. The larger part of the students is from the master Water Science and Management. Their background and knowledge of mathematics (from Wageningen, Environmental Studies, HBO etc.) is often not sufficient. Ruud Schotting gives extra math classes. However, still the work load for them is very high. The difference between the math levels of the students makes the lectures hard: too slow for one part, while the other part thinks it's too difficult.

Experiences
In the course evaluations, students react very enthusiastic about the teacher. Students like the examples from reality. In the end of the course, old exams are part of the homework, which definitely helps students to exercise and prepare for the final exam.

1.4 Stochastic hydrology

Overview

Period	3	Course code	GEO4-4420
Timeslot	C	Mean rating last year	8.0
Teacher	prof. dr. ir. M.F.P. Bierkens	Mean workload last year	15 h
Contact	m.f.p.bierkens@uu.nl Zon 128	Success rate last year	100%

Required course: AW-Principles of groundwater flow (GEO4-1434) or Land Surface Hydrology (GEO4-4404)

Acquired knowledge and skills
Knowledge: Stochastic hydrology is about statistics in the hydrology. The start is very basic (to calculate mean etc.), but the level increases fast. Students learn all about uncertainty analysis in hydrological analysis, modeling and forecasting. Also they learn how to use stochastic hydrology for interpolation or extrapolation in time and space, and data assimilation. The course contains hydrological exercises, for example to analyze discharge maxima for forecasting.
Skills: Students get a good basis for understanding the literature on stochastic hydrology. They learn to work and calculate statistics and uncertainties. Students have to select a special topic to write a research proposal about. Writing a research proposal is new compared with other courses where you have to write a paper.

Assessment, structure and work load
Two times per week lectures are given; sometimes there is a (computer) practical. The exercises you make at home and the practicals are not graded. Students are asked to chose a special topic on which they will write a research proposal (10% of grade), which they will present (10% of grade). 80% of the grade is the final exam.
The course is well organized, although students say the workload increases during the course.

Experiences
Students appreciate the significant value of the course for their program. The level of the course is good and the teachers too. However the feedback on the presentation and research proposal is minimal.

1.5 Unsaturated zone hydrology

Overview

Period	2	Course code	GEO4-4417
Timeslot	C	Mean rating last year	7.4
Teacher	dr. M.R. Hendriks prof. dr. ir. M.F.P. Bierkens prof. dr. ir. S.M. Hassanizadeh	Mean workload last year	15 h
Contact	m.r.hendriks@uu.nl Zon 2.03	Success rate last year	100 %

Acquired knowledge and skills
Knowledge: The unsaturated zone is important because of for example groundwater recharge, infiltration and overland flow, for vegetation and agriculture. The course starts with the part of Martin Hendriks which covers the basics of unsaturated zone: soil physics, matric and preferential flow and infiltration. Mark Bierkens continues and discusses the determination of soil physical parameters and unsaturated flow equations. The last lectures by Majid Hassanizadeh are more physical and cover interfacial tension, capillary flow and a critical evaluation of unsaturated flow theories.
Skills: Students learn how to work with soil moisture and infiltration curves, how to work out simple unsaturated flow equations and how to set up force diagrams concerning capillary flow.

Assessment, structure and work load
The course consists of lectures and practicals. Practicals have to be handed in and will be graded. Also students have to do duo presentations. There is a practical with the flow model Hydrus, about which students have to write a report.
The course starts with basics, with is relatively easy for those who followed the BSc course Physical Hydrology. The level increases during the course and at the end of the course the (mathematical) level is high. Most students spend an average of 11-15 hours per week on the course, but also a third says to spend more than 20 hours per week.

Experiences
Students who had the BSc course Physical Hydrology might think the level is too low at the beginning of the course. However, the second part covers new and more difficult subjects. The paper is graded, but the feedback is not much. Overall, the grades are high, probably because the presentations and papers are graded high or the final exam looks like earlier assignments/old exams.

1.6 Hydrogeological transport phenomena

Overview

Period	2	Course code	GEO4-1433
Timeslot	D	Mean rating last year	8.1
Teacher	prof. dr. ir. S.M. Hassanizadeh	Mean workload last year	19
Contact	s.m.hassanizadeh@uu.nl AW W228	Success rate last year	93 %

Book: Mayer, A.S. and S.M. Hassanizadeh, Soil and Groundwater Contamination: Nonaqueous Phase Liquids, American Geophysical Union, 224 pages, June 2005 (ISBN 0-87590-321-7). (recommended)
Book: Fetter, C.W., Contaminant hydrogeology, Macmillan, New York, (2nd ed.). 1999. (recommended)
Required course: AW-Principles of groundwater flow (GEO4-1434).

Acquired knowledge and skills
Knowledge: The course starts with laws about dissolution and volatilization and continues with flow and transport equations: advection, degradation/decay, diffusion, dispersion and adsorption. At the end of the course there is a lecture about transport in the unsaturated zone. The course fits in a sequence of courses of increasing level: Principles of Groundwater Flow (Period 1), Hydrogeological Transport Phenomena and Environmental Hydrogeology (Period 4).
Skills: In this course students learn how to come up and work out flow and transport equations for different situations and different initial and boundary conditions. The mathematical level is high. Students learn to think themselves, for example if you think a value is missing in the exercise, you have to search on the internet for an appropriate value yourself. Also transport modeling in Modflow is a topic. During the lectures there is referred to real problems and applications.

Assessment, structure and work load
Two times a week four hours lecture. Some exercises are included in the lectures. Every week students have to hand in assignments, which are graded. The work load was balanced, on average students spend . These assignments are of equal or higher level than the exercises in the lecture. There also is an excursion to a contamination site, with a guest lecture, about which you have to hand in a report. Another guest lecture at the end of the course covers virus transport.

Experiences
Students think the didactical quality of Majid Hassanizadeh is very high. Students think the course is very instructive and of high level. The lecture notes of Majid, which he sends to every student, are good. You are allowed to use them during the final exam. Overall, students get relatively low grades for their final exam, but the grades of the assignments compensate for this.

1.7 Environmental hydrogeology

Overview

Period	4	Course code	GEO4-1432
Timeslot	First half	Mean rating last year	
Teacher	A. Raoof, prof. dr. ir. S.M. Hassanizadeh, prof. dr. R.J. Schotting and some guest lecturers	Mean workload last year	
Contact	A. Raoof@uu.nl	Success rate last year	

Acquired knowledge and skills
Knowledge: The course continues where Hydrogeological transport phenomena and Principles of groundwater flow stop. Lectures are given on several topics, such as the transport of organic liquids, viruses and heat. Also the basis of multiphase flow and remediation techniques are treated.
Skills: Students have to work with modeling programs Hydrus 1D and PMWIN Modflow.

