Earth Sciences MSc

Vrije Universiteit Amsterdam - Fac. der Aard- en Levenswetenschappen - M Earth Sciences - 2017-2018

The Master programme Earth Sciences provides education of high scientific quality and academic level in Earth Sciences. The aims of the programme are to impart to the students the knowledge, attitudes, skills, and insights which render the graduated Master

-capable of practising his/her profession independently
-qualified for continuing training in scientific research.

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.

More information
-All compulsory courses and electives you find in the year schedule;
-A complete description of the programme you find in the Teaching and Examination Regulations;
-For more information about the programma you can contact the academic advisor (VU students only);
-As a VU student you need to register for all courses via VUnet. Only after you completed your enrollment for the study programme you can register for courses;
-More information on all the courses you find through the links below.

Inhoudsopgave

M Earth Sciences specialisation Education

The two-year master programme Education (E) 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 compatible. E-courses are shared with master students from other faculties. The E-programme (60 credits) is taught in Dutch.

The programme of Earth Sciences (minimum of 60 credits) should at least contain an Earth Sciences Research Project ((450267 (24 credits) or 450295, 450296, 450200 (27 credits)) and Sociale geografie II (450168, 6 credits). The remainder of the programme (total 21 or 24 EC) is to be filled with courses which can be chosen from the various master's degree programmes of the Graduate School Earth, Environment and Ecology.

The educational programme is taught in Dutch by the ‘teacher training programme’ (Faculty of Psychology and Education) and consists of 60 credits of compulsory modules (see below) More information is available at the Faculty of Psychology and Education: www.psy.vu.nl/nl/opleidingen/masteropleidingen/universitaire-lerarenopleiding

Opleidingsdelen:

- Earth Sciences specific content
- Education specific content

Earth Sciences specific content

Opleidingsdelen:

- Research project (choose one)
- Elective courses MSc Earth Sciences

Vakken:

Naam	Periode	Credits	Code
Sociale geografie II	Ac. Jaar (september)	12.0	AM_1051

Research project (choose one)

Vakken:

Naam	Periode	Credits	Code
Research Project Earth Sciences and Economics	Ac. Jaar (september)	18.0	AM_1103

Research Project Earth Surface Processes, Climate and Records	Ac. Jaar (september)	27.0	AM_1149
Research Project Solid Earth	Ac. Jaar (september)	27.0	AM_450200

Elective courses MSc Earth Sciences

Vakken:

Naam	Periode	Credits	Code
3D Seismic Interpretation and Production Geology	Periode 1	6.0	AM_450316
Advanced Geochronology	Periode 5	3.0	AM_450171
Advanced Inorganic Geochemistry	Periode 5	3.0	AM_450172
Advanced Tectonics	Periode 5	6.0	AM_1173
Capita Selecta Geology and Geochemistry	Periode 4	6.0	AM_1174
Catchment Response Analysis	Periode 1	6.0	AM_450003
Causes and Consequences of Environmental Change	Periode 1	6.0	AM_1049
Climate Modelling	Periode 3	6.0	AM_450004
Diagenesis of Sedimentary Rocks	Periode 5	3.0	AM_450169
Ecohydrology	Periode 1	6.0	AM_450014
Environmental Remote Sensing	Periode 3	6.0	AM_450145
Geothermal Energy		6.0	AM_450409
Global Biogeochemical Cycles	Periode 4	6.0	AM_450332
Groundwater Microbiology and Geochemistry (Geomicrobiology)	Ac. Jaar (september)	6.0	AM_450132
Magmatic Processes	Periode 4	6.0	AM_450189
Man and Climate	Periode 4	3.0	AM_450187
Metamorphism and P-T Evolution	Periode 4	6.0	AM_450176
Modern Climate and Geo-ecosystems	Periode 1	6.0	AM_1124
Petroleum Geology of the North Sea	Periode 2	7.0	AM_450317
Petrophysics and Reservoir Engineering	Periode 2	6.0	AM_1212
Planetary Science	Periode 1+2	6.0	AM_450273

Practical: Paleoclimate Change and Environmental Impacts	Periode 4	6.0	AM_1144
Precambrian Geology	Periode 4	3.0	AM_450164
Reflection Seismic for Geologists	Periode 4	6.0	AM_450170
Science and Communication	Periode 1	6.0	AM_470587
Science Journalism	Periode 2	6.0	AM_471014
Sediment Petrography of Heavy Minerals	Periode 3	3.0	AM_450058
Sedimentary Environments and Climate Archives	Periode 1	6.0	AM_450330
Sociale geografie II	Ac. Jaar (september)	12.0	AM_1051
Sustainable Energy Analysis	Periode 1	6.0	AM_468018
Volcanism	Periode 3	3.0	AM_450061

Education specific content

Opleidingsdelen:

- Master Leraar VHO Aardrijkskunde vanaf 2015

Master Leraar VHO Aardrijkskunde vanaf 2015

Vakken:

Naam	Periode	Credits	Code
Didactiek 1	Periode 1	6.0	O_MLDIDAC_1
Didactiek 2	Periode 2+3	6.0	O_MLDIDAC_2
Didactiek 3	Periode 4+5+6	9.0	O_MLDIDAC_3
Peergroup fase 1	Periode 1+2+3	0.0	O_MLPEERGR_1
Peergroup Fase 2	Periode 3+4+5	0.0	O_MLPEERGR_2
Praktijk 1	Periode 1	6.0	O_MLPRAK_1
Praktijk 2	Periode 2+3	9.0	O_MLPRAK_2
Praktijk 3	Periode 4+5+6	15.0	O_MLPRAK_3
Praktijk 3 voor 2-jarige Master		15.0	O_M2PRAK3
Praktijkonderzoek 1	Periode 3	3.0	O_MLPROZ_1
Praktijkonderzoek 2	Periode 4+5+6	6.0	O_MLPROZ_2

M Earth Sciences, specialisation Earth Sciences and Economics

The specialisation programme in Earth Sciences and Economics consists of 63 credits of compulsory components for all students and 27 or 30 credits for the theme of choice. The remainder (27 or 30 credits) of the programme consists of elective options.

The elective options enable students to construct their own specialization in addition to the compulsory modules and the selected theme. The student is free to choose from modules offered by the faculties FALW and FEWEB.

Opleidingsdelen:

- MSc Earth Sciences, specialisation Earth Sciences and Economics, compulsory modules for all themes
- Choose one of these courses
- Earth Sciences oriented course components, choose at least 6 EC
- Economics oriented course components, choose at least 6 EC
- Choose 18 EC of these courses
- Elective courses MSc Earth Sciences

MSc Earth Sciences, specialisation Earth Sciences and Economics, compulsory modules for all themes

Vakken:

Naam	Periode	Credits	Code
Exploring Earth Processes and Resources		6.0	AM_450405
Imaging and Assessing Landscapes		6.0	AM_1183
Master Thesis Earth Sciences and Economics	Periode 3+4+5+6	24.0	AM_1150
Project Environmental Impact Assessment	Periode 3	6.0	AM_450406
Research Project Earth Sciences and Economics	Ac. Jaar (september)	18.0	AM_1103
Water Management	Periode 1	6.0	AM_468023

Choose one of these courses

Vakken:

Naam	Periode	Credits	Code
Economics of Climate Change	Periode 2	6.0	E_STR_ECC
Geothermal Energy		6.0	AM_450409

Earth Sciences oriented course components, choose at least 6 EC

Vakken:

Naam	Periode	Credits	Code

Ecohydrology	Periode 1	6.0	AM_450014
Geothermal Energy		6.0	AM_450409
Modern Climate and Geo-ecosystems	Periode 1	6.0	AM_1124
Petroleum Systems for Earth and Economics		6.0	AM_450408

Economics oriented course components, choose at least 6 EC

Vakken:

Naam	Periode	Credits	Code
Economics of Climate Change	Periode 2	6.0	E_STR_ECC
Environmental Economics	Periode 4	6.0	E_STR_EEC
Regional and Urban Economics	Periode 2	6.0	E_STR_RUE
Transport Economics	Periode 2	6.0	E_STR_TREC

Choose 18 EC of these courses

Vakken:

Naam	Periode	Credits	Code
Advanced Spatial Analyses	Periode 2	6.0	AM_1197
Biological Oceanography	Periode 2	6.0	AMU_0021
Building Bridges between Science and Society		6.0	AMU_0010
Ecosystem Management		6.0	AMU_0011
Energy and Climate Governance	Periode 3	6.0	AM_1155
Man and Climate	Periode 4	3.0	AM_450187
Reflection Seismic for Geologists	Periode 4	6.0	AM_450170
Sedimentary Environments and Climate Archives	Periode 1	6.0	AM_450330
Spatial Processes in Ecology	Periode 1	6.0	AMU_0009
Sustainable Energy Analysis	Periode 1	6.0	AM_468018

Elective courses MSc Earth Sciences

Vakken:

Naam	Periode	Credits	Code
3D Seismic Interpretation and Production Geology	Periode 1	6.0	AM_450316
Advanced Geochronology	Periode 5	3.0	AM_450171
Advanced Inorganic Geochemistry	Periode 5	3.0	AM_450172
Advanced Tectonics	Periode 5	6.0	AM_1173
Capita Selecta Geology and Geochemistry	Periode 4	6.0	AM_1174
Catchment Response Analysis	Periode 1	6.0	AM_450003
Causes and Consequences of Environmental Change	Periode 1	6.0	AM_1049
Climate Modelling	Periode 3	6.0	AM_450004
Diagenesis of Sedimentary Rocks	Periode 5	3.0	AM_450169
Ecohydrology	Periode 1	6.0	AM_450014
Environmental Remote Sensing	Periode 3	6.0	AM_450145
Geothermal Energy		6.0	AM_450409
Global Biogeochemical Cycles	Periode 4	6.0	AM_450332
Groundwater Microbiology and Geochemistry (Geomicrobiology)	Ac. Jaar (september)	6.0	AM_450132
Magmatic Processes	Periode 4	6.0	AM_450189
Man and Climate	Periode 4	3.0	AM_450187
Metamorphism and P-T Evolution	Periode 4	6.0	AM_450176
Modern Climate and Geo-ecosystems	Periode 1	6.0	AM_1124
Petroleum Geology of the North Sea	Periode 2	7.0	AM_450317
Petrophysics and Reservoir Engineering	Periode 2	6.0	AM_1212
Planetary Science	Periode 1+2	6.0	AM_450273
Practical: Paleoclimate Change and Environmental Impacts	Periode 4	6.0	AM_1144
Precambrian Geology	Periode 4	3.0	AM_450164
Reflection Seismic for Geologists	Periode 4	6.0	AM_450170
Science and Communication	Periode 1	6.0	AM_470587
Science Journalism	Periode 2	6.0	AM_471014
Sediment Petrography of Heavy Minerals	Periode 3	3.0	AM_450058
Sedimentary Environments and Climate Archives	Periode 1	6.0	AM_450330
Sociale geografie II	Ac. Jaar (september)	12.0	AM_1051

Sustainable Energy Analysis	Periode 1	6.0	AM_468018
Volcanism	Periode 3	3.0	AM_450061

M Earth Sciences specialisation Earth Surface Processes, Climate and Records

Opleidingsdelen:

- Compulsory courses- ESPCAR
- Choose one of these courses
- Elective courses MSc Earth Sciences
- MSc Earth Sciences, specialisation Earth Surface Processes, Climate and Records, year 1
- M Earth Sciences specialisation Earth Surface Processes, Climate and Records year 2

Compulsory courses- ESPCAR

Vakken:

Naam	Periode	Credits	Code
Advanced Spatial Analyses	Periode 2	6.0	AM_1197
Global Biogeochemical Cycles	Periode 4	6.0	AM_450332
High Resolution Archives	Periode 2	6.0	AM_450331
Master Thesis Earth Surface Processes, Climate and Records	Ac. Jaar (september)	24.0	AM_1147
Modern Climate and Geo-ecosystems	Periode 1	6.0	AM_1124
Practical: Paleoclimate Change and Environmental Impacts	Periode 4	6.0	AM_1144
Research Project Earth Surface Processes, Climate and Records	Ac. Jaar (september)	27.0	AM_1149
Scotland Excursion	Periode 6	3.0	AM_450354
Sedimentary Environments and Climate Archives	Periode 1	6.0	AM_450330
Tectonic Geomorphology	Periode 2	6.0	AM_450146

Choose one of these courses

Vakken:

Naam	Periode	Credits	Code
Climate Modelling	Periode 3	6.0	AM_450004
Environmental Remote Sensing	Periode 3	6.0	AM_450145

Elective courses MSc Earth Sciences

Vakken:

Naam	Periode	Credits	Code
3D Seismic Interpretation and Production Geology	Periode 1	6.0	AM_450316
Advanced Geochronology	Periode 5	3.0	AM_450171
Advanced Inorganic Geochemistry	Periode 5	3.0	AM_450172
Advanced Tectonics	Periode 5	6.0	AM_1173
Capita Selecta Geology and Geochemistry	Periode 4	6.0	AM_1174
Catchment Response Analysis	Periode 1	6.0	AM_450003
Causes and Consequences of Environmental Change	Periode 1	6.0	AM_1049
Climate Modelling	Periode 3	6.0	AM_450004
Diagenesis of Sedimentary Rocks	Periode 5	3.0	AM_450169
Ecohydrology	Periode 1	6.0	AM_450014
Environmental Remote Sensing	Periode 3	6.0	AM_450145
Geothermal Energy		6.0	AM_450409
Global Biogeochemical Cycles	Periode 4	6.0	AM_450332
Groundwater Microbiology and Geochemistry (Geomicrobiology)	Ac. Jaar (september)	6.0	AM_450132
Magmatic Processes	Periode 4	6.0	AM_450189
Man and Climate	Periode 4	3.0	AM_450187
Metamorphism and P-T Evolution	Periode 4	6.0	AM_450176
Modern Climate and Geo-ecosystems	Periode 1	6.0	AM_1124
Petroleum Geology of the North Sea	Periode 2	7.0	AM_450317
Petrophysics and Reservoir Engineering	Periode 2	6.0	AM_1212
Planetary Science	Periode 1+2	6.0	AM_450273
Practical: Paleoclimate Change and Environmental Impacts	Periode 4	6.0	AM_1144
Precambrian Geology	Periode 4	3.0	AM_450164
Reflection Seismic for Geologists	Periode 4	6.0	AM_450170

Science and Communication	Periode 1	6.0	AM_470587
Science Journalism	Periode 2	6.0	AM_471014
Sediment Petrography of Heavy Minerals	Periode 3	3.0	AM_450058
Sedimentary Environments and Climate Archives	Periode 1	6.0	AM_450330
Sociale geografie II	Ac. Jaar (september)	12.0	AM_1051
Sustainable Energy Analysis	Periode 1	6.0	AM_468018
Volcanism	Periode 3	3.0	AM_450061

MSc Earth Sciences, specialisation Earth Surface Processes, Climate and Records, year 1

Opleidingsdelen:

- Choose one of these courses
- Compulsory courses year 1 spec. ESP
- Choose one of these courses

Choose one of these courses

Vakken:

Naam	Periode	Credits	Code
Climate Modelling	Periode 3	6.0	AM_450004
Environmental Remote Sensing	Periode 3	6.0	AM_450145

Compulsory courses year 1 spec. ESP

Vakken:

Naam	Periode	Credits	Code
Global Biogeochemical Cycles	Periode 4	6.0	AM_450332
High Resolution Archives	Periode 2	6.0	AM_450331
Modern Climate and Geo-ecosystems	Periode 1	6.0	AM_1124
Practical: Paleoclimate Change and Environmental Impacts	Periode 4	6.0	AM_1144
Research Project Earth Surface Processes, Climate and Records	Ac. Jaar (september)	27.0	AM_1149
Scotland Excursion	Periode 6	3.0	AM_450354

Sedimentary Environments and Climate Archives	Periode 1	6.0	AM_450330
Tectonic Geomorphology	Periode 2	6.0	AM_450146

Choose one of these courses

Vakken:

Naam	Periode	Credits	Code
Climate Modelling	Periode 3	6.0	AM_450004
Environmental Remote Sensing	Periode 3	6.0	AM_450145

M Earth Sciences specialisation Earth Surface Processes, Climate and Records year 2

Opleidingsdelen:

- Elective modules year 2 specialization Earth Surface Processes, Climate and Records
- Compulsory courses year 2 specialization Earth Surface Processes, Climate and Records

Elective modules year 2 specialization Earth Surface Processes, Climate and Records

Vakken:

Naam	Periode	Credits	Code
Catchment Response Analysis	Periode 1	6.0	AM_450003
Ecohydrology	Periode 1	6.0	AM_450014
Environmental Remote Sensing	Periode 3	6.0	AM_450145
Groundwater Hydraulics		6.0	AM_450009
Hydrochemistry		6.0	AM_450052
Hydrological Systems and Water Management		3.0	AM_1012
Man and Climate	Periode 4	3.0	AM_450187
Precambrian Geology	Periode 4	3.0	AM_450164
Science Journalism	Periode 2	6.0	AM_471014
Sediment Petrography of Heavy Minerals	Periode 3	3.0	AM_450058

Compulsory courses year 2 specialization Earth Surface Processes, Climate and Records

Vakken:

Naam	Periode	Credits	Code
Advanced Spatial Analyses	Periode 2	6.0	AM_1197
Master Thesis Earth Surface Processes, Climate and Records	Ac. Jaar (september)	24.0	AM_1147
Research Project Earth Surface Processes, Climate and Records	Ac. Jaar (september)	27.0	AM_1149

MSc Earth Sciences, specialisation Geology and Geochemistry

Opleidingsdelen:

- M Earth Sciences specialisation Geology & Geochemistry year 1
- M Earth Sciences specialisation Geology & Geochemistry year 2

M Earth Sciences specialisation Geology & Geochemistry year 1

Opleidingsdelen:

- MSc. ES, G. and G. electives yr 1,
- MSc Earth Sciences, specialisation Geology and Geochemistry, compulsory courses year 1

MSc. ES, G. and G. electives yr 1,

Vakken:

Naam	Periode	Credits	Code
Advanced Geochronology	Periode 5	3.0	AM_450171
Advanced Inorganic Geochemistry	Periode 5	3.0	AM_450172
Advanced Tectonics	Periode 5	6.0	AM_1173
Capita Selecta Geology and Geochemistry	Periode 4	6.0	AM_1174
Diagenesis of Sedimentary Rocks	Periode 5	3.0	AM_450169
Magmatic Processes	Periode 4	6.0	AM_450189
Metamorphism and P-T Evolution	Periode 4	6.0	AM_450176
Petrophysics and Reservoir Engineering	Periode 2	6.0	AM_1212
Reflection Seismic for Geologists	Periode 4	6.0	AM_450170

MSc Earth Sciences, specialisation Geology and Geochemistry, compulsory courses year 1

The specialisation Geology and Geochemistry focuses on the geology and geochemistry of the Earth. In doing so it integrates tectonics, petrology, geochemistry, sedimentary geology, and planetary science. The student acquires a broad background by following a set of compulsory courses in Year 1 before focusing on a research topic in one or more of the aforementioned fields.

Vakken:

Naam	Periode	Credits	Code
Geology & Geochemistry Field Excursion	Periode 1	3.0	AM_450229
Mantle Properties	Periode 1	6.0	AM_1211
Orogenesis	Periode 3	6.0	AM_450190
Petroleum Systems and Regional Geology	Periode 1	3.0	AM_450179
Research Project Geology and Geochemistry	Ac. Jaar (september)	27.0	AM_1187
Sedimentary Basins	Periode 2	6.0	AM_450154
Tectonic Geomorphology	Periode 2	6.0	AM_450146

M Earth Sciences specialisation Geology & Geochemistry year 2

Opleidingsdelen:

- MSc. ES, G. and G. electives yr 2
- MSc Earth Sciences, specialisation Geology and Geochemistry. compulsory courses year 2

MSc. ES, G. and G. electives yr 2

Vakken:

Naam	Periode	Credits	Code
3D Seismic Interpretation and Production Geology	Periode 1	6.0	AM_450316
Capita Selecta Geology and Geochemistry	Periode 4	6.0	AM_1174
Magmatic Processes	Periode 4	6.0	AM_450189
Metamorphism and P-T Evolution	Periode 4	6.0	AM_450176
Petroleum Geology of the North Sea	Periode 2	7.0	AM_450317
Planetary Science	Periode 1+2	6.0	AM_450273

Precambrian Geology	Periode 4	3.0	AM_450164
Reflection Seismic for Geologists	Periode 4	6.0	AM_450170
Volcanism	Periode 3	3.0	AM_450061

MSc Earth Sciences, specialisation Geology and Geochemistry. compulsory courses year 2

The specialisation Geology and Geochemistry focuses on the geology and geochemistry of the Earth. In doing so it integrates tectonics, petrology, geochemistry, sedimentary geology, and planetary science. The student has acquired a broad background by following a set of compulsory courses in Year 1 and will focus in Year 2 on a set of optional courses, finishing the Research Project started in Year 1, and the Master Thesis

Vakken:

Naam	Periode	Credits	Code
Geology & Geochemistry Field Excursion	Periode 1	3.0	AM_450229
Master Thesis Geology and Geochemistry	Ac. Jaar (september)	27.0	AM_1186
Research Project Geology and Geochemistry	Ac. Jaar (september)	27.0	AM_1187

M Earth Sciences specialisation Science Communication

The two-year master programme Science Communication (C-variant) 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 other faculties. The C-programme (60 credits) is taught in English and Dutch.

The programme of Earth Sciences (minimum of 60 credits) should at least contain an Earth Sciences Research Project (450267 (24 credits) or 450295, 450296, 450200 (27 credits)). All other course modules (total 33 or 37 credits) are considered elective options and can be chosen from the various master's degree programmes of the Graduate School Earth, Environment and Ecology.

The compulsory programme consists of the following two communication course modules, a Thesis (9 EC) and Research Project (21 EC) with variable course codes.
Students should take 18 credits from optional course modules .

Opleidingsdelen:

- MSc Earth Sciences, specialisation Science Communication, Earth Sciences content
- MSc Earth Sciences, specialisation Science Communication, Science Communication content

MSc Earth Sciences, specialisation Science Communication, Earth Sciences content

Opleidingsdelen:

- Elective courses MSc Earth Sciences
- Research project (choose one)

Elective courses MSc Earth Sciences

Vakken:

Naam	Periode	Credits	Code
3D Seismic Interpretation and Production Geology	Periode 1	6.0	AM_450316
Advanced Geochronology	Periode 5	3.0	AM_450171
Advanced Inorganic Geochemistry	Periode 5	3.0	AM_450172
Advanced Tectonics	Periode 5	6.0	AM_1173
Capita Selecta Geology and Geochemistry	Periode 4	6.0	AM_1174
Catchment Response Analysis	Periode 1	6.0	AM_450003
Causes and Consequences of Environmental Change	Periode 1	6.0	AM_1049
Climate Modelling	Periode 3	6.0	AM_450004
Diagenesis of Sedimentary Rocks	Periode 5	3.0	AM_450169
Ecohydrology	Periode 1	6.0	AM_450014
Environmental Remote Sensing	Periode 3	6.0	AM_450145
Geothermal Energy		6.0	AM_450409
Global Biogeochemical Cycles	Periode 4	6.0	AM_450332
Groundwater Microbiology and Geochemistry (Geomicrobiology)	Ac. Jaar (september)	6.0	AM_450132
Magmatic Processes	Periode 4	6.0	AM_450189
Man and Climate	Periode 4	3.0	AM_450187
Metamorphism and P-T Evolution	Periode 4	6.0	AM_450176
Modern Climate and Geo-ecosystems	Periode 1	6.0	AM_1124
Petroleum Geology of the North Sea	Periode 2	7.0	AM_450317
Petrophysics and Reservoir Engineering	Periode 2	6.0	AM_1212

Planetary Science	Periode 1+2	6.0	AM_450273
Practical: Paleoclimate Change and Environmental Impacts	Periode 4	6.0	AM_1144
Precambrian Geology	Periode 4	3.0	AM_450164
Reflection Seismic for Geologists	Periode 4	6.0	AM_450170
Science and Communication	Periode 1	6.0	AM_470587
Science Journalism	Periode 2	6.0	AM_471014
Sediment Petrography of Heavy Minerals	Periode 3	3.0	AM_450058
Sedimentary Environments and Climate Archives	Periode 1	6.0	AM_450330
Sociale geografie II	Ac. Jaar (september)	12.0	AM_1051
Sustainable Energy Analysis	Periode 1	6.0	AM_468018
Volcanism	Periode 3	3.0	AM_450061

Research project (choose one)

Vakken:

Naam	Periode	Credits	Code
Research Project Earth Sciences and Economics	Ac. Jaar (september)	18.0	AM_1103
Research Project Earth Surface Processes, Climate and Records	Ac. Jaar (september)	27.0	AM_1149
Research Project Solid Earth	Ac. Jaar (september)	27.0	AM_450200

MSc Earth Sciences, specialisation Science Communication, Science Communication content

Opleidingsdelen:

- Optional modules Science Communication
- Compulsory components Science Communic.

Optional modules Science Communication

Vakken:

Naam	Periode	Credits	Code

Communication, Organization and Management	Periode 2	6.0	AM_470572
Science in Dialogue	Periode 2	6.0	AM_1002
Science Journalism	Periode 2	6.0	AM_471014
Science Museology	Periode 3	6.0	AM_470590

Compulsory components Science Communic.

Opleidingsdelen:

- Choose one of these courses

Vakken:

Naam	Periode	Credits	Code
Research methods for analyzing complex problems	Periode 1	6.0	AM_1182
Science and Communication	Periode 1	6.0	AM_470587

Choose one of these courses

Vakken:

Naam	Periode	Credits	Code
Reflective Practice Internship Science Communication	Ac. Jaar (september)	30.0	AM_1163
Research Internship Science Communication	Ac. Jaar (september)	30.0	AM_1162

3D Seismic Interpretation and Production Geology

Vakcode	AM_450316 ()
Periode	Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. P.J.F. Verbeek
Examinator	dr. P.J.F. Verbeek
Lesmethode(n)	Werkcollege
Niveau	400

Doel vak

Introduce Geological Modelling of a reservoir in the subsurface to assess potential Volumes of hydrocarbons. The models are based on interpretation of 3D Seismic data and on observations in wells (well log measurements and core data). The course starts with an overview of hydrocarbon exploration. There will be three one day industry excursions (e.g. NAM, Wintershall, Shell, EBN).

Inhoud vak
- Introduction and recap exercise of seismic interpretation
- Recap of Exploration techniques; Play and Prospect Analysis & Mapping
- Simple horizon interpretation on seismic
- A visit to the NAM core store, where cores are displayed representative for the exercises

Based on a real industry 3D seismic and well dataset,
- Acquaintance with Petrel software (data loading and navigation)
- Fault interpretation and building a structural framework in Petrel
- Depth Conversion (velocity and horizon depth conversion)
- Horizon interpretation and Gridding
- Well correlation and fluid contacts
- Area-Depth analysis
- Gross Rock Volume calculations
- Fault modelling and Pillar gridding
- Petrophysics and Upscaling
- Geostatistics and Property modelling
- Building a static model
- Volume calculations
- Uncertainty workflows

Onderwijsvorm
- Lectures on specific topics
- Hands-on 3D seismic interpretation, petrophysical (correlation) analysis and geological modelling, using PC-based software (Petrel software)
- Feed-back sessions with presentations by participants
- Exercises on numerical steps in interpretation

Toetsvorm
- group presentations during the course.
- group assignment by the end of the course
- It is compulsory to attend all lectures and presentations

Literatuur
Reading material will be supplied during the course.

Vereiste voorkennis
Reflection Seismic for Geologists (FALW AM_450170)

Aanbevolen voorkennis
The following courses:
Geology of the North Sea
Petroleum Systems and Regional Geology

Doelgroep
Geology students who would like to proceed with a career in the oil and gas industry.

Uitleg in Blackboard/Canvas
This course is now usually called Integrated Subsurface Interpretation Course (ISIC) and used to be called the "Petrel Course", when it was

still given within the Shell premises in Rijswijk.

Overige informatie
Course will be given as a 4 week block course at Utrecht University in Utrecht. The course has a limited capacity.

Advanced Geochronology

Vakcode	AM_450171 ()
Periode	Periode 5
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. J.R. Wijbrans
Examinator	prof. dr. J.R. Wijbrans
Docent(en)	prof. dr. J.R. Wijbrans, dr. K.F. Kuiper
Lesmethode(n)	Werkcollege
Niveau	500

Doel vak
Students who attended this course should have gained knowledge and understanding about
Current developments in high resolution geochronology as applied to
I. the Geological Timescale, and to
II. crustal evolution studies
Analytical and methodological approaches to constrain these processes as well as the skills to
- Use the acquired knowledge to analyze, compare and explain distinct
- features of processes in which geochronological tools are required.
- Read and critically assess significant literature about these subjects
- Actively participate in group discussions

Inhoud vak
- Assessment of the literature, the rock types, mineral assemblages and their structural features, the isotopic data sets of one well understood orogen (Case history).
- the use of low- , medium and high-temperature thermochronometers
- Astronomical dating of cyclically bedded sediments.
- tephra chronology
- Intercalibration of the Geological Timescale by applying both.

The skills to use the acquired knowledge will be obtained using a case study of one orogen (from microscopic observation to the techniques required to constrain the T- t histories of various domains).

Onderwijsvorm
Lectures (6 * 3 u 45 min), assignments /self-study (6 * 4 hrs)

Toetsvorm
Essay – presentation – poster

Literatuur
Selection literature for individual essay and presentation projects to be announced on Canvas.

Vereiste voorkennis
BSc Geology

Aanbevolen voorkennis
Petrology, structural geology, tectonics courses at the BSc level.

Doelgroep
1st year MSc Earth Science Solid Earths.

Overige informatie
Course teachers include dr. Klaudia Kuiper, mr. B. Uunk, MSc and dr. J.M. O'Connor,
University of Erlangen.

Advanced Inorganic Geochemistry

Vakcode	AM_450172 ()
Periode	Periode 5
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. G.R. Davies
Examinator	prof. dr. G.R. Davies
Docent(en)	dr. P.Z. Vroon, prof. dr. G.R. Davies, prof. dr. W. van Westrenen
Lesmethode(n)	Werkgroep
Niveau	500

Doel vak
Our main aim is two-fold. First, to present an overview of the state-of-the-art in geochemical research. After this course you should be aware of the major problems that are being tackled right now by geochemists, the techniques they use, and some of the major advances that have been made in the areas discussed over the past couple of years.Second, to introduce you to the skill of reviewing and marking academic work.

Inhoud vak
Topics covered include planetary core formation, volatiles in subduction zones, geochemical tracing, and geochemical techniques applied to art history and renovation.

Onderwijsvorm
Most sessions consist of lectures introducing you to several 'hot topics' in advanced geochemistry. The information you receive in these lectures is meant to provide the background needed to understand and critically assess recent high-impact publications that we have selected in these active research areas. Lectures are generally relatively short, leaving sufficient time for discussion and self-study of these papers (and other relevant papers on the same topic that you find). The course also includes a visit to the laboratories of the Rijksmuseum.

In addition, at the start of the course students are divided into groups of two. Each group will be allowed to choose one of the topics covered in the course. Each member of each group has 10 days to individually

prepare:(1) a 200-word abstract on the paper / topic (i.e. what is the problem or controversy; what data are used).(2) a 3-page essay on the topic that discusses the major arguments in the subject region.(3) a Powerpoint presentation on the topic (maximum length 15 minutes, maximum 15 slides).You will then provide feedback on the performance of your colleague, and jointly prepare a final presentation.

The work load of this course given in SBU is (1) 5 * 70 minutes lectures + museum visit = 18 SBU, (2) 5 * 2.5 hours reading and discussing publications = 30 SBU; Preparation of abstract, essay, presentation, and review of colleague's work = 32 SBU. Total 80 SBU = 3 ECTS

Toetsvorm
The mark you obtain for this course consists of the following components: preparation of abstract (15%), essay (20%), and first draft of presentation (10%); your review of essay and presentation of a colleague (25%), and the final presentation (30%).

Literatuur
As we aim to discuss hot-off-the-press research, papers to be discussed are not known until the week before the start of the course.

Vereiste voorkennis
This is the highest level petrology- geochemistry course so a good understanding of petrology and particularly geochemistry is required. Completion of second and third year BSc. level petrology and geochemistry courses is required and it is strongly advised that "mantle properties in lithospheric development" and one of "magmatic process or metamorphic petrology" (or equivalents at other universities) have been completed successfully.

Aanbevolen voorkennis
The Mantle Properties in Lithosphere Development and Magmatic Processes courses provide useful backgrounds in isotope geochemistry.

Doelgroep
Second year MSc students in Earth Sciences.

Overige informatie
Guest lecturers include Dr. Robert van Langh (Rijksmuseum) and Dr. Gerard van der Peijl (Netherlands Forensics Institute). Additional lecturers from the VU may be involved, depending on the time of arrival of new postdoctoral researchers.

Advanced Spatial Analyses

Vakcode	AM_1197 ()
Periode	Periode 2
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. ir. J. van Vliet
Examinator	dr. ir. J. van Vliet
Docent(en)	dr. ir. J. van Vliet
Lesmethode(n)	Hoorcollege, Computerpracticum, Werkgroep

Niveau	500

Doel vak
The main objective of this course is to become familiar with more advanced approaches for the analysis of spatial problems, and to apply these approaches in a research context. Students will be trained in designing appproaches to solve spatial analysis question and in the techniques needed to do so (specifically including the Arc GIS model builder and Python Scripting). As methods evolve quickly, and sa a very large number of tools is available for spatial analysis, this course strives to teach how to learn new tools, rather than teaching how to use a predefined set of tools.

Inhoud vak
In the first part of the course we will learn how to approach spatial propblems using ArcGIS, and especially the Model builder. In this part we will analyse recently published research papers, conduct analyses of increasing complexity, and revisit some important issues related to GIS and spatial data, such as data quality, uncertainty, and meta-data, but also more technical aspects such as file types and data types.

In the second part of the course we will learn how to make a script (in Python) in order to conduct a spatial analysis. In this section we will first practice with very simple exercises, in order to learn basic principles of scripting / programming (operators, variables, functions, loops, conditional statements). Subsequently, we will learn to apply these to spatial analyses specifically, using the ArcPy module (a module to conduct GIS analyses).

At the start, each student will select a (different) case study region in Europe, to which s/he will apply a number of (environmental) spatial analyses using the methods and techniques listed above: a state-of-the-environment analysis. These analyses could include, but are not restricted to:
- Analsyis of observed land cover changes between two time periods
- Anlaysis of the thematic accuracy of a land cover map using Google Earth imagery
- Calculation of soild erosion in the case study area
- Calculation of changes in aboveground biomass and land related carbon emissions
- Consequences of land cover changes for biodiversity

These assignments are selected because they require the application of a number of different tools, and thus allow for one overarching theme while doing seperate exercises. It should be noted that the focus of the course is on the approaches and methods used to conduct a spatial analysis. Hence land use and land cover change are only used as a topic to practice these methods, while they are not the topic of this course in itself. Towards the end of the course students will write a paper in which they report on their state-of-the-environment analysis in a scientifically sound way.

Onderwijsvorm
The course will take 8 weeks of part-time (50%) study. In the first six weeks, each week will be used to conduct one spatial analysis for your case study area. Each week will start with a lecture about theory and application of spatial analyses, including some example of ongoing research in the department, and an explanation of the exercise and tools

of that week. Throughout the week students will work on this exercise independently, with the possibility of support and feedback during the computer lab hours. On friday we will have feedback and discussion lectures, where students present their intermedoiate results and provide and receive feedback.

Toetsvorm
Students will be evaluated based on their contributions to a series of Python exercises (10%) the Friday discussions/presentations (10%), the spatial analysis tools they develop (30%), and the paper (50%).

Literatuur
Selected literature will be provided on Canvas.

Vereiste voorkennis
This course assumes a basic knowledge of GIS and GIS-based spatial analysis (such as GIS and Digital Spatial Data (AB_1076), or equivalent). This requirement is met by all students that completed their BSc in Earth Sciences or Earth and Economics at VU University. No prior knowledge of programming or scripting is expected.

Aanbevolen voorkennis
Any additional experience with GIS and spatial analysis is recommended, but not necessary.

Doelgroep
Master students in Earth Sciences (ESPCaR track), other Master students in Earth Sciences, and related relevant disciplines (such as ecology or hydrology).

Overige informatie
Lecturers:
Dr. Jasper van Vliet, invited guest lecturers

Advanced Tectonics

Vakcode	AM_1173 ()
Periode	Periode 5
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. W.P. Schellart MSc
Examinator	dr. W.P. Schellart MSc
Lesmethode(n)	Werkcollege
Niveau	400

Doel vak
The main goal of this course is to develop deep insight and understanding of the processes of subduction, mantle flow and overriding plate deformation and, more generally, to gain knowledge and understanding of geodynamics, geodynamic modelling and plate tectonics. The mutual dependence and interrelatedness of different aspects of subduction will be demonstrated, including subduction zone geology, subduction zone kinematics, subduction zone geometry, subduction zone dynamics and subduction-induced mantle flow. This provides the student

with an integrated view of subduction zone processes, mantle flow and overriding plate deformation. The integrated view is further substantiated through both global and local approaches, and both process-oriented and phenomenological approaches.
The students will develop skills: (1) To quantify plate velocities and plate boundary velocities on a sphere; (2) To identify and quantify driving and resistive forces in subduction systems; (3) To evaluate and quantify overriding plate deformation rates at subduction zones; (4) To apply simple equations from fluid dynamics to geodynamic problems; (5) To critically assess and discuss the relevant scientific literature, including geodynamic modelling results, presented in such papers.

Inhoud vak
The key aspects of subduction zones are discussed from a geological, kinematic, geometric and geodynamic viewpoint, as well as in the context of the global set of active subduction zones on Earth and case studies of natural examples.
Specific topics of the course are:
1. Subduction zone geology
2. Subduction zone kinematics, plate kinematics
3. Subduction zone geometry
4. Subduction zone dynamics
5. Overriding plate deformation during subduction
6. Geodynamic modelling (analogue, numerical)
7. Geodynamic modelling (Stokes flow)
8. Geodynamic modelling (scaling, boundary conditions)
9. Subduction zone initiation
10. Subduction zone termination (collision, obduction, slab detachment)
11. Unusual subduction (ridge/plateau subduction, flat slab subduction, continental subduction)

Onderwijsvorm
Lectures (11 x 2 hours) and practicals (11 x 2 hours), one day of oral presentations (8 hours).

Toetsvorm
Practical exercises (70%), oral presentation (30%).

Literatuur
The course is mostly based on published scientific literature in the fields of Geodynamics, Tectonics, Geophysics and Geology.

Vereiste voorkennis
BSc Geology

Aanbevolen voorkennis
Structural geology, tectonics and Geophysics courses at BSc level.

Doelgroep
1st year MSc students in Solid Earth Sciences.

Biological Oceanography

Vakcode	AMU_0021 ()
Periode	Periode 2
Credits	6.0
Voertaal	Engels

Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. G.M. Ganssen
Examinator	dr. G.M. Ganssen
Niveau	500

Doel vak
At the end of the course, the students are able to:
1. Identify main biological oceanographic processes (4) and describe their interdependence
2. specify and differentiate between biological processes involved in the biological pump
3. survey relevant literature about a given research topic within biological oceanography and summarize in an abstract
4. develop and formulate a follow-up research question / objective on a given topic within biological oceanography and describe how the research should be conducted
5. present a lecture aimed at explaining a research topic to a scientific audience and proposing a continuation research project
6. explain the importance of the biology of the ocean for global change developments
7. critically discuss, oppose and defend scientific issues within the field of biological oceanography

Inhoud vak
http://studiegids.uva.nl/xmlpages/page/2016-2017-en/search-course/course/1545258
Biological Oceanography: a systems approach
Oceans cover 70% of the surface of the Earth and their vast total volume makes it the largest continuous habitat. Half of the oxygen production on Earth occurs in the oceans. The oceans have a critical function for the supply of food and raw materials, and marine ecosystems are crucial in the regulation of Earth's climate and biogeochemical cycles. Our understanding of the ocean and the life it supports is, however, far from complete. Biological oceanography improves our understanding of the principles underlying marine ecosystem organization, and the processes that govern spatial and temporal distribution, dynamics, biodiversity and evolution of auto-, hetero- and mixo-trophic organisms as well as trophic interactions. Only an interdisciplinary and (eco)system-wide approach will enable us to unravel the mysteries and the unknowns of the ocean. Physical, chemical and geological processes in the oceans are fundamental to biological oceanography and vice versa, therefore a few of the initial lectures in this course will be dedicated to the different disciplines. This course will give an in-depth insight in the current knowledge of life in the ocean from viruses to metazoans and from production to burial. The knowledge will be largely framed within the complex suite of processes that are involved in the transformation and transfer of fixed organic carbon (particulate and dissolved) from the surface to the deep ocean (collectively referred to as the 'biological pump'). The factors involved in the functioning of the biological pump are linked and diverse for different systems but influence virtually the entire ocean ecosystem.
The course consists of lectures, discussion forums, (computer) practicals, a one-day excursion, and a symposium. For the latter, students can choose a topic from a list provided (including papers as a starting point) which they will investigate and summarize (extended abstract) including a follow-up research objective for a new research project within the field. Students will be coached by teachers in this

course to come up with new research ideas and communicate these effectively. Students are expected to actively participate in discussions and provide constructive comments.

Onderwijsvorm
FORMAT
- Lectures
- Discussion forums, flipped classrooms
- Homework assignment (literature survey, abstract writing, oral presentation)
- Computer and lab practicals
- Excursion
- Student symposium

Toetsvorm
ASSESSMENT (%)
Exam: 60%
Abstract and formulation research objective: 20%
Oral presentation: 20%

Literatuur
STUDY MATERIALS
Lectures (power point files)
Selection of scientific papers (will be provided)
(not obligatory) the book: Oceanography and Marine Biology. An Introduction to Marine Science. (D.W. Townsend. Sinauer Associates, ISBN 9780878936021) may serve as introduction to the course.

Vereiste voorkennis
basics in (biological) Oceanography

Doelgroep
master students in the field of climatology, oceanography, ecology, hydrology

Intekenprocedure
This course is offered at the UvA. For more information contact: FNWI Education Service Centre, Science Park 904, servicedesk-esc-science@uva.nl, +31 (0)20 525 7100.
Enrolment via https://m.sis.uva.nl/vakaanmelden is required.

Overige informatie
Biological Oceanography: a systems approach

Building Bridges between Science and Society

Vakcode	AMU_0010 ()
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen

Inhoud vak
This is an UvA course. For the course description, please visit http://studiegids.uva.nl/

Capita Selecta Geology and Geochemistry

Vakcode	AM_1174 ()
Periode	Periode 4
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. W. van Westrenen
Examinator	prof. dr. W. van Westrenen
Lesmethode(n)	Werkcollege
Niveau	400

Doel vak
To enable students to perform an in depth literature review of a specific topic of their choice in Geology and Geochemistry research, in collaboration with one of our staff members.

Inhoud vak
The course starts with an inventory made of student interests made in collaboration with the course coordinator, after which students are coupled to a staff members. Student and staff member discuss detailed review topic, followed
by an extensive literature review culminating in a written review report at the end of the course.

Onderwijsvorm
Separate meetings planned on an individual basis between student and staff member.

Toetsvorm
A written report.

Literatuur
Extensive literature review.

Vereiste voorkennis
None.

Doelgroep
This course is suitable for both 1st and 2nd year MSc Earth Sciences students.

Catchment Response Analysis

Vakcode	AM_450003 ()
Periode	Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. ir. M.C. Westhoff
Examinator	dr. ir. M.C. Westhoff
Docent(en)	dr. ir. M.C. Westhoff
Lesmethode(n)	Werkcollege, Computerpracticum
Niveau	400

Doel vak
The objectives of the course are to provide the student with scientific theory, tools and methods for understanding and evaluating the response of a catchment to precipitation in terms of surface water flows. This requires knowledge about processes regulating the flow of water on the land surface and in river channels, the techniques for quantification of surface water flows and statistical methods for predicting extreme runoff events. In addition, experience with surface water flow modelling for predicting the behaviour of rivers under different land use or climate conditions should be acquired.