Assessment, structure and work load

The course is full-time, which means almost every day you have a lecture of a couple of hours. Next to several small exercises, one big modeling exercise has to be done in groups of three with Modflow. For this exercise you first go on an "excursion" to a pollution site. You thus have to model a real part of the soil, so you also have to deal with not knowing required parameters etc. Next to the large modeling exercise (25% of your grade), you have to do a presentation about your thesis subject (together with homework 25% of grade) and a take home exam (50%). The work load increases during the five weeks of the course.

Experiences
The variety of lectures and practicals and all different teachers and subjects is appreciated. It feels like applying your knowledge that you gained in other courses to real problems. The take home exam last year didn't cover all subjects, which was a pity and therefore a little easy.

1.8 Hydrology, climate change and fluvial systems

Overview

Period	4	Course code	GEO4-4423
Timeslot	nvt	Mean rating last year	7,7
Teacher	Prof dr. M.F.P.Bierkens and many guest lecturers	Mean workload last year	~18 h
Contact	M.F.P.Bierkens@uu.nl	Success rate last year	10 out of 11

Note: Although this course is part of the topbox of the track of 'Climate reconstruction', 100% of the students were from the track of Earth, Surface and Water (year 2013/2014).

Acquired knowledge and skills
Knowledge: The course focuses on the connection of climate (change) with hydrology. Students get to know the most recent research on climate, and the effect of climate change on hydrological patterns (evaporation, precipitation, ice melt) and vice versa (via feedback loops). Also research methods are treated (remote sensing, measurement equiptment etc).
Skills: Depending on your paper subject. You are free to choose every subject relating to climate and/or hydrology. You can also choose a model study or a small fieldwork (which you have to arrange yourself).

Assessment, structure and work load
This course is a series of colloquia, with many lectures of guest speakers. Every morning (9:30-12:00) students are required to be present at the lectures. There are three computer practicals which have to be handed in to be graded, but most of the time these practicals are in the morning, too. You have to write a course synopsis at the end. The grading differs: For 4 ECTS: course synopsis (50%) and computer practicals (50%); For 7.5 ECTS: course synopsis (25%), computer practicals (25%), paper (50%). In practice almost every student writes a paper (of which the deadline is end of September).

Experiences
The experiences differ per day, as the quality of the teachers and the background knowledge of the students differ per subject. Lectures about the atmospheric system are quite new, whereas students already know much of other subjects. Overall, the work load depends on your own choice, as you don't need to do much if you don't spend much time on the paper.

1.9 Reactive transport in the hydrosphere

Overview

Period	3	Course code	GEO4-1421

Timeslot	D	Mean rating last year	7.4
Teacher	prof. dr. ir. C.P. Slomp dr. L. Polerecky	Mean workload last year	15 h
Contact	c.p.slomp@uu.nl AW W132	Success rate last year	90%

Obligated book: Soetaert, K. and P.M.J. Herman, 2009. A practical guide to ecological modelling using R as a simulation platform. Springer. ISBN: 978-1-4020-8623-6. ca. 70 euro. (also as pdf on internet)

Acquired knowledge and skills
Knowledge: At the beginning of the course relatively simple (bio)geochemical reactions are treated, while towards the end of the course also transport processes become more complex. Also theory about modeling is subject of the course (steady states, how to solve differential equations analytically, and boundary conditions).
Skills: Students get experience with modelling with R.

Assessment, structure and work load
The course starts with the basics of modeling. Lectures are about modeling, numerical and analytical solutions, stability and feedback, and during practicals students work with R from the basis towards more difficult exercises with these subjects. Some of the practicals are graded. At the end of the course students will chose a case study. For their topic they individually have to make a model, with report and presentation. There is also a hydrological guest lecture. The structure and work load are well balanced.

Experiences
Students like to start the modeling from the basis. The book is good. Some people from the track Hydrology think it's too less hydrology, because it is mainly about modelling the dynamics in the ocean and the ocean's sediment. Especially if you're interested in earth surface hydrology, the topics in this course don't fit to your interests.

2. Coastal dynamics and fluvial systems

For each track you have to chose at least 5 track courses, of which at least 3 from the top box.

Track: Coastal dynamics and fluvial systems
Morphodynamics of wave-dominated coasts Morphodynamics of tidal systems Fluvial systems Coastal zone and river management
Hydrology, climate change and fluvial systems Advanced GIS for Geoscientists Remote Sensing Statistics & data analysis in Physical Geograhpy MSc excursion Physical Geography

2.1 Morphodynamics of wave-dominated coasts

Overview

Period	3	Course code	GEO4-4434
Timeslot	A	Mean rating last year	8.5
Teacher	Prof. Dr. B.G. Ruessink	Mean workload last year	±20 hours
Contact	b.g.ruessink@uu.nl ZON 213	Success rate last year	100%

Acquired knowledge and skills
Knowledge: physical processes behind coastal systems, morphological and hydrodynamic processes associated with wave processes and management issues related to coastal areas
Skills: hydro- and morphological modelling with Matlab and scientific writing and reading

Assessment, structure and work load
The course is very well structured with explanatory lectures and good practical assignments. The workload is rather high due to the weekly reports that, combined with the final exam, are responsible for the grade. The practicals are mostly done with Matlab and are based upon problems in real life.

Experiences
This is one of the core courses for the track Coastal dynamics and Fluvial systems. The course is rated extremely high with a 8.5 with no weak points and a lot of compliments for the teacher and the course. The contents are extremely useful for the average student and make this course one of the important and best courses within this track.

2.2 Morphodynamics of tidal systems

Overview

Period	2	Course code	GEO4-4435

Timeslot	A	Mean rating last year	
Teacher	Dr. M. van der Vegt	Mean workload last year	18 hours
Contact		Success rate last year	16 out of 17

Acquired knowledge and skills
Knowledge: physical processes behind tidal systems, morphological and hydrodynamic processes associated with tidal processes
Skills: hydro- and morphological modelling with for instance Matlab, scientific writing, oral presentation and basic laboratory experience

Assessment, structure and work load
This course is rather challenging with a large amount of information in the slides containing some very theoretical and physical subjects. The practical's and reports are the main reason for the large work load. The reports are combined with the result of the final written exam to form the grade for this course.

Experiences
This is one of the core courses for the track Coastal dynamics and Fluvial systems. The course is found to be very useful and interesting with an average grade of 7.8, despite having a high work load. The main complaints are about the lectures on the more theoretical and mathematical subjects, these subjects are harder to understand and more difficult to understand without the practicals that is present for the other subjects. The track is recently reformed and this is one of the new courses, so future years could result in an altered course as is mentioned by the teacher in the evaluation.

2.3 Fluvial systems

Overview

Period	1	Course code	GEO4-4436
Timeslot	A	Mean rating last year	
Teacher	Dr. M.G. Kleinhans	Mean workload last year	18 hours
Contact		Success rate last year	>75%

N.B. for the track coastal dynamics and fluvial systems this course is highly recommended due to the importance of the subject, it is considered to be one of the core courses for this track.

Acquired knowledge and skills
Knowledge: In the course Fluvial systems, I gained knowledge and insight about fluvial processes (e.g. sediment transport, avulsion) and associated (Quaternary) deposits.
Skills: modeling in MATLAB

Assessment, structure and work load
The course consists of lectures and practicals. The work load of this course is really high and can feel like a burden at times, but this guarantees that you learn a lot.

Experiences
In the course Fluvial systems, I gained knowledge and insight about fluvial processes (e.g. sediment transport, avulsion) and associated (Quaternary) deposits. The main skill that I acquired is modeling in MATLAB, which was done during most of the practicals. The manual for these exercises is very well done, which made the introduction to modeling a positive experience. Lectures given by different teachers provided a nice amount of variety. Overall, I think Fluvial systems was a good contribution

to my study, because it is really useful to be familiar with the process-oriented way of thinking that was taught.

2.4 Coastal zone and river management

Overview

Period	3	Course code	GEO4-4403
Timeslot	B	Mean rating last year	4.1
Teacher	Prof. Dr. H. Middelkoop & Prof. Dr. P. Hoekstra & many guest lectures	Mean workload last year	16 hours
Contact	A. Oost a.oost@uu.nl ZON 213	Success rate last year	unknown

Important note
This course is preferably done by students who completed their fieldwork and or MSc research!

Acquired knowledge and skills
Knowledge: complete overview of the processes and factors that influence river and coastal management
Skills: scientific reporting, teamwork and oral presentation

Assessment, structure and work load
The course consists of different lectures with several guest speakers and a lot of site visits with real-time case studies about river and coastal management. The grade is determined by several reports, exercises and group assignments. The high amount of assignments lead to a rather high but well distributed work load during the period.

Experiences
During the course a paper had to be written about a wetland. The paper had to be based on the RAMSAR management plans structure; there was no room to differ from this. The papers were a lot of work, but not really in depth, as all factors had to be described, also the less relevant ones. During lectures there were mostly guest speakers, which were nice, but they didn't contribute to the paper nor gave insight in management skills. Besides, Albert Oost fell sick during giving feedback on the concept of the papers, so it took until after the end of the course to return the feedback. Quite some people had to finish their papers during block 4 (and fieldwork). However, these experiences are only those from Water Science and Management students.

2.5 Hydrology, climate change and fluvial systems

Overview

Period	4	Course code	GEO4-4423
Timeslot	nvt	Mean rating last year	7,7
Teacher	Prof dr. M.F.P.Bierkens and many guest lecturers	Mean workload last year	~18 h
Contact	M.F.P.Bierkens@uu.nl	Success rate last year	10 out of 11

Note: Although this course is part of the topbox of the track of 'Climate reconstruction', 100% of the students were from the trach of Earth Surface and Water (year 2013/2014).

Acquired knowledge and skills
Knowledge: The course focuses on the connection of climate (change) with hydrology. Students get to know the most recent research on climate, and the effect of climate change on hydrological patterns (evaporation, precipitation, ice melt) and vice versa (via feedback loops). Also research methods are treated (remote sensing, measurement equipment etc.).
Skills: Depending on your paper subject. You are free to choose every subject relating to climate and/or hydrology. You can also choose a model study or a small fieldwork (which you have to arrange yourself).

Assessment, structure and work load
This course is a series of colloquia, with many lectures of guest speakers. Every morning (9:30-12:00) students are required to be present at the lectures. There are three computer practicals which have to be handed in to be graded, but most of the time these practicals are in the morning, too. You have to write a course synopsis at the end. The grading differs: For 4 ECTS: course synopsis (50%) and computer practicals (50%); For 7.5 ECTS: course synopsis (25%), computer practicals (25%), paper (50%). In practice almost every student writes a paper (of which the deadline is end of September).

Experiences
The experiences differ per day, as the quality of the teachers and the background knowledge of the students differ per subject. Lectures about the atmospheric system are quite new, whereas students already know much of other subjects. Overall, the work load depends on your own choice, as you don't need to do much if you don't spend much time on the paper.

2.6 Advanced GIS for Geoscientists

Overview

Period	1	Course code	GEO4-4433
Timeslot	D	Mean rating last year	
Teacher	Drs. M.J. Zeylmans van Emmichoven	Mean workload last year	12 hours
Contact		Success rate last year	27 out of 29

Acquired knowledge and skills
Knowledge: Practical knowledge about soil erosion and extended knowledge on the theories behind GIS systems.
Skills: thorough experience with spatial analysis in GIS & presenting GIS results both orally and visually

Assessment, structure and work load
The course consists of several supporting lectures and two main assignments with some smaller practicals. The report from one of the main assignments is half of the grade with an exam, concerning theoretical questions, making the other half of the final grade. All practicals have to be finished and there is a fairly strict compulsory attendance. The work load is pretty evenly spread with some more busy weeks just before the deadline as usual.

Experiences
The course is found to be fine with an average of a 7 for the course. Some of the complaints are, like most of the modelling courses, focused on the rather low amount of feedback and long waiting times for the assistance during practical's. The skills of the course are extremely useful and are used in all disciplines within earth sciences.

2.7 Remote sensing

Overview

Period	2	Course code	GEO4-4408
Timeslot	D	Mean rating last year	
Teacher	Dr. E.A. Addink & Prof. Dr. S.M. de Jong	Mean workload last year	15 hours
Contact		Success rate last year	16 out of 24

Acquired knowledge and skills
Knowledge: remote sensing techniques and theory behind remote sensing
Skills: using hyper spectral images, scientific reports, oral presentation, spatial analysis with remote sensing products and quality analysis of remote sensing products

Assessment, structure and work load
The course starts with some lectures covering the basic subjects about remote sensing and hyper spectral analysis. After that the course consists almost solely of practical's in which a lot of different techniques are used. These practicals are responsible for the workload of around 15 hours a week. The reports, an oral presentation and the final exam are combined into the final grade of the course.

Experiences
The practical approach of this course is widely praised by the students with the excursion to ITC (this might be skipped in 2014-2015) as the highlight of the course. Like all courses that tend to be focused on computer exercises, the complaints focus on the waiting time during practicals. The skills obtained in this course are extremely useful as mentioned earlier in.

2.8 Statistics & data analysis in Physical Geography

Overview

Period	1	Course code	GEO4-4412
Timeslot	C	Mean rating last year	
Teacher	Prof. dr. ir. F.C. van Geer & dr. ir. G. Sterk	Mean workload last year	12 hours
Contact		Success rate last year	>90%

Acquired knowledge and skills
Knowledge: extended knowledge about statistical procedures for spatial dataset and elementary statistics
Skills: different statistical procedures in Excel and R, basic data management and analytical skills for statistical problems. This course is considered a supporting course for this track but is very useful for all tracks due to the widespread use of statistics in scientific research.

Assessment, structure and work load
The course consists of lectures followed by practicals and assignment. The practicals are compulsory, but the grade of the course is determined by two equally important tests. The work load was a bit low and students spend on average ±11 hours per week.