The course contributes to the Knowledge and Understanding and Application of Knowledge and Understanding final attainment levels of the Msc Hydrology Programme. Knowledge and understanding is obtained through the studying of theory as provided in the textbook, during the oral lectures and through self-study of scientific papers on rainfall-runoff response topics. Knowledge and understanding is applied in the setting up and execution of a rainfall-runoff model and the critical evaluation of the model simulation with measured data.

Inhoud vak
The course consists of three main topics. We start with runoff processes leading to stormflow. This is followed by lectures on different hydrological modelling practices, and goodness-of-fit criteria. Finally, an overview of hydrodynamic and hydraulic theory that governs flow in open channels is given as well as an overview of discharge measuring techniques.
Topics are hill slope hydrology, hydrograph analysis, statistical methods to describe and quantify spatial and temporal variation in catchment runoff and reservoir and flow routing and scaling in hydrology The spectrum of available models for runoff modelling, from classical lumped models to data-demanding distributed, physically-based hydrological models, will also be discussed. Finally, theory and understanding will be applied in a series of modelling exercises applying the HBV-light rainfall – runoff model to simulate runoff of the Dinkel River in East Netherlands.

Onderwijsvorm
The tuition consists of eleven classroom lectures and four computer modelling workshop sessions. The number of contact hours is in the order of 42.

Toetsvorm
The assessment is through a written exam (80%) and assessment of a selection of excercises and the
modelling workshop report (20%). Grades of both assessments should be at least a 5.5

Literatuur
Main Textbook:
S.L. Dingman, 2015. Physical hydrology, 3rd edition. ISBN: 978-1-4786-1118-9

Articles (provided on Canvas)

McGlynn, B. L.; McDonnel, J. J. & Brammer, D. D., A review of the evolving perceptual model of hillslope flowpaths at the Maimai

catchments, New Zealand. Journal of Hydrology , 2002, 257, 1 - 26

Blöschl, G. Wilderer, P. (Ed.). Scaling and Regionalization in Hydrology. Treatise on Water Science , Elsevier, 2011, 519 - 535

Seibert, J. & Vis, M. J. P. Teaching hydrological modeling with a user-friendly catchment-runoff-model software package. Hydrology and Earth System Sciences, 2012, 16, 3315-3325

Selection of Reader "Hydrology of catchments, rivers and deltas", TUDelft, 2016

Chapter 5 of Hydrodynamics, surface water hydraulics and catchment rainfall– runoff response analysis, by A.A.van der Griend and M.J.Waterloo, 2014

Extra optional articles:

Kirchner, J. W. Catchments as simple dynamical systems: Catchment characterization, rainfall-runoff modeling, and doing hydrology backward. Water Resources Research, 2009, 45, W02429

Vereiste voorkennis
The student should be familiar with the subjects of the BSc course Introduction to Hydrology and Climatology (AB_1074) as detailed in the Introduction to Hydrology and Climatology (2013) course reader by M.J. Waterloo, V.E.A. Post and K. Horner.

Aanbevolen voorkennis
The student should have a good background knowledge of mathematics and physics at BSc level and have basic computer skills. In addition, the student should have basic knowledge of Earth Science, as provided by the System Earth course (AB_450067).

Doelgroep
First-year M.Sc. Hydrology students, students from Earth Sciences, Earth and Economy or Natural Sciences M.Sc. programmes.

Overige informatie
The course is open for participation to students from alternative M.Sc. programmes at the VU University Amsterdam, or from other universities. If you are a professional and wish to attend this course you can also participate on a contract basis. In both cases please do contact the course coordinator to find out if you fulfill the background knowledge requirements and for enrollment procedures.

Causes and Consequences of Environmental Change

Vakcode	AM_1049 ()
Periode	Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. A.J.A. van Teeffelen
Examinator	dr. A.J.A. van Teeffelen

Docent(en)	dr. M.H. Lamoree, prof. dr. P.H. Pattberg, prof. dr. ir. P.H. Verburg, dr. ir. C.J.E. Schulp, dr. A.J.A. van Teeffelen
Lesmethode(n)	Hoorcollege, Werkgroep, Computerpracticum, Werkcollege
Niveau	400

Doel vak
To develop a common knowledge base about the causes and consequences of environmental change and about how different disciplines perceive and address environmental problems.

By the end of this course, students:
1. can classify and illustrate the diversity of environmental problems;
2. can explain key concepts from the natural and the social sciences as they apply to the analysis of environmental problems;
3. are able to analyse causality for a selection of environmental problems, using the Drivers-Pressures-States-Impacts-Responses (DPSIR) framework in particular;
4. can critically reflect on frameworks and indicators used in analysing environmental trends;
5. are able to explain the roles of the economic system and the function of policy and governance in dealing with environmental problems;
6. understand different perspectives on the causes and consequences of environmental change, including their own, and can contrast these;
7. demonstrated a capacity to collaborate in interdisciplinary teams and contribute to a shared goal.

Inhoud vak
At present, unsustainable modes of consumption and production worldwide threaten to alter core functions of the earth system. Anthropogenic climate change and the accelerating loss of biodiversity are two pressing problems that receive much media attention. However, there are many other environmental problems at scales varying from local to global. These include for example: the spatial and temporal complexity of land use change;
unforeseen effects of contaminants; human protein needs and disruption of the nitrogen cycle; and the effects of invasive species on social-ecological systems. In short, more sustainable development pathways are urgently needed. Identifying such pathways requires an interdisciplinary understanding and the involvement of numerous academic disciplines, including the natural and social sciences.

To provide such integrated understanding, this course will introduce students to one prominent analytical framework, called Drivers-Pressures-States-Impacts-Responses (DPSIR) framework. DPSIR serves to structure problems and to identify different disciplinary contributions to understanding, analysing and dealing with problems. It contributes to the disentangling of complex problems, taking into account also limits to fully understanding such problems, for example inadequate scientific knowledge, uncertainty with regards to the benefits of environmental remediation (and particularly when the costs are known), reluctance of societies to acknowledge or to deal with environmental change, or scale mismatches between a problem and its management.

DPSIR may be seen to comprise two ‘arms’: causes of environmental change Drivers, Pressures, States), and consequences of environmental change

(Impacts and Responses). Because the impacts and responses are covered in other ERM courses, notably environmental economics and environmental policy in Period 2, this course places more emphasis on causality.
Topics range from land use, fisheries, poverty, the setting of environmental standards, stakeholders, and climate change. These topics have been selected to highlight the breadth of challenges for environment and resource management, as well as to illustrate different disciplinary perspectives. The natural science perspective attempts to understand how environmental problems emerge. The economic perspective focuses on the growth debate (does economic growth increase social welfare?) and the use of economic instruments to redress the impacts of environmental change and to implement policy. The social science perspective assesses how environmental policy and governance can modify or redirect the patterns of behaviour that are common, if not inherent, in our societies.

Onderwijsvorm
The course is worth 6 ECTS credits which corresponds to 168 hours of work per student.
The course comprises two sets of activities. The first takes place in classes, where information is presented through lectures, presentations, workshops, debates, seminars etc.
The second includes assessments where student's ability to achieve the course's objectives is tested. Assessment involves a group activity (presentation and a written assignment), and the exam. Feedback opportunities are included in class activities as well as assessments.
Approximate time allocation:
• Class: 55 hours (h=20, 2=15, pra=1, pro=4)
• Reading and exam preparation: 50 hours
• Assignment: 45 hours
• Presentations: 15 hours

Toetsvorm
Type of assessment
• Group assignment (A) worth 40% of the final grade
• Written exam (E) worth 60% of the final grade (minimum grade to pass the course: 5.0). One resit possibility in December. The last grade counts as final.
• It is compulsory to attend the indicator debate and the assignment presentations.

Literatuur
The course builds on (parts of) two text books, complemented by scientific articles, which are announced in the course guide.
Ø Matson, P. Clark, W.C., Andersson, K. (2016). Pursuing sustainability – a guide to the science and practice. Princeton University Press.
Ø Harris, J.M. and Roach, B. (2014) Environmental and Natural Resource Economics: A Contemporary Approach. 3rd Edition. Chapter 9 (Lecture Population, Affluence, Technology) and Chapters 1+7 (Lecture Economic instruments). Required text for ERM Course on Environmental Economics (Period 2).

Doelgroep
The course is part of the MSc programme 'Environment and Resource Management' but open to all MSc students.

Overige informatie

The course is coordinated by Dr. Astrid van Teeffelen, and lectured by:
• Dr. Astrid van Teeffelen (astrid.van.teeffelen@vu.nl)
• Oscar Widerberg, MSc (oscar.widerberg@vu.nl)
• Dr. Harry Aiking (harry.aiking@vu.nl)
• Dr. Pieter van Beukering (pieter.van.beukering@vu.nl)
• Dr. Marja Lamoree (marja.lamoree@vu.nl)
• Prof. Dr. Philipp Pattberg (philipp.pattberg@vu.nl)
• Dr. Nynke Schulp (nynke.schulp@vu.nl)
• Prof. Dr. Peter Verburg (peter.verburg@vu.nl)

Climate Modelling

Vakcode	AM_450004 ()
Periode	Periode 3
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. D.M.V.A.P. Roche
Examinator	dr. D.M.V.A.P. Roche
Docent(en)	prof. dr. A.J. Dolman, dr. D.M.V.A.P. Roche
Lesmethode(n)	Werkcollege, Computerpracticum
Niveau	400

Doel vak
The objective of this course is to provide an overview of numerical climate models and their applications, with a focus on Earth Science studies.

Inhoud vak
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 are 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), computer practicals and 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?

Onderwijsvorm
Lectures, discussion meetings and computer exercises.

Toetsvorm
Compulsory participation in discussion meetings, computer exercises, oral presentation and written exam.

Literatuur
Text book:
Goosse, H. (2015) Climate System Dynamics and Modelling. Cambridge University Press, 358 p., ISBN 978-1-107-44583-3

Additional:
Lecture notes and selected papers (made available through Canvas).

Overige informatie
The course is open for participation to students from alternative M.Sc. programmes at the VU University Amsterdam, or from other universities. If you are a professional and wish to attend this course you can also participate on a contract basis. In both cases please do contact the course coordinator to find out if you fulfill the background knowledge requirements and for enrollment procedures.

Communication, Organization and Management

Vakcode	AM_470572 ()
Periode	Periode 2
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. E. Muniz Pereira Urias
Examinator	dr. E. Muniz Pereira Urias
Docent(en)	dr. E. Muniz Pereira Urias
Lesmethode(n)	Hoorcollege, Werkgroep
Niveau	500

Doel vak
To get acquainted with theories on organisational behaviour
To obtain a deeper understanding of communication from the perspective of sharing and influencing results
To acquire knowledge on organisational structures and designs
To get acquainted with important theories on organisational transitions and change management
To acquire insight into different management practices in the health and life sciences sector
To gain insight in leadership and interpersonal behaviour
To obtain insight in methods for motivation and conflict management
To improve communication skills
To practise analytical and advisory skills

Inhoud vak
Organisations in the health and life science sector are changing fast, a phenomenon driven by newly emerging technologies and increasing societal complexity. A growing number of students with a beta degree will hold professional and managerial functions in these organisations. During this course students will learn how to be effective performers within these environments, both individually and in teams. This requires an understanding of the macro aspects of organisational behaviour, including designing organisations, managerial skills and ways of strategic thinking. Several speakers conduct lecturers on aspects as motivation, managing interpersonal behaviour, leadership, communication

and developing and changing organisations. The speakers explain theories from literature and relate them to their practical experiences. Also, practical cases of health care companies will be analysed and discussed, resulting in advisory reports for management. With the other students you discuss your experiences and a coach helps you relate the experiences to theory.

Onderwijsvorm
Lectures: approximately 22 hours
Response lectures: 4 hours
Training workshops 16 hours
Self-study and writing project assignment: remaining hours.

Toetsvorm
Written exam (60%;) and assignment (40%). Grades of both parts must at least be 6 or higher.

Literatuur
To be announced on Canvas

Doelgroep
Compulsory course within the Master programme Management, Policy Analysis and Entrepreneurship for the Health and Life Sciences (MPA) and the Societal differentiation of Health, Life and Natural Sciences Masters programmes

Overige informatie
Attendance to training/discussions is indispensable

Lecturers:
dr. E.M.P Urias
guest lectures will be announced on Canvas

Diagenesis of Sedimentary Rocks

Vakcode	AM_450169 ()
Periode	Periode 5
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. M. Sanchez Roman
Examinator	dr. M. Sanchez Roman
Lesmethode(n)	Werkcollege, Computerpracticum, Practicum
Niveau	500

Doel vak
• To recognize the diagenetic processes and products.
• To familiarize yourself with the most common analytical techniques that are relevant for the study of the diagenetic history and the fluid flow pattern of reservoir rocks.
• To understand the link between diagenesis and rock properties.
• To gain an overview of applications of diagenetic studies in oil industry.

At the end of this course, you should be able to:
• Characterize paleoenvironments during and just after the deposition of sediments.
• Understand sedimentary basin evolution (burial, fluids circulation) through time.
• Predict quality of carbonate reservoirs.

Inhoud vak
The course will cover carbonates and their diagenetic products and is concerned primarily with the preservation potential of the main carbonate and detrital phases under marine, meteoric and burial diagenetic settings. As a consequence, the porosity evolution in sedimentary rocks will be of relevance to this course. This has both fundamental and applied aspects. The course will involve theoretical knowledge as well as case studies.

Onderwijsvorm
Classes and microscope practical

Toetsvorm
Written exam (70%) report of prcatical (30%)

Literatuur
Course notes and handout

Vereiste voorkennis
Students are expected to have bachelor-level knowledge of:
• (carbonate) sedimentology
• stable isotope geochemistry
• petroleum geology

Didactiek 1

Vakcode	O_MLDIDAC_1 ()
Periode	Periode 1
Credits	6.0
Voertaal	Nederlands
Faculteit	Fac. der Gedrags- en Bewegingswetensch.
Coördinator	C.L. Geraedts
Examinator	C.L. Geraedts
Docent(en)	drs. J.K.W. Riksen, drs. H.R. Goudsmit, drs. Y.G. Meindersma, ir. E.J.F. Scheringa, drs. I. Pauw, drs. C.D.P. van Oeveren, drs. S. Donszelmann, drs. B. Klein, dr. H.B. Westbroek, C.L. Geraedts, dr. A.A. Kaal, dr. A. Handelzalts, dr. B. de Vries, drs. A.J.C. Monquil, drs. J.B. Penninx, drs. L.A. van der Bruggen, W. Maas, drs. H. Stouthart, drs. N.H. Ypenburg, drs. E.D. van Noort, F.L. de Vries, drs. J. Quartel MA
Lesmethode(n)	Hoorcollege, Werkgroep
Niveau	400

Doel vak
De cursus Didactiek 1 is onderdeel van de eerste fase (fase I) van de Universitaire Lerarenopleiding (ULO) van de VU, en loopt parallel aan de

cursus Praktijk 1. De cursus is breed van opzet en omvat verschillende onderdelen die in samenhang worden aangeboden: algemene didactiek (AD), vakdidactiek (VD) en peergroup (PG).

Aan het eind van de cursus heeft de student de nodige basale algemeen didactische en vakdidactische bagage aan te reiken die nodig is voor het handelen als docent in simpele en overzichtelijke situaties op niveau van één les. Hierbij wordt nadrukkelijk aangesloten bij de ontwikkelingsfase waarin de docent-in-opleiding (dio) zich bevindt (zie inhoud).

Inhoud vak
De cursus is geordend rondom zogeheten kernpraktijken die fundamenteel zijn voor het beroep van docent. Bij Didactiek 1 staan de volgende kernpraktijken centraal: (1) contact maken, (2) de les starten, (3) krediet
opbouwen en uitgeven, (4) de les voorbereiden, (5) sturen en corrigeren en (6) volledige instructie geven en de les afsluiten. De reikwijdte van het
didactisch denken en handelen is in deze eerste fase meestal nog beperkt tot één les. De genoemde kernpraktijken komen expliciet aan de orde bij AD. Bij VD wordt aangesloten bij deze kernpraktijken en wordt de vertaalslag gemaakt naar het eigen (school)vak. Daarnaast worden bij VD belangrijke vakdidactische concepten en werkwijzen geïntroduceerd

Bij PG staat de eigen onderwijspraktijk van de docent-in-opleiding (dio) centraal. Concrete vragen en situaties uit de praktijk vormen aanleiding tot analyse en reflectie. Waar bij AD en VD de nadruk ligt op de rollen van de uitvoerende en ontwerpende docent en pedagoog, wordt bij PG nadrukkelijk vorm gegeven aan de rol van onderzoekende professional.

De ervaring leert dat de kernpraktijken die bij Didactiek 1 centraal staan bij de meeste dio’s uitgebreid aan de orde komen tijdens het eerste deel van de praktijkstage (Praktijk 1). Alle inhoudscomponenten uit deze cursus worden tijdens de bijeenkomsten en in verwerking verbonden met de werkplekpraktijk van de student. De dio en de werkplekbegeleider krijgen ook suggesties voor (observatie)opdrachten die kunnen bijdragen aan de ontwikkeling van de competenties die bij deze kernpraktijken horen.

Onderwijsvorm
Alle onderwijs vindt plaats op de instituutsdag (maandag). Studenten zijn de hele dag aanwezig. In de ochtend is er een hoor/werkcollege AD, waarbij dio’s van verschillende vakken samen zitten. De colleges AD worden steeds verzorgd door een tweetal docenten. In de middag is er een werkcollege VD onder begeleiding van de vakdidacticus. Deze colleges worden samen met dio’s van hetzelfde vak in verschillende samenstellingen (homogeen en heterogeen) gevolgd.

Tenslotte zijn er, verspreid over de periode, drie PG bijeenkomsten, waarbij dio’s van verschillende vakken in kleine groepen en onder begeleiding de eigen onderwijspraktijk onder de loep nemen en eventuele concerns daarbij bespreken.

Bij alle onderdelen (AD, VD en PG) wordt een actieve houding van de student gevraagd, zowel tijdens de bijeenkomsten als daarbuiten. Regelmatig worden er verwerkingsopdrachten gegeven, waar individueel of in groepsverband aan wordt gewerkt. Deze opdrachten worden formatief geëvalueerd, onder andere door middel van (peer)feedback.

Toetsvorm
Didactiek 1 wordt afgesloten met een startproef waarin de studenten demonstreren dat zij één les kunnen ontwerpen en uitvoeren en kunnen reflecteren op de manier waarop voorbereiding, uitvoering en afronding hebben plaatsgevonden. De proef bestaat uit een lesontwerp (incl. verantwoording op basis van theorie, en eigen leerdoelen bij deze les), een videocompilatie (15 min.) van de gegeven les en een terugblik op de les. Bij het ontwerpen en uitvoeren van de les staan de kernpraktijken behandeld in de colleges algemene didactiek en vakdidactiek centraal (met een focus op de les en de leerling). De terugblik op ontwerp en uitvoering vindt plaats aan de hand van de perspectieven van een docent als professional, ontwerper, uitvoerder, pedagoog en teamlid en de daarbij behorende relevante theorie. De proef wordt beoordeeld aan de hand van een beoordelingsformulier gerelateerd aan de rubrics die voor elk van de docentperspectieven zijn geformuleerd voor fase I.

Literatuur
Bij deze cursus worden de volgende algemeen didactische handboeken gebruikt:
- Ebbens, S. & Ettekoven, S. (2016). Effectief leren – basisboek. Groningen: Noordhoff Uitgevers B.V.
- Korthagen, F. & Lagerwerf, B. (2014). Een leraar van klasse. Den Haag: Boom Lemma Uitgevers
- Teitler, P. (2013). Lessen in orde. Bussum: Coutinho.
- Kohnstamm, R. (2009). Kleine ontwikkelingspsychologie: III de puberjaren. Houten: Bohn Stafleu van Loghum.

Oudere edities van bovenstaande boeken zijn over het algemeen goed bruikbaar.
Behalve van bovenstaande literatuur wordt veelvuldig gebruik gemaakt van relevante en actuele wetenschappelijke literatuur. Deze artikelen worden tijdens de cursus ter beschikking gesteld. De literatuur die bij VD gebruikt wordt is afhankelijk van het schoolvak waarvoor wordt opgeleid.

Overige informatie
Beheersing van de inhoud van het desbetreffende schoolvak wordt als voorkennis verondersteld.

Didactiek 2

Vakcode	O_MLDIDAC_2 ()
Periode	Periode 2+3
Credits	6.0
Voertaal	Nederlands
Faculteit	Fac. der Gedrags- en Bewegingswetensch.
Coördinator	drs. L.J. van Well-van Grootheest
Examinator	drs. L.J. van Well-van Grootheest

Docent(en)	drs. J.K.W. Riksen, drs. H.R. Goudsmit, drs. Y.G. Meindersma, ir. E.J.F. Scheringa, drs. I. Pauw, drs. C.D.P. van Oeveren, drs. S. Donszelmann, drs. B. Klein, dr. H.B. Westbroek, C.L. Geraedts, dr. A.A. Kaal, dr. A. Handelzalts, dr. B. de Vries, drs. A.J.C. Monquil, drs. J.B. Penninx, drs. L.A. van der Bruggen, W. Maas, drs. H. Stouthart, drs. N.H. Ypenburg, drs. E.D. van Noort, F.L. de Vries, drs. J. Quartel MA
Lesmethode(n)	Werkgroep, Hoorcollege
Niveau	400

Doel vak
De cursus Didactiek 2 is onderdeel van de tweede fase (fase II) van de Universitaire Lerarenopleiding (ULO) van de VU, en loopt parallel aan de cursus Praktijk 2. De cursus omvat verschillende onderdelen die in samenhang worden aangeboden: algemene didactiek (AD), vakdidactiek (VD) en peergroup (PG).

Aan het eind van de cursus heeft de student de nodige algemeen didactische en vakdidactische bagage aan te reiken die nodig is voor het handelen als docent waarbij op basis van bestaande lesmaterialen wordt gewerkt.
Hierbij wordt nadrukkelijk aangesloten bij de ontwikkelingsfase waarin de docent-in-opleiding (dio) zich bevindt (zie inhoud).

Inhoud vak
Didactiek 2 is geordend rondom een aantal voor het beroep van docent fundamentele kernpraktijken. Bij Didactiek 2 staan de volgende kernpraktijken centraal: (1) leerprocessen zichtbaar maken, (2) leerprocessen bevorderen, (3) leerprocessen toetsen, (4) communiceren en leiding geven, (5) leerlingen verantwoordelijkheid geven (van docentgestuurd naar leerlinggestuurd) en (6) aandacht geven aan verschillen. Ten opzichte van de cursus Didactiek 1 wordt de focus verlegd van de (individuele) les naar het leerproces van de leerling. De reikwijdte van het didactisch denken en handelen wordt daarmee ook groter: er wordt een begin gemaakt met het ontwerpen en uitvoeren van reeksen van lessen.

De genoemde kernpraktijken komen expliciet aan de orde bij AD. Bij VD wordt aangesloten bij deze kernpraktijken en wordt de vertaalslag gemaakt naar het eigen (school)vak. Daarnaast worden bij VD belangrijke vakdidactische concepten en werkwijzen geïntroduceerd.

Bij PG staat wederom de eigen onderwijspraktijk van de dio centraal. Waar bij AD en VD de nadruk ligt op de rollen van de uitvoerende en ontwerpende docent en pedagoog, wordt bij PG nadrukkelijk vorm gegeven aan de rol van reflectieve onderzoekende professional . De samenhang tussen Didactiek 2 en Praktijk 2 komt onder andere tot stand doordat de dio en de werkplekbegeleider op school suggesties krijgen voor (observatie)opdrachten die kunnen bijdragen aan de ontwikkeling van de competenties die bij deze kernpraktijken horen. Alle inhoudscomponenten uit deze cursus worden tijdens de bijeenkomsten en in verwerking verbonden met de werkplekpraktijk van de student

In de laatste weken van de cursus is nadrukkelijker ruimte voor de eigen leervragen en behoefte van de student. Er worden keuzeworkshops aangeboden rondom uiteenlopende (vak)didactische thema’s. Ook zijn er

bijeenkomsten waarin dio's die veel moeite hebben met (o.a.) klassenmanagement extra coaching kunnen krijgen of extra aandacht verdienen op het gebied van bijvoorbeeld lesontwerp.

Onderwijsvorm
Alle onderwijs vindt plaats op de instituutsdag (maandag). Studenten zijn de hele dag aanwezig. In de ochtend is er een hoor/werkcollege AD, waarbij dio's van verschillende vakken samen zitten. De colleges AD worden steeds verzorgd door een tweetal docenten. In de middag is er een werkcollege VD onder begeleiding van de vakdidacticus. Deze colleges worden samen met dio's van hetzelfde vak in verschillende samenstellingen (homogeen en heterogeen) gevolgd .

Tenslotte zijn er, verspreid over de periode, drie PG bijeenkomsten, waarbij dio's van verschillende vakken in kleine groepen en onder begeleiding de eigen onderwijspraktijk onder de loep nemen en eventuele concerns daarbij bespreken.
Bij alle onderdelen (AD, VD en PG) wordt een actieve houding van de student gevraagd, zowel tijdens de bijeenkomsten daarbuiten. Regelmatig worden er verwerkingsopdrachten gegeven, waar individueel of in groepsverband aan wordt gewerkt. Deze opdrachten worden formatief geëvalueerd, onder andere door middel van (peer)feedback.

Toetsvorm
Didactiek 2 wordt afgesloten met een geschreven basisproef waarin de studenten demonstreren dat zij een korte lessenreeks kunnen ontwerpen en (deels) uitvoeren en kunnen reflecteren op de manier waarop voorbereiding, uitvoer en afronding hebben plaatsgevonden. De proef bestaat uit een docentenhandleiding bij de lessenreeks, gebaseerd op bestaand lesmateriaal, (incl. een globale planning, twee uitgewerkte lesontwerpen, verantwoording op basis van praktijk en theorie, en eigen leerdoelen bij deze les), een videocompilatie (15 min.) van de gegeven lessen en een terugblik op
ontwerp en uitvoering. Bij het ontwerpen en uitvoeren van de les staan de kernpraktijken behandeld in de colleges algemene didactiek en vakdidactiek centraal (met een focus op de leerling en het leerproces). De terugblik op ontwerp en uitvoering vindt plaats aan de hand van de reflectiecirkel van Korthagen, de perspectieven van een docent als professional, ontwerper, uitvoerder, pedagoog en teamlid en de daarbij behorende relevante theorie. De proef wordt beoordeeld aan de hand van een beoordelingsformulier gerelateerd aan de rubrics die voor elk van de docentperspectieven zijn geformuleerd voor fase 2.

Literatuur
Bij deze cursus worden de volgende algemeen didactische handboeken gebruikt:
- Ebbens, S. & Ettekoven, S. (2016). Effectief leren – basisboek. Groningen: Noordhoff Uitgevers B.V.
- Korthagen, F. & Lagerwerf, B. (2014). Een leraar van klasse. Den Haag: Boom Lemma Uitgevers
- Teitler, P. (2013). Lessen in orde. Bussum: Coutinho.
- Kohnstamm, R. (2009). Kleine ontwikkelingspsychologie: III de puberjaren. Houten: Bohn Stafleu van Loghum.

Oudere edities van bovenstaande boeken zijn over het algemeen goed bruikbaar.

Behalve van bovenstaande literatuur wordt veelvuldig gebruik gemaakt van relevante en actuele wetenschappelijke literatuur. Deze artikelen worden

tijdens de cursus ter beschikking gesteld. De literatuur die bij VD gebruikt wordt is
afhankelijk van het schoolvak waarvoor wordt opgeleid.

Overige informatie
Beheersing van de inhoud van het desbetreffende schoolvak wordt als voorkennis verondersteld.
Voorwaardelijk voor afronding van Didactiek 2: een voldoende beoordeling van Didactiek 1.

Didactiek 3

Vakcode	O_MLDIDAC_3 ()
Periode	Periode 4+5+6
Credits	9.0
Voertaal	Nederlands
Faculteit	Fac. der Gedrags- en Bewegingswetensch.
Coördinator	dr. B. de Vries
Examinator	dr. B. de Vries
Docent(en)	drs. J.K.W. Riksen, drs. H.R. Goudsmit, drs. Y.G. Meindersma, ir. E.J.F. Scheringa, drs. I. Pauw, drs. C.D.P. van Oeveren, drs. S. Donszelmann, drs. B. Klein, drs. W. Jongejan, dr. H.B. Westbroek, C.L. Geraedts, dr. A.A. Kaal, dr. A. Handelzalts, dr. B. de Vries, drs. A.J.C. Monquil, drs. J.B. Penninx, drs. L.A. van der Bruggen, W. Maas, drs. H. Stouthart, drs. N.H. Ypenburg, drs. E.D. van Noort, drs. J. Quartel MA
Lesmethode(n)	Hoorcollege, Werkgroep
Niveau	400

Doel vak
De cursus Didactiek 3 is onderdeel van de derde en laatste fase (fase III) van de Universitaire Lerarenopleiding (ULO) van de VU, en loopt parallel aan de cursussen Praktijk 3 en POO 2. De omvang van de cursus is een heel semester.

Aan het eind van de cursus heeft de student de verdiepende pedagogische, didactische en vakdidactische bagage die nodig is voor het handelen als docent in complexe situaties. Hierbij wordt nadrukkelijk aangesloten bij de ontwikkelingsfase waarin de docent-in-opleiding (dio) zich bevindt (zie inhoud).

Inhoud vak
Het eerste blok van de cursus Didactiek 3 is weer geordend rondom een aantal voor het beroep van docent fundamentele kernpraktijken, namelijk: (1) differentiëren, (2) toetsen, (3) gedrags- en leerproblemen herkennen, (4) omgaan met gedrags- en leerproblemen, (5) mentor zijn en (6) een plek in de schoolorganisatie innemen.
De cursussen Didactiek 1 en 2 vormen samen het basisdeel van de Universitaire Lerarenopleiding (ULO); de cursus Didactiek 3 moet gezien worden als het verdiepingsdeel. In Didactiek 3 komen meer complexe thema’s en kernpraktijken aan de orde. Het (vak)didactisch denken en handelen strekt zich nu ook uit over de lange termijn: er is bijvoorbeeld uitgebreid aandacht voor het vorm geven aan leerlijnen en het omgaan met gedrags- en leerproblemen. Ook wordt de dio

nadrukkelijker uitgedaagd om een eigen visie op onderwijs vorm te geven en uit te dragen. Zo is de lesmethode niet langer leidend, maar wordt van dio's in toenemende mate verwacht zelf invulling te geven aan de inhoud en didactiek van de lessen (waarbij natuurlijk zowel bestaand als eigen materiaal kan worden gebruikt). Tenslotte zullen de (vak) didactische overwegingen die ten grondslag liggen aan de eigen visie onderbouwd moeten worden met behulp van relevante literatuur en eigen praktijkervaringen.

In het tweede blok van de cursus is er bij AD nadrukkelijk ruimte voor differentiatie en de eigen leerbehoefte van de student. Er worden verschillende keuzemodules aangeboden rondom uiteenlopende algemeen didactische thema's, zoals de multiculturele school, zorg op school, omgaan met ordeproblemen en internationalisering. Studenten worden uitgenodigd om (voor een deel) zelf invulling te geven aan deze keuzeruimte.

Onderwijsvorm
Alle onderwijs vindt plaats op de instituutsdag (maandag). Studenten zijn de hele dag aanwezig. In de ochtend is er een hoor/werkcollege AD, waarbij dio's van verschillende vakken samen zitten. De colleges AD worden steeds verzorgd door een tweetal docenten. In de middag is er een werkcollege VD onder begeleiding van de vakdidacticus. Deze colleges worden samen met dio's van hetzelfde vak in verschillende samenstellingen (homogeen en heterogeen) gevolgd .

Tenslotte zijn er, verspreid over de periode, drie PG bijeenkomsten, waarbij dio's van verschillende vakken in kleine groepen en onder begeleiding de eigen onderwijspraktijk onder de loep nemen en eventuele concerns daarbij bespreken.
Bij alle onderdelen (AD, VD en PG) wordt een actieve houding van de student gevraagd, zowel tijdens de bijeenkomsten daarbuiten. Regelmatig worden er verwerkingsopdrachten gegeven, waar individueel of in groepsverband aan wordt gewerkt. Deze opdrachten worden formatief geëvalueerd, onder andere door middel van (peer)feedback.

Toetsvorm
Didactiek 3 wordt afgesloten met een geschreven meesterproef waarin de studenten demonstreren dat zij een volle lessenreeks kunnen ontwerpen en uitvoeren en kunnen reflecteren op de manier waarop voorbereiding, uitvoer en afronding hebben plaatsgevonden. De proef bestaat uit een lessenreeks met een coherente leerlijn en expliciet gemaakte inhoudelijke en didactische keuzes. Het materiaal bevat: een lessenserie met een toets, een koppeling aan en neerslag van de (pedagogische) onderwijsvisie en visie op het vak van de student en de school, docentenhandleiding, leerlingmateriaal, evaluatie met collega's en leerlingen, een videocompilatie (15 min.) van de gegeven lessen en een terugblik op ontwerp en uitvoering. Bij het ontwerpen en uitvoeren van de les maakt de student een relevante selectie uit de kernpraktijken die tijdens de opleiding centraal hebben gestaan. De terugblik op ontwerp en uitvoering vindt plaats aan de hand van de reflectiecirkel van Korthagen, de perspectieven van een docent als professional, ontwerper, uitvoerder, pedagoog en teamlid en de daarbij behorende relevante theorie. Hierbij staat de student stil bij zijn/haar ontwikkeling op het gebied van deze rollen. De proef wordt beoordeeld aan de hand van een beoordelingsmodel gerelateerd aan de rubrics die voor elk van de docentperspectieven zijn geformuleerd voor fase 3 (een startbekwame docent).

Literatuur
Bij deze cursus worden de volgende algemeen didactische handboeken gebruikt:
- Ebbens, S. & Ettekoven, S. (2012). Effectief leren – basisboek. Groningen: Noordhoff Uitgevers B.V.
- Korthagen, F. & Lagerwerf, B. (2014). Een leraar van klasse. Den Haag: Boom Lemma Uitgevers
- Teitler, P. (2013). Lessen in orde. Bussum: Coutinho.
- Kohnstamm, R. (2014). Kleine ontwikkelingspsychologie: III de puberjaren. Houten: Bohn Stafleu van Loghum.

Daarnaast wordt veelvuldig gebruik gemaakt van relevante en actuele wetenschappelijke literatuur. Deze artikelen worden tijdens de cursus ter beschikking gesteld. De literatuur die bij VD gebruikt wordt is afhankelijk van het schoolvak waarvoor wordt opgeleid.

Overige informatie
Beheersing van de inhoud van het desbetreffende schoolvak wordt als voorkennis verondersteld.
Voorwaardelijk voor afronding van Didactiek 3: een voldoende beoordeling van Didactiek 2.

Ecohydrology

Vakcode	AM_450014 ()
Periode	Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. A.J. Dolman
Examinator	prof. dr. A.J. Dolman
Lesmethode(n)	Werkcollege, Computerpracticum
Niveau	400

Doel vak
Ecohydrology is a combination of ecology (study of how organisms interact with each other and with the natural environment) and hydrology (study of how water cycles in terrestrial environments). It focuses on the role of ecosystems in the water cycle of terrestrial landscapes. The objectives of the course is to provide understanding of the functioning of ecosystems in relation to water availability and the movement of water in terrestrial ecosystems under different climates. This ecohydrological knowledge forms the basis for supporting decisions on sustainable land use from a water resources point of view. It requires fundamental theoretical knowledge on plant physiology and on the exchange of water between the soil, vegetation and the atmosphere. As such, limitations to ecosystem functioning posed by water availability in relation to evaporation and transpiration by different plant communities is a central theme in this course. In addition, the student needs to learn basic computer programming for meteorological data processing and analysis.

Inhoud vak

This course describes and discusses basic interactions between the vegetated land surface, the atmosphere and the hydrosphere. Basic questions dealt with include: what determines the broad vegetation patterns of the world, and how do these in turn determine the ecohydrological behaviour of different vegetation types? This requires understanding of primary ecohydrological processes (rainfall and cloud water interception, transpiration, soil moisture dynamics) and feedback mechanisms between the vegetation and the atmosphere as well as insight into the measurement, data analysis and modelling of these processes. The ecohydrological aspects of Dynamic Vegetation Models (DGVMs) will be discussed. Tropical and temperate deforestation impacts on catchment hydrological functioning and climate as well as desertification processes are considered. Ecohydrological processes in boreal and tundra regions, as well as in montane cloud forests will be discussed in some detail. Emphasis throughout the course is on a combination of process understanding, interpretation of experimental results, and modelling. Finally, a computer programming workshop is included to become familiar with the basics of computer programming, meteorological data processing, analysis and rainfall interception modelling.

Onderwijsvorm
The tuition consists of nine classroom lectures, a half-day student presentation session and a computer work.

Toetsvorm
Written test on lecture notes and selected literature (65%), computer assignments (15%), and a presentation to be given on a pre-determined topic (20%).

Literatuur
Scientific papers and handouts are provided during the course via Canvas

Vereiste voorkennis
The student should be familiar with the subjects of the BSc course Introduction to Hydrology (450024) as detailed in the Introduction to Hydrology (2012) .

Aanbevolen voorkennis
The student should have a good background knowledge of mathematics and physics at BSc level and basic computer skills

Doelgroep
First-year MSc Hydrology students, students from alternative Earth Sciences, Earth and Economy or Natural Sciences MSc programmes

Overige informatie
The course is open for participation to students from alternative M.Sc. programmes at the VU University Amsterdam, or from other universities. If you are a professional and wish to attend this course you can also participate on a contract basis. In both cases please do contact the course coordinator to find out if you fulfill the background knowledge requirements and for enrollment procedures.

Economics of Climate Change

Vakcode	E_STR_ECC ()
Periode	Periode 2

Credits	6.0
Voertaal	Engels
Faculteit	School of Business and Economics
Coördinator	dr. S. Poelhekke
Examinator	dr. S. Poelhekke
Docent(en)	prof. dr. R.S.J. Tol, dr. S. Poelhekke
Lesmethode(n)	Hoorcollege
Niveau	400

Doel vak
This course focuses on climate change: one of the greatest challenges of our time. What can the science of economics teach us about its causes and potential solutions? What are the costs and benefits of climate change? Should we tax carbon, cap-and-trade emission rights, or subsidize solar and wind power? Why is it so difficult to sign environmental agreements such as 'Kyoto' and 'Paris' despite the high stakes? Does trade harm the environment? Will our industry move abroad if we take a leading role and 'go it alone'?

After having completed this course, you will know the answers to the above questions and be able to enter into the economic policy debate well informed.

Moreover, you will:
- have a deep understanding of the fundamental difficulties and complexities of environmental policy making in an international context;
- have gained insights in the economics of international agreements and international trade;
- are able to apply to theory to cases such as climate change, acidification and ozone depletion;
- have sharpened your economic analysis in the group discussions and improved your presentations skills.

Inhoud vak
The course consists of lecturers teaching the state- of- the- art, and students giving presentations on seminal papers in the literature.

The lectures cover the following topics (provisional scheme)

- Introduction: Externalities and environmental policy
- Economic impacts of climate change
- Climate change policy making: instruments and costs
- The economics of acidification and ozone depletion
- Trade the environment: pollution havens versus factor endowments
- International environmental agreements

The first eight lectures are on the economics of climate change and climate policy, and also on the problems of acidification and ozone depletion. The following subjects are analysed. What is climate change, and what are its causes and consequences? What are the economic impacts of climate change? What are the costs of emission reduction? How can emission reductions be achieved? What lessons do acidification and ozone policy hold for climate policy? What is optimal and equitable climate policy? How likely is this in reality? Are there effective and acceptable alternatives to optimal climate policy?

The last six classes are on the relationship between trade and the environment. Common wisdom is that trade is the source of many environmental problems. One of the main reasons for this is that governments are afraid that domestic environmental policies will reduce the home economy's international competitiveness and hence environmental policies are set too lax. In the first four lectures we analyze to what extent this fear is correct, both theoretically and empirically. We compare how the trade- off between international competitiveness and the environment depends on the type of pollutant (local pollutants such as PM10, or transboundary pollutants, such as SO2) as well as on the size of the domestic economy. In lectures 5 and 6 we turn to the issue of international agreements. Writing down a protocol which requires countries to reduce their emissions of CO2 or SO2 is easy (see for example the Kyoto Protocol), but what are the incentives for countries to actually join
the coalition? And what is the role of trade sanctions therein?

Toetsvorm
essay
presentations
take home exam

Literatuur
Books:
- Perman et al., Natural Resource and Environmetal Economics, Addison Wesley, 4th edition, 2011.
- Richard Tol, Climate Economics: Economic Analysis of Climate, Climate Change and Climate Policy, Edward Elgar Publishing, 29 aug. 2014 - 208 pagina's
- Copeland and Taylor, Trade and the Environment, Princeton University Press, 2003

Articles (tbd):
- Nordhaus, William D & Yang, Zili, 1996. "A Regional Dynamic General-Equilibrium Model of Alternative Climate-Change Strategies," American Economic Review, vol. 86(4), pages 741-65.
- Hoel, Michael & Shapiro, Perry, 2003. "Population mobility and transboundary environmental problems," Journal of Public Economics, Elsevier, vol. 87(5-6), pages 1013-1024, May.
- Scott Barrett, Self-Enforcing International Environmental Agreements, Oxford Economic Papers , New Series, Vol. 46, Special Issue on Environmental Economics (Oct., 1994), pp. 878-894.
- Santiago J. Rubio & Alistair Ulph, 2006. "Self-enforcing international environmental agreements revisited," Oxford Economic Papers, Oxford University Press, vol. 58(2), pages 233-263, April.
- de Zeeuw, Aart, 2008. "Dynamic effects on the stability of international environmental agreements," Journal of Environmental Economics and Management, Elsevier, vol. 55(2), pages 163-174, March.
- Levinson, Arik. 2009. "Technology, International Trade, and Pollution from US Manufacturing." American Economic Review, 99(5): 2177-92.
- Wolfgang Keller and Arik Levinson, "Pollution Abatement Costs and Foreign Direct Investment Inflows to U.S. States", The Review of Economics and Statistics, 2002, vol. 84, issue 4, pages 691-703.
- Steven Poelhekke and Frederick van der Ploeg, "Green havens and pollution havens", The World Economy, forthcoming.

Vereiste voorkennis
Microeconomics.

Ecosystem Management

Vakcode	AMU_0011 ()
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen

Inhoud vak
This is an UvA course. For the course description, please visit
http://studiegids.uva.nl/

Energy and Climate Governance

Vakcode	AM_1155 ()
Periode	Periode 3
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. P.H. Pattberg
Examinator	prof. dr. P.H. Pattberg
Docent(en)	prof. dr. P.H. Pattberg, O.E. Widerberg
Lesmethode(n)	Werkcollege, Hoorcollege
Niveau	400

Doel vak
After concluding this course, students should:

Be able to define and explain key concepts of relevance to the climate change governance and energy issue;

Understand the causes, impacts and effects of climate change and the key scientific controversies in the regime;

Be able to identify, explain and analyze the various policy options for mitigation and adaptation at different levels of governance with a specific focus on energy related options;

Be able to understand the key political challenges in the climate change regime, the common problems facing all countries, and the various and changing coalitions in the regime;

Be able to explain the long-term objective, the principles, the commitments of countries and other key elements of the Climate Change Convention, the quantified commitments of developed countries, and the flexibility mechanisms under the Kyoto Protocol;

Be able to explain the role of energy in the climate change regime, and the various aspects of policy with respect to renewable energy transition

Be able to define and explain the role of market mechanisms in the climate change regime, their advantages and disadvantages, and their potential in ad-dressing the climate change problem;

Be able to make a judgment about which principles, policy instruments and approaches are likely to be most efficient, equitable and/or effective in addressing the climate change problem, including energy policy.

Inhoud vak
Global governance of human-induced climate change, including both mitigation and adaptation, is a hotly debated subject. Current (international and transnational) climate policy is the result of a complex and long-lasting negotiation process at multiple levels of governance. In this process, the science of the complex earth and climate system is closely linked to questions on the socio-economic effects of climate change, the options for global environmental governance as determined by the structure of international organizations, international economic and political relations and environmental law.