Experiences
The course is considered to be somewhat less inspirational compared to other courses. However, all students that did this course, both in the recent and less recent years, are very positive about the extremely practical use of the skills obtained in this course. It is a recommendation for most students

for the knowledge about statistics that is a bit underrepresented in the bachelor and other courses of Earth Sciences.

2.9 Excursion physical geography (Denmark/Switzerland)

Overview

Period	4	Course code	GEO4-4418
Timeslot	First half	Mean rating last year	
Teacher	Prof Dr. Piet Hoekstra or Dr. M. van der Perk	Mean workload last year	-
Contact	J. Beltman	Success rate last year	100%

Note on forehand

The excursion is in the even years to Denmark and led by Prof. Dr. Piet Hoekstra and is focused on glacial, coastal, sedimentary and some fluvial processes. The excursion in the odd years takes place in the upper Rhine and Germany under the jurisdiction of Dr. M. van der Perk and focusses on hydrological, fluvial and soil processes. The cost of both excursions is around 450 euros. The excursion is mostly for students of physical geography and their associated track. In case of a high amount of participants, as happened in 2012 and 2014, the teachers can decide to select on the followed track and courses.

Acquired knowledge and skills

Apart from the difference in subjects, which are described on the Osiris page, the gained knowledge and skills are mostly practical. During the excursion students learn to recognize different features in real life and understand the spatial- and timescales of different processes. Some small scale field days lead to some experience on collecting data in the field with various tools.

Assessment, structure and work load

The excursion typically takes place in the first two weeks of May. During these weeks the days are mostly spend in the field on various sites. Active participation of the students is a requirement during the day, one oral presentation is obligatory during the excursion and is assigned randomly. After the excursion a paper about an excursion site is the final part of the pass or no pass grade of the course. Compared to the other fieldworks this is a relatively easy course with a fairly low work load but with a high amount of information.

Experiences

The excursion is typically rated as fairly easy and somewhat cheap study points (despite the payment). However, the subjects are found to be very interesting with a high amount of information. This is mainly due to the visible link between processes and their results. The atmosphere is, like most excursions and fieldwork, excellent and is a major plus for the excursion.

3. Geohazards and Earth observation

For each track you have to chose at least 5 track courses, of which at least 3 from the top box.

Track: Geohazards and Earth observation
Land surface process modelling/Earth surface modelling
Remote sensing
Hazards and risk assessment
Statistics & data analysis in Physical Geography
Tectonophysics
Land surface hydrology
Unsaturated zone hydrology
Advanced GIS for Geoscientists
Tectonophysics
MSc excursion Physical Geography

3.1 Land surface process modelling

Overview

Period	3	Course code	GEO4-4406
Timeslot	A	Mean rating last year	8.3
Teacher	Dr. D.J. Karssenberg	Mean workload last year	16
Contact	d.karssenberg@uu.nl ZON 103	Success rate last year	67%

Acquired knowledge and skills
Knowledge: theory behind modelling in geosciences, schematization steps in physical processes & link between observations and models
Skills: scientific reports, different software environments (Python & PCRaster) and executing different model steps

Assessment, structure and work load
The course is a combination with an explanatory lectures about theoretical subjects and computer practicals. During the course several reports have to be handed in that are a part of the final grade. The last couple of weeks consists mostly of working on a study project that is more important for the final grade. The final exam is mainly about the theory behind the models and land surface processes. The work load is average with about 15 hours a week of work.

Experiences
Coming soon.

3.2 Remote sensing

Overview

Period	2	Course code	GEO4-4408
Timeslot	D	Mean rating last year	
Teacher	Dr. E.A. Addink & Prof. Dr.	Mean workload last year	15 hours

	S.M. de Jong		
Contact		Success rate last year	16 out of 24

Acquired knowledge and skills
Knowledge: remote sensing techniques and theory behind remote sensing
Skills: using hyper spectral images, scientific reports, oral presentation, spatial analysis with remote sensing products and quality analysis of remote sensing products

Assessment, structure and work load
The course starts with some lectures covering the basic subjects about remote sensing and hyper spectral analysis. After that the course consists almost solely of practical's in which a lot of different techniques are used. These practicals are responsible for the workload of around 15 hours a week. The reports, an oral presentation and the final exam are combined into the final grade of the course.

Experiences
The practical approach of this course is widely praised by the students with the excursion to ITC (this might be skipped in 2014-2015) as the highlight of the course. Like all courses that tend to be focused on computer exercises, the complaints focus on the waiting time during practicals. The skills obtained in this course are extremely useful as mentioned earlier in.

3.3 Hazards and risk assessment

Overview

Period	3	Course code	GEO4-4425
Timeslot	D	Mean rating last year	7.8
Teacher	Prof. dr. S.M. de Jong + many guest lecturers	Mean workload last year	16 hours
Contact	s.m.dejong@uu.nl ZON 202	Success rate last year	unknown

Acquired knowledge and skills
Knowledge: first encounter with various hazards, mainly their risks and how they are nowadays monitored and mitigated, the role of earth scientists in hazard risk assessment
Skills: making a scientific poster, writing an advice while taking into account various interests (eg. society, politics, business, science), applying some simple computer models for risk assessment
The course is very well-described on Osiris. The course is not specific for the track Earth Materials. It is recommended for everyone with a broad interest and general earth science background.

Assessment, structure and work load
The course is well-structured with lectures, computer practicals (20%), a group poster presentation, an individual report + presentation (40 %) and a final exam (40 %). Almost every week we worked on another topic with a guest lecturer, but the course quality was permanently monitored by De Jong. The work load was balanced and students experienced it as medium (>11 hrs) to high (> 20 hrs).

Experiences
The small group and excellent coordinator resulted in a good atmosphere, motivated students and space for discussions during the classes. We learned about many different hazards, both natural as human-induced. The consequence of such a broad approach is that many exercises do not go into depth, but this also varied for the different lecturers. Also the amount of feedback varied per lecturer. It was great to have guest lecturers from outside the university, such as TNO and the European Committee. The course is very society-focused.

3.4 Statistics & data analysis in Physical Geography

Overview

Period	1	Course code	GEO4-4412
Timeslot	C	Mean rating last year	
Teacher	Prof. dr. ir. F.C. van Geer & dr. ir. G. Sterk	Mean workload last year	12 hours
Contact		Success rate last year	>90%

Acquired knowledge and skills
Knowledge: extended knowledge about statistical procedures for spatial dataset and elementary statistics
Skills: different statistical procedures in Excel and R, basic data management and analytical skills for statistical problems. This course is considered a supporting course for this track but is very useful for all tracks due to the widespread use of statistics in scientific research.

Assessment, structure and work load
The course consists of lectures followed by practicals and assignment. The practicals are compulsory, but the grade of the course is determined by two equally important tests. The work load was a bit low and students spend on average ±11 hours per week.

Experiences
The course is considered to be somewhat less inspirational compared to other courses. However, all students that did this course, both in the recent and less recent years, are very positive about the extremely practical use of the skills obtained in this course. It is a recommendation for most students for the knowledge about statistics that is a bit underrepresented in the bachelor and other courses of Earth Sciences.