The course includes:
an overview of the science of climate change, its impacts (IPCC Fifth Assessment Report) uncertainties, mitigation, adaptation;

discussion of climate change policy options at multiple levels of governance, including the international climate change regime, national and European policies, and transnational approaches;

analysis of the political challenges in climate change and the positions of different countries and actors;

assessment of the economics of climate change including analyzing the flexible mechanisms (Emission trading, Clean Development Mechanisms) and options for Post Kyoto measures;

analysis of the challenges for a transition to renewable energy at various scales;

the relation between global energy policy (including its geo-political aspects) and the climate change regime.

Onderwijsvorm
Seminar/‘Werkcollege’ (s)

Toetsvorm
Written examination (E), Report (R), Simulation (Sim)

Weight of each component: 40/40/20

Compensation: is it possible to compensate one component with another?
NO

Mode of re-examination for the different components: re-sit for both written exam and final and paper

Literatuur
See Course manual on Canvas

Aanbevolen voorkennis
basic knowledge of environmental policy and governance

Doelgroep
master students

Environmental Economics

Vakcode	E_STR_EEC (60442040)
Periode	Periode 4
Credits	6.0
Voertaal	Engels
Faculteit	School of Business and Economics
Coördinator	prof. dr. C. Fischer
Examinator	prof. dr. C. Fischer
Docent(en)	dr. G.C. van der Meijden
Lesmethode(n)	Hoorcollege
Niveau	400

Doel vak
The course aims to teach students why natural resource management should not be left to the free market. After following this course, students are able to characterize several types of market failure and to explain how each of these causes environmental problems, such as overexploitation of natural resources and air pollution. Moreover, students will be able to explain which policy instruments can be used by the government to tackle environmental problems that arise in a market economy. Students will also learn how to use stated and revealed preference methods to value the environment. Finally, students will be taught how renewable resources (such as forestry and fisheries), and non-renewable resources (such as fossil fuels) should optimally be exploited from a social welfare perspective and how the optimal exploitation differs from the exploitation in a market equilibrium. There is also a lecture on the economic impact of natural resources, and whether these are a curse or a blessing.

The course consists of lectures, homework assignments, tutorials, and presentation/discussion sessions. The lectures are aimed at developing a thorough understanding of key economic, environmental and ethical aspects of environmental problems, and of the link between theory, methods and empirical analysis. The goal of the homework assignments that will be discussed during the tutorials is to practice the use of modern economic methods to analyse and solve problems in the field of environmental economics. The presentation/discussion sessions are intended to improve the participants' economic reasoning and communication skills. In these sessions, students will present a journal article in class, and they are expected to participate in a group discussion afterwards.

After following this course, you:
• can explain why, and under which conditions, the free market does not result in an efficient outcome.
• are capable of showing how externalities can be 'internalized' by using market instruments, like Pigouvian taxes, quotas and tradable

permits, etc.
• are able to advise environmental policy makers on which policy instruments to use under different circumstances in order to correct the market outcome
• use stated and revealed preference methods to attach a monetary value to environmental services
• can explain how non-renewable resources like fossil fuels, are exploited in a market economy and how the exploitation differs from the optimum
• can show how renewable resources, like fishery and forestry, are exploited in a market economy and how the exploitation differs from the social optimum
• are able to describe and explain the optimal climate policy in the global economy and to explain how sub-optimal climate policies can lead to a ‘Green Paradox’, in the sense that the problem of climate change is aggravated instead of diminished upon the introduction of those policies
• are able to describe the most important interactions between the economy and the environment, and their relationship with sustainable development.
• are able to explain why resource rich countries often suffer from low rates of economic growth, and what they can do to avoid this so-called Resource Curse.
• are able to work with simple mathematical models to analyse the effects of environmental policy and to determine the time profile of renewable and non-renewable resources, both in the optimum and in the market equilibrium
• have improved your presentation and discussion skills

Inhoud vak
The following topics will be dealt with in the course:
- interaction between the economy and the environment
- environmental policy: Pigouvian taxes, quotas, and tradable emission permits
- non-renewable resource use: scarcity and market structure
- renewable resource use: fishery and forestry
- non-renewable resource use and climate change
- climate policy and the ‘Green Paradox’
- sustainable development
- welfare economics and market failures
- resource-rich economies and the ‘Resource Curse’
- theory and methods for environmental valuation
The topics for the group discussions and student presentations can be chosen by the participants. They should be based on articles published in scientific journals.

Onderwijsvorm
Lectures, assignments, student presentations, and group discussions.

Toetsvorm
Written exam (60%), assignments (30%), and presentation/participation (10%). Passing the course is conditional on the exam grade being 5.0 or higher.

Literatuur
To be announced.

Aanbevolen voorkennis
Advanced microeconomics.

Environmental Remote Sensing

Vakcode	AM_450145 ()
Periode	Periode 3
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. S.S.N. Veraverbeke
Examinator	dr. S.S.N. Veraverbeke
Docent(en)	dr. S.S.N. Veraverbeke
Lesmethode(n)	Werkcollege, Computerpracticum
Niveau	400

Doel vak
The course objectives are:
- Understanding of fundamental principles of electromagnetic radiation and remote sensing in applications focused on land, ocean and atmosphere
- Air- and spaceborne image interpretation
- Knowledge of various satellite sensor systems and data availability
- Performing image analyses using both GIS and object-oriented coding

Inhoud vak
Topics include:
- Definition of remote sensing and the electromagnetic spectrum
- Short history of remote sensing
- Fundamental radiation laws
- Variety of remote sensing technologies (RADAR, LIDAR, optical, thermal), sensor systems (polar-orbiting and geostationary), and important satellite missions
- Photogrammetry
- Geometric, atmospheric and topographic image corrections
- Principal component analysis
- Land cover mapping
- Spectral indices
- Spectral mixture analysis
- Change detection and multitemporal analysis
- Soil moisture retrievals
- Applications focused on ocean and atmosphere
- Visual image interpretation and color composites
- Digital image analysis using GIS and object-oriented coding

Onderwijsvorm
Lectures, including guest lectures, supplemented with reading materials.
Computer lab sessions.

Toetsvorm
Written exam and lab assignments.

Literatuur
Selection of scientific papers and book sections.
Chuvieco, Emilio. Fundamentals of Satellite Remote Sensing: An Environmental Approach. CRC press, 2016.
Lillesand, Thomas, Ralph W. Kiefer, and Jonathan Chipman. Remote sensing and image interpretation. John Wiley & Sons, 2015.

Aanbevolen voorkennis
Good background knowledge of mathematics and physics, and basic knowledge of GIS and object-oriented coding is recommended.

Doelgroep
First-year MSc Hydrology students and students from alternative Earth Sciences, Earth and Economy or Natural Sciences MSc programs.

Exploring Earth Processes and Resources

Vakcode	AM_450405 ()
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. A.J. Dolman
Examinator	prof. dr. A.J. Dolman
Docent(en)	prof. dr. A.J. Dolman, prof. dr. H. Doust
Lesmethode(n)	Werkcollege, Computerpracticum
Niveau	400

Doel vak
Sedimentary basins and mountain belts provide important resources to humanity, including drinking water, hydrocarbons, minerals and geothermal energy. Surface and crustal to lithospheric scale processes determine the living environment and provide benefits, through geo-resources, as well as threats imposed, for instance, by geohazards like earthquakes and they also contribute to our vulnerability to global change. Understanding of the links between the state of the Earth's surface and the main processes active therein is therefore of great importance. This course aims at
• Arming the students with phenomenological understanding of Earth surface processes at different spatial and time scales, which are needed to further understand locations and potential of economic-relevant reserves (e.g. oil, gas, but also fresh water).
• An enhanced understanding of many facets of petroleum exploration industry and its impact on society including a review of the natural requirements needed for petroleum accumulation and the concept of petroleum systems.
• An enhanced understanding of our global hydrological cycle and the vulnerability of our water resources.
At the end of the course the student should have a basic knowledge of earth system processes at different spatial and temporal scales, with special emphasis on sustainable exploration of our natural resources.

Inhoud vak

The course contains 3 parts plus a series of oral presentations given by the students. The first part deals with fast shallow surface processes and focuses on the hydrological and biogeochemical cycles. The second part deals with sedimentary processes and petroleum systems. The last part consists of practicals where the students will work on case

studies to enhance their understanding on the Earth System and how process knowledge could lead to a more sustainable exploration of our natural resources.

Onderwijsvorm
Oral lessons in the form of lectures and tutorials/seminars where various topics are presented by the lecturer and discussed in common with the students. Students must be aware that the content of this course is difficult to find in one-two textbooks. Therefore, understanding the handouts is essential. Our advice is to attend the oral lessons during class hours.

Practical lessons - The bulk of this course is made up by a number of practical exercises, including a computer practical, a paper assignment and an oral presentation. Both the paper and oral presentation will be part of the final evaluation

Toetsvorm
Written exam (50%), Scientific Paper (30 %), and oral presentation (20 %)

Literatuur
All materials will be digitally provided through Blackboard. For in-depth and further study we recommend the following literature:

Einsele, G. (2000), Sedimentary Basins: evolution, facies and sediment budget, second edition, 792 pp., Springer.

Allen, P. A. and Allen, J. R. Basin Analysis (2005): Principles and Applications, second edition, 400pp, Blackwell Publishing.

Aanbevolen voorkennis
Students are required to know the basic Earth surface processes related to hydrology, and biogeochemical cycles (i.e. Evaporation, Runoff, photosynthesis, respiration), advance basic notions of deformation (faults, deformation, plate tectonics) and sedimentary evolution (rock types, preferably basic notions of sequence stratigraphy), which were already studied during their BSc curriculum.

Doelgroep
MSc Earth Science and Economics students, MSc students from alternative Earth Sciences, Earth and Economics or Natural Sciences MSc programmes

Overige informatie
This course is cancelled

Geology & Geochemistry Field Excursion

Vakcode	AM_450229 ()
Periode	Periode 1
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. F.M. Brouwer
Examinator	dr. F.M. Brouwer
Docent(en)	dr. F.M. Brouwer

Lesmethode(n)	Veldwerk
Niveau	400

Doel vak
The aim of this course is to familiarise students with the multidisciplinary aspects of studying geological processes, using different kinds of local observations that can be synthesised to generate larger scale insights. This approach is illustrated by looking at the coupling between orogenic cores and sedimentary basins as part of the dynamic lithosphere. Another objective of the course is to orient students in tackling phenomenological observations derived from particular natural laboratories. It is the aim to make students familiar with the principles of 'problem-based learning techniques' by making field observations.

Inhoud vak
The excursion follows a transect through the Central Alps en Dolomites. The excursion addresses a range of inter-related tectonic, petrological and sedimentary processes. Students will consider these processes directly in front of the outcrops, and through presentations and extended discussion in the evening. The students learn to understand the nature, structure and evolution of the Alps and train critical thinking and communication skills in group discussions and individual presentations.

Onderwijsvorm
11 day field programme and evening sessions

Toetsvorm
Information written down in the field note books will be evaluated and their overall evaluation will be part of the grade (35%). Every student is required to present part of one field day tp the rest of the group in the evening (20%). A written examination is scheduled during the return trip or after our return to Amsterdam (35%). Active participation in the field surveys and discussions / presentations during the evening sessions (10%)

Literatuur
Excursion guide and possibly selected additional publications from the scientific literature.

Vereiste voorkennis
Participation in the compulsory programme of the Track Geology and Geochemistry of the MSc Earth Sciences and having passed 12 ec worth of courses from this programme.

Aanbevolen voorkennis
Sedimentary Basins AM_450154 and Orogenesis AM_450190.

Doelgroep
Compulsory for students in year 2 of the MSc Earth Sciences - Geology and Geochemistry.

Intekenprocedure
Admission is granted to students who took the compulsory courses of year 1 of the G&G programme in Blocks 1-3) and have earned at least 12 ec for those courses. Participants should register in time (before June 1st) using VUnet and should notify the responsible staff by e-mail.

Overige informatie
Rules concerning the deadline for subscription and having proper mountain equipment will be strictly enforced. Due to field logistics, the excursion may start a few days earlier than the official start of the academic year. The final dates will be announced as early as possible, but before June 1st.

Geothermal Energy

Vakcode	AM_450409 ()
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. M.P. Bokhorst
Examinator	dr. M.P. Bokhorst
Lesmethode(n)	Hoorcollege, Computerpracticum
Niveau	500

Doel vak
• To provide students with an overview of the current status and future outlook of geothermal exploration and production (heat/cold and electricity)
• To assess its impact in the energy-transition challenge, being a major alternative source for renewable energy.
• To provide insight into the energetical and economical aspects of different ways to supply thermal energy to buildings and processes.
• To review main categories of operational geothermal systems, the governing processes and relevant boundary conditions, linking hydrogeology to subsurface understanding
• To assess exploration concepts of geothermal prospecting and see how they can be applied to future subsurface analysis and energy supply prediction
An additional practical aim is to improve your communication and writing skills.

Inhoud vak
This course provides a comprehensive overview of existing systems that are used to supply thermal energy to buildings and/or industrial processes. The course starts with a general introduction to the history of geothermal exploration and production, what kind of geothermal systems exist, and how these are linked to particular subsurface and economical conditions. In addition it is explained what benefits of geothermal energy exist compared to other energy resources. Subsequently different aspects are explained in more detail. We will first
concentrate on the demand side, by showing how the heat and cold demand of a building can be provided by different types of energy systems and how the economical aspects of the different options relate. Later on we will focus on the hydrogeological parameters that contribute to successful geothermal systems. This is achieved through a review of several such systems, including borehole heat exchangers (closed loop systems), aquifer thermal energy storage (ATES or open loop systems) and systems for the production of deep geothermal heat for heating and/or electricity production (enhanced geothermal

systems). Special emphasis is placed on the relation of subsurface conditions and operational excellence.
During the course the students are put in the role of consultants that have to choose an optimal solution for the customer. A business case is build in which different geothermal options have to be considered and compared to a conventional solution for climate control in the buildings concerned.

Onderwijsvorm
The course uses two different methods:
Oral lessons in the form of lectures and tutorials/seminars (distributed equally) where various topics are presented by the lecturer and discussed in common with the students. Students must be aware that the content of this course is difficult to find in one-two textbooks. Therefore, understanding the handouts is essential. Our advice is to attend the oral lessons during class hours. Further students are expected to read and present material from selected papers in a short presentation and abstract.
Practical lessons: this course includes a number of practical exercises and a few case studies. Exercises and case studies will be worked out individually and in small groups and discussed in class. The rule of thumb: this is individual work, unless otherwise specifically noted.

Toetsvorm
The final mark is made up of assignments (10%), a presentation (pre), an excursion(10) (exc) and a 1-page abstract of relevant paper(s) (10%) (O) and case
studies (70%).
The practicals and case studies will cover the topics presented during the course.

Literatuur
All materials will be digitally provided through Canvas

Vereiste voorkennis
To facilitate a rapid in- depth study at MSc level, students are required to know in advance basic notions of hydrogeology (groundwater flow, impact of wells on hydraulic head) which were already studied during their BSc curriculum. Furthermore sufficient knowledge of mathematics and MS Office (Excel) is required.

Global Biogeochemical Cycles

Vakcode	AM_450332 ()
Periode	Periode 4
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. G.R. van der Werf
Examinator	prof. dr. G.R. van der Werf
Docent(en)	dr. J. van Huissteden, dr. G.M. Ganssen, prof. dr. G.R. van der Werf, prof. dr. ir. J.W. Erisman, prof. dr. G.J.A. Brummer
Lesmethode(n)	Computerpracticum, Hoorcollege
Niveau	400

Doel vak
To understand and quantify the role of biogeochemical cycles (Carbon, Nitrogen, Phosphorus, Water) in the Earth system.

Inhoud vak
The course starts with an overview of the major global biogeochemical cycles, their role in the Earth system, and how they are modified by humans. The main subject is exchange of C, N, P, and S between the soil, water, atmosphere, and biota on global and local scales in different climatic zones (tropics, temperate, boreal and arctic zone) and environments. We address the relation of biogeochemical cycles with the climate system. Each week consists of two lectures where the first one serves as an introductory lecture and the second a more in-depth view of a theme in global biogeochemical cycles. The themes include: 1) the global terrestrial carbon cycle, 2) forests, 3) the nitrogen cycle, 4) the oceanic carbon cycle, 5) oceanic cycles of N, P, and S, 6) wetlands, and 7) disturbances including deforestation and forest fires.

Onderwijsvorm
12 Lectures, assistance with essay writing

Toetsvorm
Written exam

Literatuur
W.H. Schlesinger: Biogeochemistry: An analysis of Global Change, 3th edition (Academic Press).
Lecture notes and additional literature will be made available during the course.

Doelgroep
MSc students Earth Sciences, Hydrology, Environment and Resource management

Groundwater Hydraulics

Vakcode	AM_450009 ()
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Lesmethode(n)	Werkcollege
Niveau	400

Doel vak
This course module will no longer be offered. It has been replaced by Groundwater Processes.

The student has profound knowledge and insight in the terminology and the theory of groundwater hydraulics; in particular the mathematical notion and its physical meaning. The student can apply the theory to a range of basic/classical problems using graphical and analytical solution methods and has knowledge of the limitations of applicability of the methods used.

Onderwijsvorm
The course consists of 12 working lectures of about (~ 4 hr) each. The sessions comprise the following elements: lecture, discussion of studied theory, and desk exercises. The practicing with exercises is supervised; answers to exercises are published on blackboard after each session. The remaining time (~120 hr) should be devoted to self-study including preparation study for the sessions and for the written exam.

Aanbevolen voorkennis
Successful participation requires a good background in mathematics (notably algebra, vectors, differentiation, (partial) differential equations and integral calculus) and physics (in particular dimensional analysis and working with units) at the level of the BSc course Wis- en Natuurkunde (450073). Familiarity with basic groundwater hydrology (e.g., Inleiding Hydrologie 450024 / Inleiding Hydrologie en Klimatologie AB_1074) is also recommended.

Doelgroep
Students in the Hydrology Master

Groundwater Microbiology and Geochemistry (Geomicrobiology)

Vakcode	AM_450132 ()
Periode	Ac. Jaar (september)
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	U. Nunes da Rocha
Examinator	U. Nunes da Rocha
Niveau	400

Doel vak
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 role of microorganisms in nutrient cycli
- Important microbial processes in polluted and pristine groundwater ecosystems
- The dependency of microbial presence and activity on environmental conditions
- Modern methods in microbial ecology
Students can relate the obtained knowledge to hydrology.

Inhoud vak
Theory will consist of:

Introduction to environmental microbiology:
- Microbial growth, metabolism and kinetics in relation to environmental conditions.
- Types and diversity of micro-organisms in groundwater ecosystems.
- Interactions between micro-organisms.
- Basics of molecular microbiology; overview of modern techniques in microbial ecology and biogeochemistry.

Impact of microbiological processes on hydrochemistry:
- Microbial contribution to important biogeochemical processes and nutrient cycles.
- Microbial mediated mineral dissolution and precipitation.

Degradation of organic contaminants in groundwater:
- Biodegradation, bioremediation and "natural attenuation" of pollution.

Onderwijsvorm
~90 hours of guided self-study (the student will study the book Brock Biology of Microbiology, on basis of 5 modules containing instructions and about 20 questions per module), 70 hours for essay writing. After each of
the five modules, the student and lecturer discuss the answers (~1 h per module).

Toetsvorm
Written essay (70% of final mark) on a geo-microbiological subject, linked to the interests of the student and general course content. Oral discussion on the essay and studied text (30%).

Literatuur
Michael T. Madigan, John M. Martinko, Kelly S. Bender, Daniel H. Buckley, David A. Stahl (2014), Brock biology of microorganisms, 14th edition. Pearson Higher Education. ISBN-3: 9781292018317 (about 85 euro) [you may also use the 13th edition]

Weber K.A. et al.(2006), Microorganisms pumping iron: anaerobic microbial iron oxidation and reduction. Nature Reviews in Microbiology, 4, p. 752-764.

Handout for guided self-study (via lecturer).

Intekenprocedure
The course can be started at any time during the academic year, in consultation with the coordinator

Overige informatie
This course is an elective option for master students in Hydrology. The course is also open to students in the masters Biology and Earth Sciences. Part of the content can be adapted to fit the interest and educational background of the student. Students are advised to contact the coordinator before starting.

High Resolution Archives

Vakcode	AM_450331 ()
Periode	Periode 2
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. C.J. Beets
Examinator	dr. C.J. Beets
Docent(en)	dr. C.J. Beets, dr. H.J.L. van der Lubbe MSc, dr. M. Sanchez Roman
Lesmethode(n)	Werkcollege, Computerpracticum, Hoorcollege

Niveau	400

Doel vak
• To understand global climate change at seasonal to decadal time scales
• To appreciate the different climate sensitivity of low and high latitudes
• to couple climate records from terrestrial and marine settings
• To gain overview over future climate studies and their dillemmas

At the end of this course, you should be able to:
• Interpret, and recalculate commonly used climate proxy datasets
• Critically read and question climate change publications
• Have state-of-the-art knowledge of the research field of high-resolution climate archive studies, and the challenges that lie ahead.

Inhoud vak
The course will target seasonal-decadal climate archive studies, including the climate phenomena that act on such time scales. This course focuses on various marine and terrestrial climate archives that record on (sub)decadal time scales with special emphasis on process studies and the validation of proxies. The effects of ENSO, NAO, and solar forcing of climate will be studied in various archives at high and low latitudes. Furthermore we will investigate archives that record seasonal variation at high and low latitudes.

Typical climate processes under study are:
- ENSO and NAO forcing of climate
- Solar Forcing of climate
- Atmospheric and oceanic teleconnections
- Seasonality patterns at high and low latitudes

Typical climate archives to be studied are:
- (Varved) sediments
- Ice cores
- Speleothems
- Corals
- bivalves

Onderwijsvorm
Classes, Literature discussion, and computer practicals

Toetsvorm
Literature discussion essay (50%) report of computer practical (50%)

Literatuur
Course notes and selected peer-reviewed research papers (because we aim at including state-of-the-art research papers, these will be selected by teaching staff at the start of the course)

Vereiste voorkennis
Students are expected to have bachelor-level knowledge of:
• paleoclimatology
• stable isotope geochemistry

Hydrochemistry

Vakcode	AM_450052 ()
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Lesmethode(n)	Werkcollege, Computerpracticum, Practicum
Niveau	400

Doel vak
This course module will no longer be offered. It has been replaced by Water Quality.

To acquire a qualitative and a quantitative insight in how biogeochemical processes and the geochemical composition of the subsurface determine and change the chemical composition of water during the hydrological cycle: from precipitation, via soil, and groundwater, to surface water. To be able to interpret hydrochemical data with various methods, and to apply the numerical geochemical model PHREEQC to hydrochemical problems and interpret the simulation results. To obtain basic skills in performing laboratory analyses.

Inhoud vak
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; weathering of silicates; cation exchange; surface complexation; redox-processes; effects of evaporation and mixing of different water types; introduction to geochemical modelling; lab and field analysis of inorganic solutes in water.

Onderwijsvorm
Working lectures (8x4 hours), Computer practical (4x4 hours), Lab practical (1x4 hours). Total contact hours is 52 hours.

Toetsvorm
Written examination of lecture-subjects (100%); evaluation of computer and laboratory practical reports (pass/no pass).

Literatuur
C.A.J. Appelo & D. Postma, 2005. Geochemistry, groundwater and pollution. 2nd edition; digital content distributed via blackboard: lecture slides, course manual, computer and lab practical manuals.

Vereiste voorkennis
inleiding in de anorganische geochemie (450022; BSc Earth Sciences) or course of similar level (to be decided by dr. B.M. van Breukelen).

Doelgroep
Hydrology Master students

Hydrological Systems and Water Management

Vakcode	AM_1012 ()
Credits	3.0

Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Lesmethode(n)	Werkgroep, Hoorcollege
Niveau	400

Doel vak
To provide insight into: groundwater occurrences on earth in various aquifer systems; actual and ancient recharge and discharge; methods of hydrological and hydrochemical systems analysis; groundwater monitoring and tracing; palaeogroundwater; the effects of groundwater pumping; fresh/salt relationships; and water management with emphasis on MARS (Managed Aquifer Recharge Systems), artificial recharge and river bank filtration in particular.

Inhoud vak
After introducing the concepts of porosity and permeability the hydrogeological characteristics of various regions in the world are explored, in connection with their geomorphology, lithology / sedimentology and structural geology.
Groundwater mapping techniques based on both a hydrological and hydrochemical systems analysis are presented. The dynamics in flow and chemistry of groundwater are elucidated and explained in terms of natural and man-made variations in groundwater recharge and discharge, fresh and salt water intrusion / inundation, pollution and leaching of aquifers, and climate change.
The occurrences of and how to recognize palaeogroundwater are explained. Environmental effects of groundwater pumping, like wetland degradation, land subsidence, salinization and acidification pass in review.
Methods are presented, to monitor groundwater pressure and quality, to determine the origin and age of groundwater, and to image groundwater flow using physical, chemical and isotope tracers. Various techniques are presented to manage groundwater in stressed environments. The focus is here on MARS (Managed Aquifer Recharge Systems, like artificial recharge and river bank filtration). Special attention is given to define suitable hydro(geo)logical settings for MARS and to optimize water quality improvements during aquifer passage.

Onderwijsvorm
Lectures (~24 contact hours), practical exercises (8 hours), literature study (60 hours).

Toetsvorm
Written examination (100%)

Literatuur
a) Hydrochemistry and Hydrology of the coastal dune area of the Western Netherlands. Available via Stuyfzand (25 €).
b) Syllabus (from Canvas).
c) Physical and Chemical Hydrogeology by Schwartz & Domenico (1998 or later): Available at Geo-VUsie (10% discount).

Additional reading (not obligatory)
• De Vries, J.J. 2002. Regional Hydrogeology. Course syllabus 2nd edition, ca. 167p. Available through Stuyfzand (10 €).
• Dufour, F.C. 2000. Groundwater in the Netherlands; facts and figures. NITG-TNO Delft, Ch.7-12.
• Davis & de Wiest 1966. Hydrogeology. Available in Library.

Vereiste voorkennis
450024 (Inleiding Hydrologie)

Aanbevolen voorkennis
Advice regarding previous courses taken: AB_450024: Inleiding Hydrologie.

Overige informatie
For questions regarding the course, besides ‘contact hours’, you can contact:
Prof. dr. Pieter Stuijfzand, room E-237, phone 020-5987.968 (VU) or 06-10945021 (mobile), pieter.stuyfzand@falw.vu.nl or pieter.stuyfzand@kwrwater.nl

Imaging and Assessing Landscapes

Vakcode	AM_1183 ()
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. E. Koomen
Examinator	dr. E. Koomen
Docent(en)	dr. E. Koomen
Lesmethode(n)	Hoorcollege, Computerpracticum, Excursie
Niveau	400

Doel vak
The landscape is the visible result of human interaction with its physical surroundings and this course explores various ways to map the results of this process and discusses its impact on the way people value their surroundings. The course aims to introduce methods, techniques and new developments in imaging (mapping) and assessing (evaluating) the landscape.

The course starts with an overview of GIS-based methods to map the surface of the earth. It introduces classic and novel approaches to collect spatially explicit data that help describe landscape forms and capture the way humans interact with their physical surroundings. Specific attention is paid to new ways to map human activity. This introductory part of the course enables you to understand the quality issues involved in collecting and using spatial data from a variety of traditional and novel sources. In addition you are able set up and execute a mapping exercise while applying relevant visualisation concepts.

The second part of the course elaborates on the concept of landscape and discusses various approaches to classify and value landscapes. The analysis of landscape values relates to issues such as openness, cultural history, ecology, physical geography and perception. Such valuation efforts will be applied in impact assessments of various types of spatial plans. This part of the course provides you with knowledge on different valuation methods and allows you to independently form and underpin an opinion on the value of landscapes.

Inhoud vak
The following topics are included in this course:
• Geodata capture (methods, data sources, classic cartography and novel approaches using volunteered geographical information, twitter data, mobile phone records etc.).
• Data quality (error, accuracy and consistency, quality aspects of novel data sources).
• Visualisation (cartographic principles, aggregation, scale, classification).
• Practical applications of novel data sources in imaging the landscape.
• Introduction to the landscape concept: differences between landscape, land use and land cover; examples of well-known landscapes; classification attempts in the Netherlands and abroad; recalling the Dutch historic-geographic landscapes.
• Describing the main landscape components (openness, cultural history, ecology and physical geography) and showing how these can be implemented in spatial analysis;
• Valuing landscapes: indicating differences in perspectives between, for example, experts and general public.
• Economic valuation of landscape values: introducing stated and revealed preference methods and applying these to find the value of open space.
• Impact assessments: what threatens landscapes and how can we assess impacts of, for example, road infrastructure, land consolidation and urbanisation? Showing examples of existing GIS-based applications.
• Landscape and planning: how are landscapes protected in the Netherlands and abroad?

Onderwijsvorm
The course consists of eight lectures (of two hours) and several non-supervised practical assignments. To finalise the assignments students will have to spend time in addition to the scheduled lectures and practicals. All assignments will be evaluated as part of the final assessment. In addition a one-day field trip is organised to a location near Amsterdam to show a landscape threatened by development, discuss its values and evaluate the role of policy in protecting it. Active participation to the excursion is required.

Toetsvorm
The assessment will be based on a written final examination (40%) and the average mark for the practical assignments (60%). For each of these components students should obtain a mark of 5.5 or higher.

Literatuur
The relevant literature will contain scientific papers in English that will be listed on Canvas at start of the course. These papers will be provided through (links on) Canvas.

Vereiste voorkennis
This course assumes that students have a working knowledge of GIS basics as is, for example, obtained in the Digital spatial data course offered as part of the Earth Sciences and Earth Sciences and Economics Bachelor programmes of VU. A catch-up opportunity based on distance learning can be provided for students lacking this knowledge. Please consult teaching staff prior to the course when this applies to you. You have to ensure that your GIS-knowledge is up to date before the course starts.

Aanbevolen voorkennis
Basic knowledge about the processes that shape landscapes is expected, as is some familiarity with the peculiarities of the origin of Dutch landscapes. For those lacking this, reference is made to the following books:
• Lambert, A.M. (1985) The making of the Dutch landscape: an historical geography of the Netherlands, 2nd edition, Seminar Press Ltd, London/New York; or (in Dutch)
• Barends, S. et al. (2005) Het Nederlandse landschap. Een historisch-geografische benadering. 9e druk, Matrijs, Utrecht.

Doelgroep
The course is an elective module in the Earth Sciences Master programme, but it is open to all others with an interest in the mapping and valuation of landscapes provided they possess the required knowledge listed in this course description. Note that the course is only taught with sufficient attendance (see registration procedure).

Intekenprocedure
The course will only be taught when at least seven students are willing to actively participate. So make sure you register and show up! For smaller groups an alternative educational form may be considered.

Magmatic Processes

Vakcode	AM_450189 ()
Periode	Periode 4
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. P.Z. Vroon
Examinator	dr. P.Z. Vroon
Docent(en)	dr. P.Z. Vroon, prof. dr. G.R. Davies, prof. dr. W. van Westrenen, dr. J.M. Koornneef
Lesmethode(n)	Werkcollege
Niveau	500

Doel vak
The main aim of the course is to provide an overview of the geochemical structure and evolution of the Earth’s interior. After this course you are able to (1) understand the interaction between physical and chemical processes in the Earth’s interior,(2) select geochemical tools to solve problems regarding melting and chemical evolution of the Earth’s interior, (3) understand why and how trace elements are fractionated between mantle minerals and melt,(4) describe how different mantle components evolved isotopically over time. An emphasis will be placed on improving data handling using Excel, scientific writing, oral presentation, and critical assessment.

Inhoud vak
Distribution of major and trace elements between solid and liquid phases; geochemical modeling 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 the principal geodynamic environments and their effects on magmatic processes.

Onderwijsvorm
Lectures with associated class and home work exercises; preparation of a student paper and its oral presentation, including critical interaction between staff and students. The course counts for 6 ECTS = 160 SBU which are divided between the different components of this course in the following way (1) 12 * 3 hour lectures = 108 SBU, Presentation and essay = 28 SBU, Homework exercises = 24 SBU, Total 160 SBU = 6 ECTS

Toetsvorm
The mark you obtain for this course consists of the following components:Homework exercises (20%), Paper and its presentation (40%), Written exam (40%)

Literatuur
Selected specialist literature papers include Blundy J, Wood B (1994) Nature 372, 452-454.

Blundy J, Wood B (2003) Earth and Planetary Science Letters 210, 383-397. A full list of literature required for the preparation of essays and presentation will be provided at the start of the course.

Vereiste voorkennis
The Mantle Properties in Lithosphere Development course (code AM_450156) is mandatory for the Magmatic Processes course.

Aanbevolen voorkennis
The BSc Earth Science course "Inleiding in de Anorganische Geochemie" (AB_450336) is not required, but contains a broad overview of many of the basic isotopic systems which will be discussed in the Magmatic Processes course. If you are not familiar with the contents of the BSc course "Inleiding in de Anorganische geochemie", then you should read the handouts provided on Canvas.

Doelgroep
First year MSc students in Earth Sciences

Man and Climate

Vakcode	AM_450187 ()
Periode	Periode 4
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. G.M. Ganssen
Examinator	dr. G.M. Ganssen
Docent(en)	dr. G.M. Ganssen, dr. S.J. Kluiving
Lesmethode(n)	Werkcollege
Niveau	500

Doel vak
Students are able to assess the best method(s) for any kind of climate research on both longer and shorter time scales which also implies knowledge and insight in climate research which is earth and life sciences based and climate research which is social sciences based (historical climatology). Students also learn about strategies of adaptation and resilience of past societies to climatic change in both marginal and none marginal place. Finally students learn to put into perspective present and any future climate research through study of climate research of the past half a century (IPCC-report).

Inhoud vak
How did climate during the Quaternary shape the development of Human ancestors during this time period? How have people adapted (or failed to adapt) to marginal and non-marginal environments and to climate change? How can we distinguish between natural versus anthropogenic climate change and what are Future perspectives regarding climate change? These questions lead to looking at climate change on a longer time scale, focusing on the early hominids. It also implies looking at a variety of climate research methods ranging from the natural sciences focusing on the longer time scale to historical climatology focusing at the shorter time scale. In order to be able to distinguish between the natural and anthropogenic of climate change, there is also a need to investigate strategies of adaptation of past communities to climate change, gaining insight in and understanding of their resilience and even of their perception of past climate and weather conditions.

The focus of the course is on the following theme questions:
1. How did large and abrupt climate change events interact with the development of humans and/or hominids from the Pleistocene to the Holocene? Assess the complex reciprocal relationship between human societies and climate. Analyse relation of ‘spikes’ in climate records with archaeological and historical events.

2. How can we distinguish between natural and anthropogenic climate change? What are future perspectives regarding climate change? Investigate adaptation strategies of past communities to climate change. Gain insight in understanding of human’s resilience and perception of past climate.

3. What is the Anthropocene and when does it start? Explore the Anthropocene concept: adaptation or resilience of past societies to climate change? Analyse major transition phases from archaeological and historical sources in relation to trends of geological proxies.

4. How can we reconstruct climate variations from man’s records retrieved in archaeology, ancient studies and historical geography? Apply combined earth and social science methodologies in climate research. Analyse different spatial and temporal examples in European and Middle-Eastern landscapes.

Onderwijsvorm
Seminars and study group (20 h), reading literature and preparation of research case (44 h), preparing for the exam (20 h)

Toetsvorm
Student presentation of research case (60%), Written exam (40%)

Literatuur
Differs per instructor and will be made available on Canvas.

Mantle Properties

Vakcode	AM_1211 ()
Periode	Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. W. van Westrenen
Examinator	prof. dr. W. van Westrenen
Lesmethode(n)	Hoorcollege, Werkcollege
Niveau	400

Doel vak
Our main aim in this course is to make you appreciate that heat and its transport provide a fundamental link between processes near the Earth's surface (subduction, orogenesis, rifting, dynamic topography), and processes in the deeper parts of the Earth (including initial differentiation, convection and partial melting). An additional practical aim of this course is to start improving your communication and writing skills.

Inhoud vak
In this course we will (1) Provide you with an up-to-date overview of what seismology, petrology, and mineral physics tell us about the properties of and processes in the Earth's interior; (2) Clarify the links between heat, pressure, mineral properties, density variations, and observations including the composition of the Earth's core, seismic structure of the mantle, dynamic topography, and melt compositions, in part by having you perform a series of hands-on exercises. (3) Improve your presentation skills by having you prepare a presentation and attend a dedicated feedback session.

Onderwijsvorm
The course consists of eight half-day lectures that may include exercises, one separate exercise session, one seminar session, and one feedback session

Toetsvorm
The final mark you are given for this course consists of the following components: (1) Presentation (20%); 1-page abstract (10%); Assignments (20%); Written exam (50%)

Literatuur
Literature references that are required background reading will be provided on Canvas at the start of the course.

Vereiste voorkennis
Students should have a basic understanding of global geophysics, mineralogy and petrology, as presented for example in the textbook of Klein and Philpotts (Earth Materials)

Doelgroep
Geology and Geochemistry specialization Year 1 students

Master Thesis Earth Sciences and Economics

Vakcode	AM_1150 ()
Periode	Periode 3+4+5+6
Credits	24.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. M.P. Bokhorst
Examinator	dr. M.P. Bokhorst
Niveau	500

Doel vak
Writing the masterthesis in the MSc-program Earth Sciences and Economics. The student learns to show (s)he is able to write a proposal, collect and interpret literature, collect own data and write a discussion in a relevant topic combining Earth Sciences and Economics.

Inhoud vak
Finding a thesis topic and doing research independently.

Onderwijsvorm
There are no lectures. Only a presentation session at the end or in the second half of the thesis period.

Toetsvorm
Master theis sreport is graded by a first supervisor and a second assessor. Both must be researchers or teachers on a relevant topic at VU University. Presentations graded by the coordinator.

Literatuur
Relevant literature found by the student and first supervisor.

Vereiste voorkennis
The full first year program of Earth Sciences and Economics

Aanbevolen voorkennis
All other subjects in the program of Earth Sciences and Economics

Doelgroep
Second year students in the MSc Earth Sciences, spec. ES&E

Intekenprocedure
First, select a first supervisor at VU and discuss a topic. If the student has no supervisor or topic yet, inform the subjects coordinator for a strategy to find one. Second, find a second assessor. Third, write a proposal. The research must contain at least 25-75% or 75-25% Earth Sciences vs. Economics.
Fourth, fill out an agreement form, provided by the coordinator. Let both first supervisor and second assessor sign and finally the coordinator. Fifth, now you can start the research.

Overige informatie
The thesis must be written in English, unless agreed differently with the coordinator BEFORE THE START of the research.
The thesis may be extended only via the examination board for a very good research, and only if agreed BEFORE THE START of the project.
The thesis may contain an internship. The external supervisor may only advise the first supervisor at VU and may not replace him/her.
Internships must be discussed with the coordinator BEFORE THE START of the project.All other subjects in the program of Earth Sciences and Economics

Master Thesis Earth Surface Processes, Climate and Records

Vakcode	AM_1147 ()
Periode	Ac. Jaar (september)
Credits	24.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. C.J. Beets
Examinator	dr. C.J. Beets
Niveau	600

Doel vak
Learning to prepare and conduct a research project, or to successfully fulfill a work placement/traineeship in trade, industry, government or otherwise; and to write a scientific report at the academic Master's level. In practical conduct, working methods, attitude, collaboration, writing and other communication the student should demonstrate his or her:
- advanced knowledge and understanding of the field, thus providing a basis or opportunity for originality in developing and applying ideas;
- problem solving abilities in new or unfamiliar environments within broader contexts;
- ability to integrate knowledge and to handle complexity;
ability to clearly communicate conclusions, and the knowledge and rationale underpinning these, to specialist and non-specialist audiences.

Inhoud vak
Research project or work placement (traineeship) in the master's specialization Earth Surface Processes; with a volume of 24 EC (16 weeks) and related master thesis report. Next to this you need to attend 4 MSc presentations and give one yourself.

Onderwijsvorm
Research project or work placement/traineeship.

Toetsvorm
Written report/thesis, research methodology, attitude and presentation

Aanbevolen voorkennis
The Research project Earth Surface Processes AM_1149 should be completed before the start of the thesis.

Overige informatie
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 or research project. This agreement should be put forward to secretary of the Examination Board 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 EC 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 website.The Research project Earth Surface Processes AM_1149 should be completed before the start of the thesis.

Master Thesis Geology and Geochemistry

Vakcode	AM_1186 ()
Periode	Ac. Jaar (september)
Credits	27.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. W. van Westrenen
Niveau	600

Doel vak
Learning to prepare and conduct a research project, or to successfully fulfil a work placement/traineeship in trade, industry, government or otherwise; and to write a scientific report thereof at the academic Master's level. In practical conduct, working methods, attitude, collaboration, writing and other communication the student should demonstrate his or her:
- advanced knowledge and understanding of the field, thus providing a basis or opportunity for originality in developing and applying ideas;
- problem solving abilities in new or unfamiliar environments within broader contexts;
- ability to integrate knowledge and to handle complexity;
- ability to clearly communicate conclusions, and the knowledge and rationale underpinning these, to specialist and non-specialist audiences.

Inhoud vak
Research project or work placement (traineeship) in the master's specialisation Geology and Geochemistry with a volume of 27 EC (18 weeks) and related master thesis report.

Onderwijsvorm
Research project or work placement/traineeship.

Toetsvorm
Written report and oral presentation

Vereiste voorkennis
This course is only accessible to students who:
- have earned their bachelor's degree

have earned at least 36 EC in the master specialisation programme concerned, as registered by the student administration on March 1st. Otherwise, admission is possible only when granted by the Examination Board.

Overige informatie
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 or research project. This agreement should be put forward to the master co-ordinator (Prof dr W. van Westrenen) 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 EC.
Information on Master thesis projects is provided by department staff and is made available on the departmental pages of the Faculty website.

Metamorphism and P-T Evolution

Vakcode	AM_450176 ()
Periode	Periode 4
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. F.M. Brouwer
Examinator	dr. F.M. Brouwer
Docent(en)	prof. dr. J.R. Wijbrans, dr. F.M. Brouwer
Lesmethode(n)	Werkcollege
Niveau	500

Doel vak
Gain a 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. This approach will be the basis for critically assessing PTt paths and; hence deriving the implications for geodynamic processes preserved in metamorphic rocks. Learning the basics of phase equilibrium modelling using Thermocalc, TheriakDomino and/or Perple_X. Expand skills in optical microscopy as applied to metamorphic rocks.

Inhoud vak
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. Diffusion mechanisms and the concept of closure temperature as pertaining to geochronology of metamorphic processes. Critical assessment of PTt- data. Relation between PTt- paths and geodynamic processes.

Onderwijsvorm

Lectures with associated class- and homework and tutorial seminars. Three 15- to 30-minute written tests to help keep track of your progress. Practicals: microscopy, chemographic analysis, calculation of phase equilibria, geothermobarometric calculations, online assignment closure temperature. Individual poster presentation with an accompanying 'elevator pitch' on a selected subject.
Contact hours: 12 half-day classes made up of lectures and practical exercises. One half day class of student presentations and one written examination (2.5 hours).

Toetsvorm
All practical assignments must be completed; together they make up 30% of the final mark. The three written tests together count for 5% of the final mark. The poster and presentation each make up 12.5% of the final mark whilst the remaining 40% is for the written examination.

Literatuur
Textbook: Winter (2010) An introduction to igneous and metamorphic petrology, 2nd ed., Prentice Hall.
Some chapters from Bucher & Grapes (2011) Petrogenesis of metamorphic rocks, 8th ed., Springer, which may be copied from the teacher or the library.
Papers to be used as background reading for lectures will be listed on the Canvas-site at the start of the course. The list of papers that serve as topics for the presentations is made available in the first week of the course.

Doelgroep
First year MSc Earth Sciences students in the geology & Geochemistry track; second year students are very welcome to take this course as well. Together with Magmatic Processes this course forms a comprehensive preparation for research and master thesis projects in the hard rock geology / petrology / geochemistry subdisciplines.

Overige informatie
This course fits well within the lithosphere orientation of Geology & Geochemistry, together with courses like Magmatic Processes, Advanced Inorganic Geochemistry and Advanced Geochronology. It builds on Mantle Properties and Orogenesis, as well as courses in petrology, chemistry and tectonics at the BSc level.