3.5 Tectonophysics

Overview

Period	2	Course code	GEO4-1409
Timeslot	B	Mean rating last year	7.6
Teacher	Dr. R. Govers, S.A.P.L. Cloetingh	Mean workload last year	
Contact	R.Govers@uu.nl	Success rate last year	

Acquired knowledge and skills
Knowledge: geophysical processes on the scale of plates and the lithosphere, analyzed by comparing quantitative models and observations. The first part of the course focuses on the lithosphere and its properties (temperature and heat flow, rheology, slab-pull, lithosphere-astenosphere coupling), the second part focuses on plate boundary processes (ridge dynamics, subduction zone dynamics, foreland and fore arc basins, fold and thrust belts).
Skills: Modeling using the Fortran programming language, analysis of numerical models and their merits and shortcomings, building and analyzing of analogue models, presenting scientific results in oral and written form. The course description on Osiris is very accurate, although an analogue modelling exercise in the Tec-lab is not mentioned. This course does not fit directly into the Earth Materials track, but might be of interest to those who are interested in (quantitative analysis of) large-scale tectonic processes.

Assessment and work load

The course was well-structured with 2 hours of lecture and 2 hours of practical session per scheduled day and 1 assignment per week. An exception was the Tec-lab practical, which involved no lectures. The final part of the course concerned a literature study, writing an essay and oral presentations. There is no exam for this course, nevertheless the workload is heavy. Students are expected to study a paper before each lecture. The time needed for assignments is variable, but all can be finished within a week. If large problems arise with an assignment, additional time is sometimes provided.

Experiences
The organization of the course and the quality of teaching were really good. The small group leads to a relaxed atmosphere in which all students can participate in discussions. A selection of assignments was graded and feedback was given, others were just checked without much feedback. The Tec-lab practicals need some revision, since the building and running of models takes a long time in which no additional exercise was given.

3.6 Land surface hydrology

Overview

Period	1	Course code	GEO4-4404
Timeslot	B	Mean rating last year	7.6
Teacher	dr. R. van Beek	Mean workload last year	16 h
Contact	r.vanbeek@uu.nl Zon 1.10	Success rate last year	22 out of 28

Book: S. Dingman Physical Hydrology, 2nd Edition (ISBN: 978-1-57766-561-8). (Obligated)
Principles of Groundwater flow (GEO4-1434) and Land Surface Hydrology are “obligated” for master students with the track Hydrology. One of them or both courses are often required for subsequent hydrology courses. Land Surface Hydrology is also part of the second year of the master Water Science and Management.

Acquired knowledge and skills
Knowledge: After an introduction of the global hydrological cycle, the course focuses on the hydrology within a catchment. Students learn several ways to describe the conversion of precipitation to runoff and storage. Ways to separate base flow from quick flow are discussed, as well as ways to describe the propagation of a flood wave (routing). Also there is a lecture on water management (interpret stream flow data for design purposes).
Skills: Students learn to analyze and interpret precipitation and runoff data. Also students learn ways to describe these data mathematically to make runoff forecasts. A small chapter is spent on errors and uncertainties. A lot of exercises are done with Excel, and some basic modeling with PC Raster.

Assessment, structure and work load
The course is well divided into different ways to obtain the knowledge. There are lectures, practicals (not graded) and computer practicals with Excel (not graded). One lecture students have to read two papers and discuss them. Students have to write a paper based on literature and a model report of a model they made themselves. Overall, the work load is evenly divided. Only the work load at the end of the course is high, because the deadline for the model report is close to the final exam. But the teacher is willingly to improve this.

Experiences
Students think the course is of high value for their track. The course evaluations state the teacher is very committed to help the students with the exercises or their model. This is good, because the

modeling is independent and students have to find out how to make/adapt the model themselves, without some introduction lectures.
The reviews on the book are not very good. There is a lot of information, the main issues are hard to recognize. The reader is fine.
The feedback on the papers is late (after the final exam), but very specific. The final exam is of a high level, you really should practice old exams.

3.7 Unsaturated zone hydrology

Overview

Period	2	Course code	GEO4-4417
Timeslot	C	Mean rating last year	7.4
Teacher	dr. M.R. Hendriks prof. dr. ir. M.F.P. Bierkens prof. dr. ir. S.M. Hassanizadeh	Mean workload last year	15 h
Contact	m.r.hendriks@uu.nl Zon 2.03	Success rate last year	100 %

Acquired knowledge and skills
Knowledge: The unsaturated zone is important because of for example groundwater recharge, infiltration and overland flow, for vegetation and agriculture. The course starts with the part of Martin Hendriks which covers the basics of unsaturated zone: soil physics, matric and preferential flow and infiltration. Mark Bierkens continues and discusses the determination of soil physical parameters and unsaturated flow equations. The last lectures by Majid Hassanizadeh are more physical and cover interfacial tension, capillary flow and a critical evaluation of unsaturated flow theories.
Skills: Students learn how to work with soil moisture and infiltration curves, how to work out simple unsaturated flow equations and how to set up force diagrams concerning capillary flow.

Assessment, structure and work load
The course consists of lectures and practicals. Practicals have to be handed in and will be graded. Also students have to do duo presentations. There is a practical with the flow model Hydrus, about which students have to write a report.
The course starts with basics, with is relatively easy for those who followed the BSc course Physical Hydrology. The level increases during the course and at the end of the course the (mathematical) level is high. Most students spend an average of 11-15 hours per week on the course, but also a third says to spend more than 20 hours per week.

Experiences
Students who had the BSc course Physical Hydrology might think the level is too low at the beginning of the course. However, the second part covers new and more difficult subjects. The paper is graded, but the feedback is not much. Overall, the grades are high, probably because the presentations and papers are graded high or the final exam looks like earlier assignments/old exams.

3.8 Advanced GIS for Geoscientists

Overview

Period	1	Course code	GEO4-4433
Timeslot	D	Mean rating last year	
Teacher	Drs. M.J. Zeylmans van Emmichoven	Mean workload last year	12 hours

Contact		Success rate last year	27 out of 29

Acquired knowledge and skills
Knowledge: Practical knowledge about soil erosion and extended knowledge on the theories behind GIS systems.
Skills: thorough experience with spatial analysis in GIS & presenting GIS results both orally and visually

Assessment, structure and work load
The course consists of several supporting lectures and two main assignments with some smaller practicals. The report from one of the main assignments is half of the grade with an exam, concerning theoretical questions, making the other half of the final grade. All practical's have to be finished and there is a fairly strict compulsory attendance. The work load is pretty evenly spread with some more busy weeks just before the deadline as usual.

Experiences
The course is found to be fine with an average of a 7 for the course. Some of the complaints are, like most of the modelling courses, focused on the rather low amount of feedback and long waiting times for the assistance during practical's. The skills of the course are extremely useful and are used in all disciplines within earth sciences.