Modern Climate and Geo-ecosystems

Vakcode	AM_1124 ()
Periode	Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. G.M. Ganssen
Examinator	dr. G.M. Ganssen
Docent(en)	dr. G.M. Ganssen
Lesmethode(n)	Werkcollege, Hoorcollege
Niveau	400

Doel vak
In the first part the course gives an introduction of modern atmospheric and oceanic processes which form an important basics for the reconstruction of the climate of the past. Next to important basic parameters which trigger the modern circulation of both spheres, atmosphere and oceans, the main circulation paterns will be discussed together with the implications for the global climate.
In the second part the modern ocean changes and their implications for the geoecosystems will be discussed. Together, this will form the basic understanding of processes which govern changes in the geological past.

Inhoud vak
-the basic parameters and properties for atmospheric and ocean processes leading to the formation and circulation of air and water masses
- characterization of climatic regions of the world from the poles to the tropics
- special features of the climate systems like the monsoon, ENSO and NAO systems
- the effect of ocean changes on geoecosystems now and in the recent past

Onderwijsvorm
Lectures and workshops, literature reading, oral and written presentations by the students and discussing the results and quality of the presentation

Toetsvorm
Written exam after week 2 about the basics (50% of the grade)
oral and written presentation of a topic (second part of the course, 50% of the grade)

Literatuur
Lecture notes (powerpoints of the presentations by the teacher), selected papers and Ruddiman, W.F., 2013. Earth's Climate: past and future.W.H. Freeman and Company New York.

Vereiste voorkennis
Some basic knowledge of the climate system, interest in climate change

Doelgroep
Students from the geo and environmental study areas

Intekenprocedure
Subscription via BB

Orogenesis

Vakcode	AM_450190 ()
Periode	Periode 3
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. J.R. Wijbrans
Examinator	prof. dr. J.R. Wijbrans

Docent(en)	prof. dr. J.R. Wijbrans, dr. F.M. Brouwer, dr. W.P. Schellart MSc
Lesmethode(n)	Werkcollege, Computerpracticum, Onderwijs
Niveau	400

Doel vak
Students attending this course will gain knowledge and understanding about mountain building processes (subduction, accretion, collision), their consequences (metamorphism, syn- orogenic magmatism, and sedimentary basin formation, etc.), and the methods constraining those processes such as microscopic analysis, thermochronology or numerical modelling.
Mutual relationships and feed- back relations of orogenic processes in space and time are illustrated for different segments of orogens ranging from the external to the core zones.
Furthermore, students will develop skills (1) to analyse, compare and explain distinct features of orogenic structures, (2) to apply numerical modelling as a tool to tackle orogenic processes quantitatively, and to (3) critically assess and discuss relevant literature as well as numerical modelling results.

Inhoud vak
Key aspects of mountain building are discussed in the context of natural examples like the Alpine mountain chain in Europe and in across-disciplinary manner.
Specific topics are:
- The anatomy, tectonic development, and thermal evolution of convergent continental margins, subduction and continental collision zones;
- Deformation, metamorphism and magmatism in axial zones;
- PTt- paths: observation, interpretation and numerical modeling;
- The interaction between orogens and sedimentary basins in internal and external zones of orogens;
- The late stage evolution of orogens: modes of syn- orogenic extension, orogenic collapse, and exhumation mechanisms;
- Real-world examples; European Alps, Andes, Himalaya.

The skills to use the acquired knowledge will be obtained using a case study of one orogen (from microscopic observation to the techniques required to constrain the T- t histories of various domains).

Onderwijsvorm
tuition Lectures (9 * 3 u 45 min), computer practical (4 * 3 hrs 45min), assignments /self-study (12 * 3 hrs)

Toetsvorm
Exam (50%), Reports (20%), Essay – presentation – poster (20%)

Literatuur
The course will be based on chapters from:
- "Geodynamics of the Lithosphere", 2nd ed. Kurt Stüwe, Springer 2007.
- "An introduction to igneous and metamorphic petrology", 2nd ed., Winter, Prentice Hall 2010. (available through GeoVUsie)
- Global Tectonics, 3rd ed., P. Kearey and F. Vine, Blackwell 2008.
- Orogenesis, 1st edition, M.R.W. Johnson, S.L. Harley, Cambridge 2012.

Selection literature for individual essay and presentation projects to be announced on Canvas.

Vereiste voorkennis
BSc Geology

Aanbevolen voorkennis
Petrology, structural geology, tectonics courses at the BSc level.

Doelgroep
1st year MSc Earth Science Solid Earths

Peergroup fase 1

Vakcode	O_MLPEERGR_1 ()
Periode	Periode 1+2+3
Credits	0.0
Voertaal	Nederlands
Faculteit	Fac. der Gedrags- en Bewegingswetensch.
Coördinator	drs. I. Pauw
Examinator	dr. A. Handelzalts
Lesmethode(n)	Werkgroep
Niveau	400

Doel vak
In de peergroup staat de rol als ‘professional’ centraal. Studenten leren de regie te nemen over hun eigen leerproces en hun visie op onderwijs te beschrijven. Ze ontwikkelen een professionele identiteit, waarin ze de eisen die het beroep van docent aan ze stelt verbinden met eigen waarden en motieven. In peergroups reflecteren studenten op hun handelen in de praktijk, leiden daaruit ontwikkelpunten af, formuleren acties en evalueren deze. Verschillende instrumenten en methodes worden gebruikt (logboek, reflectiecirkel, intervisie, videoreflectie, etc.) om de student in staat te stellen de complexiteit van de onderwijspraktijk te doorgronden en hiervan te leren.

Peergroup Fase 2

Vakcode	O_MLPEERGR_2 ()
Periode	Periode 3+4+5
Credits	0.0
Voertaal	Nederlands
Faculteit	Fac. der Gedrags- en Bewegingswetensch.
Coördinator	dr. A. Handelzalts
Examinator	dr. A. Handelzalts
Lesmethode(n)	Werkgroep

Doel vak
In de peergroup staat de rol als ‘professional’ centraal. Studenten leren de regie te nemen over hun eigen leerproces en hun visie op onderwijs te beschrijven. Ze ontwikkelen een professionele identiteit, waarin ze de eisen die het beroep van docent aan ze stelt verbinden met eigen waarden en motieven. In peergroups reflecteren studenten op hun handelen in de praktijk, leiden daaruit ontwikkelpunten af, formuleren

acties en evalueren deze. Verschillende instrumenten en methodes worden gebruikt (logboek, reflectiecirkel, intervisie, videoreflectie, etc.) om de student in staat te stellen de complexiteit van de onderwijspraktijk te doorgronden en hiervan te leren.

Petroleum Geology of the North Sea

Vakcode	AM_450317 ()
Periode	Periode 2
Credits	7.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. W. van Westrenen
Examinator	prof. dr. W. van Westrenen
Docent(en)	prof. dr. J. de Jager
Lesmethode(n)	Hoorcollege
Niveau	500

Doel vak
The objective of this course is to give students a detailed understanding of the geology of the wider North Sea area and Northwest European petroleum provinces as an excellent example of a very rich and varied petroleum province. The course will provide an in-depth and comprehensive review of the many aspects of exploration and development as they are applied to one of the World's classic and most important petroleum provinces about which much detailed information is available. It provides excellent examples of how petroleum systems work and how oil and gas are trapped in a range of different settings spanning a considerable period of the geological time scale. Emphasis is placed on the impact of the geological history the occurrence and distribution of hydrocarbons.

Inhoud vak
Different lecturers from Utrecht University and Vrije Universiteit Amsterdam will address the many aspects of the petroleum geology of the wider North Sea area, including the Norwegian Atlantic margin. Several staff actively working in the petroleum industry will present aspects of the petroleum geology of the North Sea from their practical perspectives.
The course will start with a regional overview of the geological development of the area. In this module, the geology, structural setting and basin fill through time of the North Sea will be discussed. The aspects of the geological development of the North Sea relevant to the presence and distribution of hydrocarbons, such as traps, reservoirs, seal and source rocks will be highlighted. The multiple reservoir levels developed in the area and their properties and characteristics will be reviewed in some detail. Attention will be paid, through reference to several example fields, to many of the practical problems faced by exploration and development geologists in evaluating the uncertainties related to volume and productivity evaluation. The petroleum fields of the area will be placed in their petroleum system context and an analysis of the
"plays" (families of similar fields) present will be proposed and presented for discussion and review by the students. Several specific aspects of the geology of the wider North Sea area, such as structural

inversion, halokinesis and overpressure development, will be presented and their impact on the petroleum geology will be discussed.
A field Study-trip to S.W. England is part of the course. During this short trip, students will be shown outcrops of many of the most important source and reservoir formations of the area, as well as some of the structural styles represented. This will provide an opportunity to experience the 3-dimensional geometry of the rock types first-hand.

Onderwijsvorm
Lectures, project work, student presentation, and field study.

Toetsvorm
Evaluation of project work, student presentation and written examination.

Literatuur
The lecturers will make extensive literature lists available.

Vereiste voorkennis
This course is only accessible to MSc students.

Overige informatie
Lecturer: Dr. João Trabucho (Utrecht University)

Petroleum Systems and Regional Geology

Vakcode	AM_450179 ()
Periode	Periode 1
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. W. van Westrenen
Examinator	prof. dr. W. van Westrenen
Docent(en)	prof. dr. H. Doust
Lesmethode(n)	Werkcollege
Niveau	400

Doel vak
1) To give students a good understanding of the geological concepts that control the occurrence of petroleum (oil and gas) accumulations.
2) To review some of the world's main geological settings with significant petroleum resources, and to pick out the main lessons they provide.
4) To review the concepts of petroleum systems and plays and see how they relate to sedimentary basin evolution.
5) To study how these concepts can be applied to subsurface analysis for prediction of as of yet undiscovered oil and gas fields (exploration) and for production of petroleum resources.
6) To provide students with a good idea of worldwide impact of petroleum (oil and gas) exploration and production and what it means to society.

Inhoud vak
This course reviews a number of issues, technical and otherwise, that impact on exploration for hydrocarbons worldwide. Emphasis is placed on the need to be able to study subsurface issues from the most regional to

the most local and to integrate data and concepts from all sorts of different disciplines. The main objective of the course is to teach students to appreciate the overall application of basin studies to the evaluation of petroleum resources. The strong link between basin tectonics and stratigraphy at all scales, as well as the importance of taking an integrated view through developing regional geologic skills are emphasized.

The course commences with a general introduction to what hydrocarbons are, what they are used for and discusses current and expected future supply and demand scenarios. This part of the course is directed towards an appreciation of petroleum exploration in its societal and management context, making a link to important and controversial issues facing global development. Much of the course deals with the geological parameters that contribute to some of the most important and successful petroleum systems in the world. Different geological settings with rich petroleum resources will be discussed such as: deltaic settings, rift basins, epeiric platform areas, carbonate reef settings, deep-water fold belts, etc. Specific examples from these settings will be presented from petroleum provinces around the globe: Middle East, Asia-Pacific, Southern Atlantic, North Sea, etc. Several exercises will be included based on data from these areas. Other issues discussed include the tools and technologies applied in exploration and how exploration is carried out in practice. The concepts of risk and volume assessment as applied in Petroleum Industry for undrilled potential petroleum fields will be introduced with examples and exercises. The course also includes an introduction to important elements of oil and gas field development, as well as a module on so-called Unconventional Gas (Shale Gas, Basin Centre Gas and Coalbed Methane).

Onderwijsvorm
Lectures, practical examples worked by students.

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

Literatuur
Syllabus can be obtained from the lecturer (dr. Hemmo Bosscher from SHELL). Powerpoint presentation
material is posted on Canvas.

Overige informatie
This course is followed jointly by MSc Earth Science students from Utrecht University and Vrije Universiteit Amsterdam. The course is taught by Dr. Hemmo Bosscher (SHELL).
Students are carried on a rollercoaster 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.

Petroleum Systems for Earth and Economics

Vakcode	AM_450408 ()
Credits	6.0
Voertaal	Engels

Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. W. van Westrenen
Examinator	prof. dr. W. van Westrenen
Lesmethode(n)	Computerpracticum, Hoorcollege
Niveau	400

Doel vak

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 coupled lithosphere-basin modelling techniques for prospect prediction
To review the concepts of petroleum systems and plays and see how they can be applied to future subsurface analysis and energy supply prediction
To review integrated techno-economic performance assessment techniques for hydrocarbon exploration and production both on asset and portfolio level

Inhoud vak

This course reviews a number of issues, technical and otherwise, that impact on exploration for hydrocarbons worldwide. Emphasis is placed on the need to be able to study subsurface issues from the most regional to the most local and to integrate data and concepts from all sorts of different disciplines.
The main objective of the course, is to teach students to appreciate the overall application of basin studies to management of petroleum resource evaluation, The strong link between basin tectonics and stratigraphy at all scales, as well as the importance of taking an integrated view through developing regional geologic skills are emphasized.
The course commences with a general introduction to what hydrocarbons are, what they are used for and discusses current and expected future supply and demand scenarios. This part of the course is directed towards an appreciation of petroleum exploration in its societal and management context, making a link to important and controversial issues facing global development.
Much of the course deals with the geological parameters that contribute to some of the most important and successful petroleum systems in the world - this is achieved through a review of several such systems, defined by geography and theme. Special emphasis is placed on rift basins, the Middle East, the North Sea, the Far East, and Latin America. Other issues discussed include technologies applied in exploration and how exploration is carried out in practice (including legal aspects).
For selected case studies the petroleum systems performance will be assessed on prospect level using novel coupled lithosphere and basin modelling techniques allowing to predict new opportunities in mature and frontier basin exploration.
The course closes with a review of important elements of oil and gas field development. It includes a review of best practices and methodologies to develop assets under high geological uncertainty. Practical exercises are used demonstrate ways to optimise performance

of development.

Onderwijsvorm
Lectures, practical examples worked by students, videos (if time)

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

Literatuur
Syllabus can be obtained from the lecturer. Powerpoint presentation material is posted on Blackboard.
For in-depth and further study we recommend the following literature: Allen, P. A. and Allen, J. R. Basin Analysis (2005): Principles and Applications, second edition, 400pp, Blackwell Publishing.

Vereiste voorkennis
To facilitate a rapid in- depth study at MSc level, students are required to know in advance basic notions of deformation (faults, deformation, plate tectonics) and sedimentary evolution (rock types, preferably basic notions of sequence stratigraphy), which were already studied during their BSc curriculum.

Overige informatie
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!

Petrophysics and Reservoir Engineering

Vakcode	AM_1212 ()
Periode	Periode 2
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. P.J.F. Verbeek
Examinator	dr. P.J.F. Verbeek
Docent(en)	dr. P.J.F. Verbeek
Lesmethode(n)	Hoorcollege, Werkcollege, Computerpracticum
Niveau	500

Doel vak
To understand
- The main principles of Petrophysics relevant for Geologists, including the acquisition and use of petrophysical data, the analysis and how results are used in static (geological) and dynamic subsurface models.
- The main principles and use of Reservoir Engineering data, and the role of Reservoir Engineering in order to arrive at economically meaningful reservoir fluid models constrained by realistic geological model(s).
- The most important terms and some of the basic formulae used by Petrophysicists and Reservoir Engineers.
- When to contact a Petrophysical and Reservoir Engineering expert.

Inhoud vak
Petrophysics involves assessing rock and fluid properties and their uncertainties from a collection of measurements done on core and log data, acquired in new and existing boreholes. Techniques have been developed mainly to optimise the development of hydrocarbon assets but may also be applied elsewhere, to determine properties of water bearing formations e.g. in the search for water or mining.

The Reservoir Engineering discipline aims to determine the (dynamic) flow characteristics of a fluid reservoir; measurements usually consist of observations of the pressures and production volumes from a well or a series of Wells often as a function of time. Reservoir Engineers usually control how fluids are produced from a reservoir. They also contribute to the calculation of required production facilities. In the Petroleum Industry, Reservoir Engineering is responsible for (and spends most time on) the identification and quantification of economically producible oil and gas volumes and the determination of the reserve.

A reservoir model used by Reservoir Engineering is usually based on a geological model of the subsurface. Geologists need a good understanding what geological information is important to the Reservoir Engineer. In later phases of the lifetime of a producing reservoir, the reservoir may exhibit deviation from the expected fluid flow behaviour, as a result of detailed geological complexities. This is another moment when the cooperation between geologist and Reservoir Engineer is essential in order to obtain an improved combined geological and fluid flow model.

Onderwijsvorm
A four-week course “Petrophysics and Reservoir Engineering for Geologists” in the afternoons. The exact timing of the course will be such that it interferes least with other courses. The course will be hosted by the course coördinator and consists of a series of lectures by guest lecturers and course coordinator plus Petrophysical Exercise A/B which is done by teams of 2 students on a workstation, under supervision.

Toetsvorm
Students will sit a written Examination (theory) for Petrophysics and Reservoir Engineering. In addition, for Petrophysics, students will need to deliver a Report on Exercises A and B.

Literatuur
Handouts via Canvas. Reports and Literature, to be distributed.

Vereiste voorkennis
Bachelor degree. One of the following: Introduction to Geology; Environmental Science; System Earth; Energy; Climate and Sustainability; or Permission of the Coordinator.

Aanbevolen voorkennis
Besides knowledge on geology, this course will use the knowledge on (arithmetics and) mathematics as received during the bachelor education.

Doelgroep
Those students that are interested in evaluation of the subsurface e.g. in geothermal energy, CO2 Sequestration or in the oil/gas industry. The

course targets mainly Geology students, but may also be useful to those interested in environmental topics.

Uitleg in Blackboard/Canvas
The (Long) name of this course is "Subsurface Engineering for Geologists / Petrophysics and Reservoir Engineering for Geologists"

Overige informatie
After the course, the student will
- Have an understanding of petrophysical data acquisition methods and measurement types including the underlying physics.
- Be able to assess basic quality of data and recognise inconsistencies, more generally, when to call in a petrophysical expert.
- Have seen examples of the effects of normal and thrust faults on logs.
- Be able to recognize lithology from log data.
- Be able to perform a basic evaluation of reservoir properties like porosity, permeability and fluid saturation from a combination of core, log and drilling data.
- Be able to assemble a simple petrophysical data acquisition request for typical carbonate and siliciclastic environments.
- Have an understanding of capillarity, water saturation profiles and models and free water levels, and the role in subsurface modelling.
- Have an understanding of how petrophysical results are used in static models, and what common pitfalls are, in particular in the upscaling from log scale to model cell scale.
- Know the basics of generating synthetic seismograms.
- Know the the principal tasks of a Reservoir Engineer
- Know the basic building blocks for dynamic modelling of fluid flow in a reservoir
- Understand Reservoir Engineering terms, concepts and basic formulae - Be aware of fluid Recovery Mechanisms and Recovery Factor
- Be aware of basics of Hydrocarbon Reserves Management
- Be aware of Production analysis, prediction and optimisation
- Have seen some (semi-) analytical Reservoir Engineering methods
- Have seen examples of Dynamic (3D) reservoir simulation/modelling
- Have an understanding of the most important uncertainties in Petrophysical and Reservoir Engineering data and modelling, in the methods and in the results.

Planetary Science

Vakcode	AM_450273 ()
Periode	Periode 1+2
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. W. van Westrenen
Examinator	prof. dr. W. van Westrenen
Docent(en)	dr. P.Z. Vroon, prof. dr. G.R. Davies, prof. dr. W. van Westrenen, prof. dr. B.H. Foing
Lesmethode(n)	Werkcollege
Niveau	500

Doel vak
The main aim of this course is to provide an in-depth overview of state-of-the-art knowledge about the formation and evolution of the large and small bodies in our solar system. This overview serves to compare and contrast processes that are important on Earth with processes active on other planetary bodies.

Inhoud vak
A series of lectures will examine the bodies that make up our solar system, how they formed and differentiated and over what timescale they were
geologically active. The role of
water in shaping both internal and external structures of planetary bodies will be examined. The course will include discussion of recent advances in
astrobiology and exoplanetary science. The course will conclude with a visit to ESTEC where there will be presentations to and from ESTEC staff.

Onderwijsvorm
Lectures plus a day long visit to ESTEC where each student will make a critical review of a recent planetary science paper and groups will present a Space mission concept developed during the course. The course counts for 6 EC = 160 SBU, which are divided between the different components of this course in the following way (1) 14 * 3 hour lectures = 115 SBU, (2) Background reading and preparation of ESTEC presentations = 36 SBU (3) Excursion to ESTEC = 9 SBU, total 160 SBU = 6 EC

Toetsvorm
The final mark for this course consists of the following components: Written exam (60%), Individual poster and presentation at ESTEC (20%), Group poster and presentation at ESTEC (20%).

Literatuur
Recommended background literature: Peter Bond – Exploring the solar system.
The text book is augmented with recent scientific papers that will be made available at the start of the
course.

Aanbevolen voorkennis
Background in geology / geochemistry is recommended but not required

Overige informatie
Guest lectures may be provided by Dr. Inge Loes ten Kate (Utrecht University), dr. Arie van den Berg (Vrije Universiteit), dr. Bert Vermeersen (TU Delft), Prof. Carsten Dominik (UvA) and dr. Daphne Stam (TU Delft)

Practical: Paleoclimate Change and Environmental Impacts

Vakcode	AM_1144 ()
Periode	Periode 4
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen

Coördinator	dr. M.A. Prins
Examinator	dr. M.A. Prins
Docent(en)	dr. M.A. Prins
Lesmethode(n)	Lezing, Practicum, Werkgroep, Excursie

Doel vak
- To provide hands-on experience with the most relevant methods used in paleoclimate/paleoenvironmental research.
- To assess new data in the context of previous (published) studies.
- To introduce the basics of scientific reporting.

Inhoud vak
The practical comprises a series of lectures, lab classes, discussion meetings, concluded by a series of meetings during which the obtained results will be written up in a research report. During the practical a marine and/or a terrestrial sediment core/section will be investigated. The research includes core description, defining sampling strategy, basic sample processing, determination of micropaleontological, palynological, geochemical and geophysical sediment properties, and data analysis. The emphasis will be on both long-term climate change (glacial-interglacial time scale) and on millennial-scale climate change records (e.g., Heinrich events, deglaciation). Participation in lectures, laboratory work, oral presentations and discussion meetings are compulsory.