3.9 Excursion physical geography (Denmark/Switzerland)

Overview

Period	4	Course code	GEO4-4418
Timeslot	First half	Mean rating last year	
Teacher	Prof Dr. Piet Hoekstra or Dr. M. van der Perk	Mean workload last year	-
Contact	J. Beltman	Success rate last year	100%

Note on forehand
The excursion is in the even years to Denmark and led by Prof. Dr. Piet Hoekstra and is focused on glacial, coastal, sedimentary and some fluvial processes. The excursion in the odd years takes place in the upper Rhine and Germany under the jurisdiction of Dr. M. van der Perk and focuses on hydrological, fluvial and soil processes. The cost of both excursions is around 450 euros. The excursion is mostly for students of physical geography and their associated track. In case of a high amount of participants, as happened in 2012 and 2014, the teachers can decide to select on the followed track and courses.

Acquired knowledge and skills
Apart from the difference in subjects, which are described on the Osiris page, the gained knowledge and skills are mostly practical. During the excursion students learn to recognize different features in real life and understand the spatial- and timescales of different processes. Some small scale field days lead to some experience on collecting data in the field with various tools.

Assessment, structure and work load
The excursion typically takes place in the first two weeks of May. During these weeks the days are mostly spend in the field on various sites. Active participation of the students is a requirement during the day, one oral presentation is obligatory during the excursion and is assigned randomly. After the excursion a paper about an excursion site is the final part of the pass or no pass grade of the course.

Compared to the other fieldworks this is a relatively easy course with a fairly low work load but with a high amount of information.

Experiences
The excursion is typically rated as fairly easy and somewhat cheap study points (despite the payment). However, the subjects are found to be very interesting with a high amount of information. This is mainly due to the visible link between processes and their results. The atmosphere is, like most excursions and fieldwork, excellent and is a major plus for the excursion.

4. Environmental geochemistry

For each track you have to chose at least 5 track courses, of which at least 3 from the top box.

Track: Environmental geochemistry
Aquatic and environmental geochemistry Reactive transport in the hydrosphere Kinetic Processes Environmental hydrogeology
Hydrogeological transport phenomena Microbes and biogeochemistry Principles of groundwater flow Mineral and isotope tracers of Earth processes Field research instruction geochemistry

4.1 Aquatic and environmental geochemistry

Overview

Period	1	Course code	GEO4-1439
Timeslot	A	Mean rating last year	8.3
Teacher	Dh. T. Behrends	Mean workload last year	15 h
Contact	AW W136 t.behrends@uu.nl	Success rate last year	33%

No entry requirements and the course is also not an entry requirement for another course.

Acquired knowledge and skills
Knowledge: The course is about the processes (equilibrium) that control the composition of different water bodies. The processes are: acid base reactions, redox reactions, solubility of solids, metal speciation in aqueous solution, distribution of compounds between different phases and the adsorption of ions and organic compounds at the solid-liquid interface.
Basic knowledge of equilibrium thermodynamics is useful (course: Physical Chemistry GEO2-1202)
Skills: You also learn how to work with MINEQL 4.6, which is a chemical equilibrium speciation model.

Assessment, structure and work load
Every week a new topic is started. The topics are: acid base chemistry, metal speciation, redox chemistry, gas water equilibrium, solid solution equilibrium and solid water interface. So there is a nice structure.

There are three short reports that need to be made that are spread well over the period. The reports are about assignments that need to be done by MINEQL 4.6.

Experiences
The lectures are written on the blackboard. This means that the slides only have pictures and graphs on them without any text. So it is clever to be present at the lectures and to make notes!
At the beginning of every new topic you will get a handout with questions that will be answered and the different subjects that will be told. This is nice when preparing for the exam, you know what will be expected from you and it is nice when preparing for the exam.

Tip 1.) You may use two A4 sheets with notes during the exam. Use them good, write so many things on it as you can. It really helps remembering the subject matter and you do not need to learn anything by hard.
Tip 2.) Look at the older exams they all have the same structure and topics, so take that advantaged!

4.2 Reactive transport in the hydrosphere

Overview

Period	3	Course code	GEO4-1421
Timeslot	D	Mean rating last year	7.4
Teacher	prof. dr. ir. C.P. Slomp dr. L. Polerecky	Mean workload last year	15 h
Contact	c.p.slomp@uu.nl AW W132	Success rate last year	90%

Obligated book: Soetaert, K. and P.M.J. Herman, 2009. A practical guide to ecological modelling using R as a simulation platform. Springer. ISBN: 978-1-4020-8623-6. ca. 70 euro. (also as pdf on internet)

Acquired knowledge and skills
Knowledge: At the beginning of the course relatively simple (bio)geochemical reactions are treated, while towards the end of the course also transport processes become more complex. Also theory about modeling is subject of the course (steady states, how to solve differential equations analytically, boundary conditions).
Skills: Students get experience with modeling with R.

Assessment, structure and work load
The course starts with the basics of modeling. Lectures are about modeling, numerical and analytical solutions, stability and feedback, and during practicals students work with R from the basis towards more difficult exercises with these subjects. Some of the practicals are graded. At the end of the course students will chose a case study. For their topic they individually have to make a model, with report and presentation. There is also a hydrological guest lecture. The structure and work load are well balanced.

Experiences
Students like to start the modeling from the basis. The book is good. Some people from the track Hydrology think it's too less hydrology, because it is mainly about modelling the dynamics in the ocean and the ocean's sediment. Especially if you're interested in earth surface hydrology, the topics in this course don't fit to your interests.

4.3 Kinetic processes

Overview

Period	2	Course code	GEO4-1426
Timeslot	A	Mean rating last year	6.8
Teacher	Dh. T. Behrends Prof. dr. C.J. Spiers	Mean workload last year	16 h
Contact	AW W136 t.behrends@uu.nl	Success rate last year	100 %

No entry requirements and the course is also not an entry requirement for another course.

Acquired knowledge and skills
Knowledge: You learn how to derive and apply quantitative expressions for describing the rates of biogeochemical processes, like Michaelis-Menten kinetics and the Arrhenius equation. Also the transition state theory will be explained (two weeks) and used. A few weeks before the exam dr. Spiers will teach one week, about kinetic processes in rock-fluid systems under non-hydrostatic conditions.
Skills: You will work with Excel.

Assessment, structure and work load
In the weeks before the Christmas break you will have graded assignments as homework. In the last two weeks before the Christmas break (so four lectures) there are guest lectures from Lubos Polerecky about statistical thermodynamics (which relates to the transition state theory). Directly after the Christmas break you will do a presentation of 45 minutes in groups of two. The presentation will cover a whole week of lectures. This presentation needs to be made in the Christmas break. After the week with presentation, you will get the contribution of Chris Spiers. The last week there is a guest lecture of Niels de Hartog (geochemical hydrogeologist).

Experiences
The variety of the course and the different aspects is nice. You see that kinetic processes are very important in many fields.
The lectures given by Thilo are written on the blackboard. This means that the slides only have pictures and graphs on them without any text. So it is clever to be present at the lectures and to make notes!
The homework assignments from Zhangs textbook (which will be online on blackboard) are not strongly related to the lectures. This makes them difficult.

Tip 1.) You may use two A4 sheets with notes during the exam. Use them good, write so many things on it as you can. It really helps remembering the subject matter and you do not need to learn anything by hard.

Tip 2.) For the homework exercises some of the answers are presented at the back of the book. So that you can check if it is correct.

4.4 Environmental hydrogeology

Overview

Period	4	Course code	GEO4-1432
Timeslot	First half	Mean rating last year	
Teacher	A. Raoof, prof. dr. ir. S.M.	Mean workload last year	

	Hassanizadeh, prof. dr. R.J. Schotting and some guest lecturers		
Contact	A. Raoof@uu.nl	Success rate last year	

Acquired knowledge and skills
Knowledge: The course continues where Hydrogeological transport phenomena and Principles of groundwater flow stop. Lectures are given on several topics, such as the transport of organic liquids, viruses and heat. Also the basis of multiphase flow and remediation techniques are treated.
Skills: Students have to work with modeling programs Hydrus 1D and PMWIN Modflow.

Assessment, structure and work load
The course is full-time, which means almost every day you have a lecture of a couple of hours. Next to several small exercises, one big modeling exercise has to be done in groups of three with Modflow. For this exercise you first go on an "excursion" to a pollution site. You thus have to model a real part of the soil, so you also have to deal with not knowing required parameters etc. Next to the large modeling exercise (25% of your grade), you have to do a presentation about your thesis subject (together with homework 25% of grade) and a take home exam (50%). The work load increases during the five weeks of the course.

Experiences
The variety of lectures and practicals and all different teachers and subjects is appreciated. It feels like applying your knowledge that you gained in other courses to real problems. The take home exam last year didn't cover all subjects, which was a pity and therefore a little easy.

4.5 Hydrogeological transport phenomena

Overview

Period	2	Course code	GEO4-1433
Timeslot	D	Mean rating last year	8.1
Teacher	prof. dr. ir. S.M. Hassanizadeh	Mean workload last year	19
Contact	s.m.hassanizadeh@uu.nl AW W228	Success rate last year	93 %

Book: Mayer, A.S. and S.M. Hassanizadeh, Soil and Groundwater Contamination: Nonaqueous Phase Liquids, American Geophysical Union, 224 pages, June 2005 (ISBN 0-87590-321-7). (Recommended)
Book: Fetter, C.W., Contaminant hydrogeology, Macmillan, New York, (2nd ed.). 1999. (Recommended)
Required course: AW-Principles of groundwater flow (GEO4-1434).

Acquired knowledge and skills
Knowledge: The course starts with laws about dissolution and volatilization and continues with flow and transport equations: advection, degradation/decay, diffusion, dispersion and adsorption. At the end of the course there is a lecture about transport in the unsaturated zone. The course fits in a sequence of courses of increasing level: Principles of Groundwater Flow (Period 1), Hydrogeological Transport Phenomena and Environmental Hydrogeology (Period 4).
Skills: In this course students learn how to come up and work out flow and transport equations for different situations and different initial and boundary conditions. The mathematical level is high. Students learn to think themselves, for example if you think a value is missing in the exercise, you have to search on the internet for an appropriate value yourself. Also transport modeling in Modflow is a topic. During the lectures there is referred to real problems and applications.

Assessment, structure and work load
Two times a week four hours lecture. Some exercises are included in the lectures. Every week students have to hand in assignments, which are graded. The work load was balanced, on average students spend. These assignments are of equal or higher level than the exercises in the lecture. There also is an excursion to a contamination site, with a guest lecture, about which you have to hand in a report. Another guest lecture at the end of the course covers virus transport.

Experiences
Students think the didactical quality of Majid Hassanizadeh is very high. Students think the course is very instructive and of high level. The lecture notes of Majid, which he sends to every student, are good. You are allowed to use them during the final exam. Overall, students get relatively low grades for their final exam, but the grades of the assignments compensate for this.

4.6 Microbes and biogeochemistry

Overview

Period	3	Course code	GEO4-1440
Timeslot	C	Mean rating last year	7.6
Teacher	Jack Middelburg and Martin Thullner	Mean workload last year	
Contact	j.b.m.middelburg@uu.nl	Success rate last year	13 out of 13

Acquired knowledge and skills
Knowledge: This is quite a chemical course. It focuses on the pathways of the main elements present in the ocean and how biogeochemical processes interact with this. The course also has a biological aspect in which you learn different types of microbiological organisms such as bacteria/ plankton and archaea ect.
Skills: You gain a more in-depth picture of the biogeochemical processes happening in the oceans and ocean sediments.

Assessment, structure and work load
The workload of this course is average, although the information density is quite high. Every week you have lectures (often 3 or 4 hours a day!) and near the end of the period there are a few computer practicals too. The assessment of the course is as follows: Term paper (15%); presentations (15%); final examination (70%).

Experiences
It was nice to learn more about microbes / microbiology in an aquatic setting as, even though as a paleoclimatologist/chemist you may easily forget this, they play a major role in biogeochemical processes taking place in the sediment!

4.7 Principles of groundwater flow

Overview

Period	1	Course code	GEO4-1434
Timeslot	D	Mean rating last year	7.8
Teacher	prof. dr. R.J. Schotting	Mean workload last year	16-20 h
Contact	r.j.schotting@uu.nl AW W234	Success rate last year	-

Book: Charles R. Fitts, Groundwater science. Academic press, June 2002. ISBN 0-12-257855-4. (Obligated)
Principles of Groundwater flow and Land Surface Hydrology (GEO4-4404) are “obligated” for master students with the track Hydrology. One of them or both courses are often required for subsequent hydrology courses. Principles of Groundwater flow is also part of the master Water Science and Management.

Acquired knowledge and skills
Knowledge: The course gives a good overview of the basic principles to quantify flow of water through saturated porous media. All different subjects (porous media properties, flow equations, field tests etc.) are given on Osiris. A difference between Osiris and the actual course is that no attention is paid to solute transport and there is no excursion to a groundwater remediation site (this excursion is part of the course Hydrogeological Transport Phenomena GEO4-1433).
Many applications of the obtained knowledge are discussed. An introduction to the groundwater modeling program Modflow is given by Amir Raoof. Also an excursion to the drinking water company Oasen is part of the program.
Skills: The main skill you obtain is to set up and work out groundwater equations for different situations. Mathematics (differentials, super position principle etc.) is important during the whole course.

Assessment, structure and work load
Lectures cover the main part of the course. There are no practicals; students exercise by making their homework. Each part of the homework contributes to the final grade. Every homework exercise has the same weighing, while the homework assignments in the end of the course definitely take more time than the first couple of homework assignments. The workload at the end of the course is therefore higher than in the first weeks of the course.
Next to the tutorials, there are some Modflow classes and an excursion to the drinking water company Oasen. No presentation, no papers to read or to write.
Students following Principles of Groundwater Flow have a very different background. Students who do the track Hydrology from the master Earth Surface and Water often have a bachelor Earth Sciences. They followed Water in GEO processes and Physical Hydrology, have a good background and know mathematics well. For them, the work load is quite low and the learning curve is slow. The larger part of the students is from the master Water Science and Management. Their background and knowledge of mathematics (from Wageningen, Environmental Studies, HBO etc.) is often not sufficient. Ruud Schotting gives extra math classes. However, still the work load for them is very high. The difference between the math levels of the students makes the lectures hard: too slow for one part, while the other part thinks it’s too difficult.

Experiences
In the course evaluations, students react very enthusiastic about the teacher. Students like the examples from reality. In the end of the course, old exams are part of the homework, which definitely helps students to exercise and prepare for the final exam.

4.8 Mineral and isotope tracers of Earth processes

Overview

Period	3	Course code	GEO4-1417
Timeslot	C	Mean rating last year	7.1
Teacher	Dr. M.J. van Bergen; dr. M.R. Drury	Mean workload last year	
Contact	M.R.Drury@uu.nl	Success rate last year	

Acquired knowledge and skills
Knowledge: The main focus lies in application of (stable) isotope dating methods, which can be used for dating and tracing rocks and processes. A recap about trace element distribution in magma and rocks is necessary to understand mixing models regarding volcanics. Knowledge about the geodynamics of mantle convection and geochemical analysis of rocks gives a wide view of the evolution of the asthenosphere/atmosphere/lithosphere-interaction. Many machines and apparatus used in the field are introduced and explained.
Skills: Critical thinking regarding scientific papers and writing one yourself. Osiris gives quite an accurate description of the course; the knowledge about quantitative modeling is however not integrated in the course. The course fits well in the Earth Structure and Dynamics Master and Earth Materials track.

Assessment and work load
The course was taught by Manfred van Bergen (for the magmatics and isotopes) and Olivier Plumper (for the mineral fluid reactions and apparatus). Lectures with tutorials were combined. Exercises needed to be handed in in combination with a written test at the end of the course. Each week a homework exercise had to be handed in for gradation. The work load was balanced but heavy, due to a lot of scientific paper reading and exercises.

Experiences
The course was well-organized by the combination of two teachers. However, it lacked feedback on my weekly handed in exercises. Several students complained about this in the course evaluation. The different parts do complement each other well in the combination of the litho-/asthenosphere geodynamics with the hydrosphere reactions. Lectures are not definitely necessary to understand the knowledge. Knowledge of the teachers themselves is however very useful in understanding the whole picture of the course. The exam did cover the course aims and goals.

4.9 Field research instruction geochemistry

Overview

Period	4	Course code	GEO4-1431
Timeslot	Second half	Mean rating last year	-
Teacher	Dh. T. Behrends	Mean workload last year	-
Contact	AW W136 t.behrends@uu.nl	Success rate last year	-

No entry requirements and the course is also not an entry requirement for another course.

Acquired knowledge and skills
In the course you will become familiar with key processes controlling nutrient dynamics (mainly phosphate, ammonium and silicic acid) in aquatic environments (river and estuary). You will design an incubation experiment in the lab and will collect samples in the field which will be analysed in the lab.

Knowledge: Basic knowledge of geochemical processes and aquatic chemistry. Some lab experience is handy but not necessary.

Assessment, structure and work load
At the beginning of the fourth period (so during the course in the first part of the fourth period) groups of students will be made where each group has his own topic (sediment, estuary and river).

With your group you will give a presentation about the articles that are written previous year. Further will each student prepare a presentation (max. 30 minutes) about a given topic, which accounts for 30% of the grade. Each week there will be a meeting of 1 hour to discuss how the preparations are going.

The field work starts in Utrecht with a week of preparation. In this week all the presentations will be presented and lectures will be followed. Also the different chemical analysis that will be used during the fieldwork will be practiced in the lab.

The field campaign (two weeks) is (with enough participants) in the Bay of Brest (France). The transport will be done with busses (driven by the students), the accommodations are apartments. During the fieldwork campaign, water samples from rivers, estuaries, and marine locations are collected and analyzed. Additionally, sediment cores will be taken and analyzed. Back in Utrecht you have two weeks to make a report with your group which accounts for 50% of the grade. The other 20% is for your performance in the field.

Experiences
The preparation in the weeks before the course were not very useful. Because you're busy with the other course so not much can be done for this course. The first week in Utrecht was useful but more supervision would be nice. During the field campaign we have done many different things which was very nice. Prepare for long days of work (12 hours a day).

Floor's master track: Environmental geochemistry

Since this track can be found in the masters Earth, Life and Climate as well in Earth Surface and Water it could be thought that a hydrological background is preferred. I think that a background in hydrology certainly has an advantage but is absolutely not necessary. I did not follow any hydrological courses in my bachelor and I did not find any problems following this track.

The courses that I have followed are Aquatic and environmental geochemistry, Principles of groundwater flow, Kinetic processes, Hydrogeological transport phenomena, Reactive transport, Quantitative Water Management, Environmental hydrogeology and Field research instruction Geochemistry. The courses Aquatic and environmental geochemistry and Kinetic processes are the chemistry courses of this track and I think a pre for this master track.

You should be aware of the fact that the course Principles of groundwater flow is an entry requirement for the courses Hydrogeological transport phenomena and Environmental hydrogeology. Hydrogeological transport phenomena is also an entry requirement for the course Environmental hydrogeology. So if you are interested in the hydrological part make sure you have followed the courses Principles of groundwater flow and Hydrogeological transport phenomena. So in the first period I would recommend to take microbes and biogeochemistry course as a third course.

Looking back, I would not have chosen the courses Quantitative Water Management and Environmental hydrogeology. Quantitative Water Management has the level of a first year bachelor course. I think the course Mineral and isotope tracers of Earth processes is a better choice. In the course Environmental hydrogeology there is a lot of repetition of the courses Principles of groundwater flow and Hydrological transport phenomena. Instead of Environmental hydrogeology I would choose the course Organic geochemistry.

5. M-Profile: Earth and sustainability

The M-profile Earth and sustainability is chosen next to a track. It is open to students of all Master's programmes Earth Sciences of the Utrecht University. To fulfill the track and M-profile requirements, students have to have at least 30 ECTS of course modules of the chosen track, of which 15 ECTS from the top box, and at least 30 ECTS from the profile-related courses.

Earth and Sustainability
Introduction to the Energy and Resource System
Themes in Global Change and Ecosystems
Sustainable Energy Supply & Solutions
Ecosystem Modelling
Energy & Resource Efficiency
Fossil Resources * (**not** for Earth Sciences students)
Energy Policy and Transitions
Climate Systems and Adaptation
Environmental Ethics and Sustainable Development
Development Themes

Courses of this track are not evaluated by us yet.