Onderwijsvorm
- An introductory lecture will highlight the outline of the practical course.
- Lectures on palynology, marine micropaleontology, sedimentology and applied methods.
- Students will be motivated to present and discuss the obtained results during a series of discussion meetings.
- Laboratory work, data analysis, preparation of presentations.
- Self-tuition.

Toetsvorm
- Laboratory work (25 %)
- Oral presentations and participation in discussion meetings (25 %)
- Written report (50 %)

Literatuur
A course manual and list of selected literature (book chapters, articles) will be made available via Canvas.

Aanbevolen voorkennis
A recommended requirement is that students have followed the following master courses (period 1 and 2):
- Modern Climate and Geoecosystems (AM_1143)
- Sedimentary Environments and Climate Archives (AM_450330)
- From Source to Sink (AM_450146)
- High Resolution Archives (AM_450331)

Doelgroep
Master students Earth Sciences

Overige informatie

A recommended requirement is that students have followed the following master courses (period 1 and 2):
- Modern Climate and Geoecosystems (AM_1143)
- Sedimentary Environments and Climate Archives (AM_450330)
- From Source to Sink (AM_450146)
- High Resolution Archives (AM_450331)

Praktijk 1

Vakcode	O_MLPRAK_1 ()
Periode	Periode 1
Credits	6.0
Voertaal	Nederlands
Faculteit	Fac. der Gedrags- en Bewegingswetensch.
Coördinator	drs. Y.G. Meindersma
Examinator	drs. Y.G. Meindersma
Docent(en)	drs. J.K.W. Riksen, drs. H.R. Goudsmit, drs. Y.G. Meindersma, drs. I. Pauw, drs. C.D.P. van Oeveren, drs. S. Donszelmann, dr. H.B. Westbroek, C.L. Geraedts, dr. A.A. Kaal, dr. A. Handelzalts, drs. A.J.C. Monquil, drs. J.B. Penninx, drs. L.A. van der Bruggen, W. Maas, drs. H. Stouthart, drs. N.H. Ypenburg, drs. E.D. van Noort, F.L. de Vries, drs. J. Quartel MA
Lesmethode(n)	Werkgroep
Niveau	400

Inhoud vak
Op de school wordt de aandacht op dezelfde kernpraktijken gericht als gedurende de instituutsopleiding. De werkplekbegeleider is op de hoogte van de onderwerpen die op de instituutdag gebruikt worden en gebruikt dezelfde rubric als de instituutsopleiders en vakdidactici om de vorderingen van de studenten te beoordelen.

Onderwijsvorm
Onder begeleiding van de werkplekbegeleider nemen de studenten steeds een groter en actiever aandeel in het lesgeven en werken in de school. Studenten met een baan (zij-instromers, onderwijstrainees etc) geven in dit stadium al zelfstandig les. Bij deze studenten is de nadruk bij de begeleiding vanuit de werkplekbegeleider op het niveau van didactische handelen in de les.

Toetsvorm
Op de school geven de studenten een presentatie over hun prestaties in de eerste acht weken. Dat doen ze aan de hand van de relevante rollen (vier van de vijf waarbij uitvoerder, ontwerper en pedagoog de meeste aandacht krijgen bij de reflectie op het lesgeven). De werkplekbegeleider gebruikt de rubric om het functioneren van de studenten in de klas te evalueren.

Praktijk 2

Vakcode	O_MLPRAK_2 ()
Periode	Periode 2+3
Credits	9.0

Voertaal	Nederlands
Faculteit	Fac. der Gedrags- en Bewegingswetensch.
Coördinator	dr. A. Handelzalts
Examinator	drs. Y.G. Meindersma
Docent(en)	drs. J.K.W. Riksen, drs. H.R. Goudsmit, drs. Y.G. Meindersma, ir. E.J.F. Scheringa, drs. C.D.P. van Oeveren, drs. S. Donszelmann, dr. H.B. Westbroek, C.L. Geraedts, dr. A.A. Kaal, dr. A. Handelzalts, drs. A.J.C. Monquil, drs. J.B. Penninx, drs. L.A. van der Bruggen, W. Maas, drs. H. Stouthart, drs. N.H. Ypenburg, drs. E.D. van Noort, F.L. de Vries, drs. J. Quartel MA
Lesmethode(n)	Werkgroep
Niveau	400

Inhoud vak
Tijdens de praktijkstage werken studenten aan het verder ontwikkelen van de kernpraktijken die in het instituutsdeel aan de orde zijn gekomen.
Net als in fase 1 komt de verbinding tussen theorie en praktijk aan de orde. Op de werkplek wordt de aandacht op dezelfde vaardigheden gericht als tijdens de instituutsopleiding. Dit betekent dat studenten, samen met hun werkplekbegeleider, gericht werken aan de verschillende thema's besproken in de (vak)didactiekcolleges van Didactiek 1 en 2.

Onderwijsvorm
Onder begeleiding van de werkplekbegeleider nemen de studenten steeds een groter en actiever aandeel in het lesgeven en werken in de school.

Toetsvorm
De praktijkbeoordeling wordt uitgevoerd door de vakdidacticus/instituutsopleider en de werkplekbegeleider aan de hand van het eerste lesbezoek en de ingevulde rubric.

Overige informatie
Voorwaardelijk voor afronding van Praktijk 2: een voldoende beoordeling van Praktijk 1 en Didactiek 1.

Praktijk 3

Vakcode	O_MLPRAK_3 ()
Periode	Periode 4+5+6
Credits	15.0
Voertaal	Nederlands
Faculteit	Fac. der Gedrags- en Bewegingswetensch.
Coördinator	drs. Y.G. Meindersma
Examinator	drs. Y.G. Meindersma
Docent(en)	drs. J.K.W. Riksen, drs. H.R. Goudsmit, drs. Y.G. Meindersma, drs. I. Pauw, drs. C.D.P. van Oeveren, drs. S. Donszelmann, dr. H.B. Westbroek, C.L. Geraedts, dr. A.A. Kaal, dr. A. Handelzalts, drs. A.J.C. Monquil, drs. J.B. Penninx, W. Maas, drs. H. Stouthart, drs. N.H. Ypenburg, drs. E.D. van Noort
Niveau	400

Inhoud vak
In het verdiepingsdeel gaat de student meer en meer zelf(standig) lesgeven. De voorbereiding en evaluatie wordt samen met de werkplekbegeleider gedaan. Op de werkplek komen dezelfde onderwerpen aan de orde als in het instituut: vakdidactische verdieping van onderwijsconcepten en –strategieën, aandacht voor het afstemmen van onderwijs op de behoeften van individuele leerlingen, diversiteit en excellentie.

Op de werkplek wordt de aandacht op dezelfde vaardigheden gericht als tijdens de instituutsopleiding. Dit betekent dat studenten, samen met hun werkplekbegeleider, gericht werken aan de verschillende thema's besproken in de vakdidactiekdidactiek en de keuze modules. Het instituut biedt hiervoor concrete handreikingen aan in de vorm van een stageplan (gekoppeld aan de rubric).

Onderwijsvorm
Onder begeleiding van de werkplekbegeleider nemen de studenten steeds een groter en actiever aandeel in het lesgeven en werken in de school.

Toetsvorm
Voor de beoordeling van Praktijk 3 maakt de student in blok 6 een afspraak met zijn WPB en SO voor een afrondend lesbezoek. In overleg met de WPB en SO bepaalt de student welke klas hiervoor het meest geschikt is.
Na afloop van het lesbezoek blikken WPB en SO met de student terug op de les. WPB en SO beoordelen de les aan de hand van de checklist (rubric). Gecombineerd met het oordeel van vakdidacticus aan de hand van de tweede lesbezoek wordt een cijfer vastgesteld.

Overige informatie
Voorwaarden voor afronding van Praktijk 3: een voldoende beoordeling van Praktijk 2 en Didactiek 2.

Praktijk 3 voor 2-jarige Master

Vakcode	O_M2PRAK3 ()
Credits	15.0
Faculteit	Fac. der Gedrags- en Bewegingswetensch.
Coördinator	dr. A. Handelzalts
Examinator	dr. A. Handelzalts
Niveau	400

Inhoud vak
In het verdiepingsdeel gaat de student meer en meer zelf(standig) lesgeven. De voorbereiding en evaluatie wordt samen met de werkplekbegeleider gedaan. Op de werkplek komen dezelfde onderwerpen aan de orde als in het instituut: vakdidactische verdieping van onderwijsconcepten en –strategieën, aandacht voor het afstemmen van onderwijs op de behoeften van individuele leerlingen, diversiteit en excellentie.

Op de werkplek wordt de aandacht op dezelfde vaardigheden gericht als tijdens de instituutsopleiding. Dit betekent dat studenten, samen met hun werkplekbegeleider, gericht werken aan de verschillende thema's

besproken in de vakdidactiekdidactiek en de keuze modules. Het instituut biedt hiervoor concrete handreikingen aan in de vorm van een stageplan (gekoppeld aan de rubric).

Onderwijsvorm
Onder begeleiding van de werkplekbegeleider nemen de studenten steeds een groter en actiever aandeel in het lesgeven en werken in de school.

Toetsvorm
Voor de beoordeling van Praktijk 3 maakt de student in blok 6 een afspraak met zijn WPB en SO voor een afrondend lesbezoek. In overleg met de WPB en SO bepaalt de student welke klas hiervoor het meest geschikt is.
Na afloop van het lesbezoek blikken WPB en SO met de student terug op de les. WPB en SO beoordelen de les aan de hand van de checklist (rubric). Gecombineerd met het oordeel van vakdidacticus aan de hand van de tweede lesbezoek wordt een cijfer vastgesteld.

Overige informatie
Voorwaarden voor afronding van Praktijk 3: een voldoende beoordeling van Praktijk 2 en Didactiek 2.

Praktijkonderzoek 1

Vakcode	O_MLPROZ_1 ()
Periode	Periode 3
Credits	3.0
Voertaal	Nederlands
Faculteit	Fac. der Gedrags- en Bewegingswetensch.
Coördinator	dr. H.B. Westbroek
Examinator	dr. H.B. Westbroek
Docent(en)	drs. J.K.W. Riksen, dr. J.M.H. Swennen, drs. H.R. Goudsmit, drs. Y.G. Meindersma, ir. E.J.F. Scheringa, prof. dr. M. Meeter, drs. I. Pauw, drs. C.D.P. van Oeveren, drs. S. Donszelmann, drs. B. Klein, drs. W. Jongejan, drs. L.J. van Well-van Grootheest, dr. T. Bosma, dr. H.B. Westbroek, C.L. Geraedts, dr. A.A. Kaal, dr. A. Handelzalts, dr. B. de Vries, drs. A.J.C. Monquil, drs. J.B. Penninx, drs. L.A. van der Bruggen, W. Maas, drs. H. Stouthart, drs. N.H. Ypenburg, drs. E.D. van Noort, drs. J. Quartel MA
Lesmethode(n)	Werkgroep, Hoorcollege
Niveau	400

Doel vak
Tijdens praktijkonderzoek 1 en 2 vullen studenten de tijdens hun master opgedane onderzoeksvaardigheden aan met onderzoeksvaardigheden voor de eigen onderwijspraktijk.

Inhoud vak
In praktijkonderzoek 1 richt de opdracht zich primair op het leren herkennen, waarderen en gebruiken van verschillen type bronnen (praktijkbronnen, vakliteratuur en wetenschappelijke literatuur) om praktijkproblemen te analyseren en te duiden. Studenten krijgen handvatten aangereikt om bronnen te zoeken en te

beoordelen op kwaliteit en bruikbaarheid voor de (eigen) praktijk.

Onderwijsvorm
De begeleiding vindt plaats op het instituut en bestaat uit de volgende vormen: college en werkcolleges.

Toetsvorm
Praktijkonderzoek 1 wordt afgesloten met een onderbouwd advies voor de (eigen) praktijk

Literatuur
Relevante en actuele artikelen over verschillende kernpraktijken die in fase 1 en 2 aan de orde zijn geweest. De artikelen worden beschikbaar gesteld, en zelf opgezocht

Overige informatie
Binnen Didactiek 1 en 2 hebben de studenten kennisgemaakt met het toepassen van relevante bronnen, waaronder onderzoeksartikelen, om praktijksituaties te duiden.

Praktijkonderzoek 2

Vakcode	O_MLPROZ_2 ()
Periode	Periode 4+5+6
Credits	6.0
Voertaal	Nederlands
Faculteit	Fac. der Gedrags- en Bewegingswetensch.
Coördinator	dr. H.B. Westbroek
Examinator	dr. H.B. Westbroek
Docent(en)	drs. J.K.W. Riksen, dr. J.M.H. Swennen, drs. H.R. Goudsmit, drs. Y.G. Meindersma, ir. E.J.F. Scheringa, prof. dr. M. Meeter, drs. I. Pauw, drs. C.D.P. van Oeveren, drs. S. Donszelmann, drs. B. Klein, drs. W. Jongejan, drs. L.J. van Well-van Grootheest, dr. T. Bosma, dr. H.B. Westbroek, C.L. Geraedts, dr. A.A. Kaal, dr. A. Handelzalts, dr. B. de Vries, drs. A.J.C. Monquil, drs. J.B. Penninx, drs. L.A. van der Bruggen, W. Maas, drs. H. Stouthart, drs. N.H. Ypenburg, drs. E.D. van Noort
Lesmethode(n)	Hoorcollege, Werkcollege
Niveau	400

Doel vak
Tijdens het praktijkonderzoek vullen studenten de tijdens hun master opgedane onderzoeksvaardigheden aan met onderzoeksvaardigheden voor de eigen onderwijspraktijk.

Inhoud vak
In Praktijkonderzoek 2 worden onderzoeksvragen uit de onderwijspraktijk vertaald in empirisch onderzoek. De student analyseert data uit de onderwijspraktijk om een antwoord te vinden op de onderzoeksvraag en rapporteert de bevindingen in een onderzoeksverslag en een presentatie aan de collega’s in de school en aan mede-studenten op het instituut. Er wordt met name aandacht besteed aan de aard en doelen van praktijkonderzoek, en consequenties die dit heeft voor kwaliteitseisen en de betekenis van praktijkonderzoek voor de beroepspraktijk.

Onderwijsvorm
De begeleiding vindt plaats op school (academische opleidingsschool) en op het instituut en bestaat uit de volgende vormen: colleges, werkcolleges, duo-begeleiding (VO docent/ULO docent).

Toetsvorm
Praktijkonderzoek 2 wordt afgesloten met een verslag en een posterpresentatie over hun bevindingen en ze delen hun bevindingen zowel op het instituut als op school.

Literatuur
- Van der Donk, C., & Van Lanen, B. (2012). Praktijkonderzoek in de school. 2de druk. Coutinho, Bussum. ISBN 9789046903001
- Relevante en actuele artikelen over het onderzoeksonderwerp (via Canvas en zelf verzamelen).

Vereiste voorkennis
Vereiste voorkennis: Praktijkonderzoek 1 en onderzoekservaring op masterniveau in het eigen domeinvak.

Precambrian Geology

Vakcode	AM_450164 ()
Periode	Periode 4
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. J.R. Wijbrans
Examinator	prof. dr. J.R. Wijbrans
Docent(en)	prof. dr. J.R. Wijbrans, dr. P.Z. Vroon
Lesmethode(n)	Werkcollege
Niveau	500

Doel vak
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 summarize the Precambrian Geology in a general and interdisciplinary manner covering the evolution of the lithosphere, the hydrosphere, the atmosphere and the biosphere.

Inhoud vak
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).

Onderwijsvorm
Lectures (8 * 3 u 45 min), assignments /self-study (8 * 2 hrs).

Toetsvorm

Essay – presentation – poster

Literatuur
H.R. Rollinson, Early Earth Systems A Geochemical Approach, Wiley Blackwell, 1st edition 296 pp. Selection literature for individual essay and presentation projects to be announced on Canvas.

Vereiste voorkennis
BSc Geology

Aanbevolen voorkennis
Petrology, sedimentology, structural geology courses.at the BSc level.

Doelgroep
2nd year MSc Earth Sciences.

Overige informatie
Guest teachers include
prof. Dr. R. Hengeveld (emeritus professor Animal Ecology, VU University),
dr. P.Mason (Utrecht University).Petrology, sedimentology, structural geology courses.at the BSc level.
dr. A. Kloppenburg, 4D-Geo, The Hague
dr. L. Kriegsman, Naturalis, Leiden

Project Environmental Impact Assessment

Vakcode	AM_450406 ()
Periode	Periode 3
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. M.P. Bokhorst
Examinator	dr. M.P. Bokhorst
Lesmethode(n)	Werkcollege, Computerpracticum, Excursie
Niveau	400

Doel vak
After successfully completing this course the student:
• Is able to apply geographical information systems and multicriteria analysis to a real-life case study;
• Obtained project management skills;
• Has a good overview of the tasks, roles and activities of specialists working at consultancy firms and commercial research organizations;
• Knows the important do’s and don’ts for making tenders;
• Can write a research report that is client-oriented and scientifically sound.

Inhoud vak
In this course students will experience how commercial consultancy firms operate. They organize their work in projects. During the course the students have to deal with all relevant aspects of working in projects: writing a tender (including cost estimation, time schedules), managing a project (task divisions, communication, time writing, sending bills),

data management, analysis, reporting, presenting. There will be introducing lectures, workshops, an excursion to the Vondelpark and opportunities to get advice.

Onderwijsvorm
Students carry out an Environmental impact assessment in a group of about six. By definition, Environmental Impact Assessments (EIAs) have an important spatial component. Most relevant steps of the EIA must be taken, including the problem definition, choosing the relevant alternatives (including the zero alternative and the most environmentally friendly alternative), gathering data for an effects table, setting up maps, ranking alternatives and writing a report. The case study will deal with the Vondelpark's drainage system.

Toetsvorm
Students will be assessed on specific assignments: writing a tender (in couples), process management (in groups of 5-7 students), the environmental impact assessment report and presentation .
Details about the assignment are in the study manual.The students will be assessd.

Literatuur
Vondelpark. (2011, March 6). In Wikipedia, The Free Encyclopedia. Retrieved 11:02, March 11, 2011, from http://en.wikipedia.org/w/index.php?title=Vondelpark&oldid=417414362
An introductory text about the study area.
Van Herwijnen, and Janssen, R. (2004) Software support for multi-criteria decision making. In Sustainable Management of Water Resources: an integrated approach. Giupponi C., Jakeman T., & Kasserberg D., (eds.), Edward Elgar, Cheltenham. Available from Google Books.
An introductory text about DEFINITE.
Janssen, R. (2001). On the use of multi-criteria analysis in environmental impact assessment in the Netherlands. Journal of multi-criteria decision analysis, vol. 10, no. 2, pp. 101-109.
Use of multi-criteria analysis in practice. Selection of alternatives and evaluation criteria. Application issues and pitfalls.
Van Drunen, M., R. Janssen and N Groenendijk (2001). Interactive tutorial evaluation methods. IVM/Vrije Universiteit, Amsterdam, Universiteit Twente, Enschede.
This is a tutorial that can be run from any computer using Windows Explorer. Go to: http://www.ivm.vu.nl/en/projects/Projects/spatial-analysis/DEFINITE/index.asp scroll down to Tutorial. Read the instructions. Click on: DEFINITE tutorials, Download and unzip the files. Run: Evaluationmethods 1 UK.exe. This tutorial teaches you the basics of multicriteria analysis (and cost-benefit analysis). If you are short on time you could do lessons 1-5 and 11 only.

Vereiste voorkennis
Students must have followed Empirical Methods for Spatial Policy (AM_450401) and Assessing the Landscape (AM_450404).

Overige informatie
lecturer:
Wouter Wuite MSc

Reflection Seismic for Geologists

Vakcode	AM_450170 ()

Periode	Periode 4
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. P.J.F. Verbeek
Examinator	dr. P.J.F. Verbeek
Lesmethode(n)	Werkcollege, Computerpracticum
Niveau	400

Doel vak
Understanding the fundamentals and limitations of the application of reflection seismic to describe geology in the subsurface at depths of 200 m - 6 km.
This includes,
- Seismic Sequence Stratigraphic interpretation
- Seismic Stuctural interpretation
- Seismic Acquisition and processing principles and potential problem areas
- Calibration with petrophysical information/synthetic seismogrammes and potential problems
- Time Depth Conversion methods
- Modern Techniques, Volume interpretation, Use of Special Attributes
- Examples/Special Case studies (4D time lapse, use of Seismic inversion)
In an extensive workstation Exercise (A/B), the theory will be applied to a real 3D dataset, using an industry interpretation software package. The Exercise part of the course is done by Teams. Teamwork is essential in this type of work and will also be gauged during the assessment.

Inhoud vak
Assuming a basic knowledge of the principles of reflection seismology, this course provides a modular programme with hands-on experience on interpreting seismic 3D data and integrating data from well logs, principles and interpretation of reflection seismic data and geology. Special attention will be paid to pitfalls in data acquisition, processing and interpretation. During the course standard methodologies will be applied used in hydrocarbon exploration and development in the industry.
The course consists of,
- Introduction to seismics. The introduction will cover the technical and methodological principles of reflection seismology. Note that this section will built on already existing Applied Geophysics course knowledge; special emphasis will be on the recognition of processing errors and distinguishing them from geological information contained in the seismic images.
- Structural interpretation. Students will learn how to interpret basic geological features, such as strata relationships, faults and folds as well as the reliability of seismic interpretation at various scales;
- Seismic Sequence Stratigraphy entails the extraction of stratigraphic, sedimentological and basin evolution information from seismic data. This information can be used in exploration and basin analysis to derive regional
analysis of sedimentary basin-fills in order to construct models for gross lithology prediction (Students should review the principles of sequence stratigraphy, acquired during their BSc courses);

- Interpretation on workstation. Students work on a case study using standard workstation methodologies and learn how to handle, visualize and interpret 2D and 3D seismic data using a standard industrial software package;
- Advanced seismic interpretation This section will show examples of recently developed techniques in 3D seismic information analysis

Onderwijsvorm
The course uses two different methods:
- Oral lessons, where the lecturer presents various topics. Students must be aware that the content of this course is difficult to find in textbooks. Therefore, understanding the handouts is essential. Our advice is to attend all oral lessons. The exam will test the theoretical knowledge and contributes 50% to the final score.
- Practical Exercise A/B. The practicals are done in Teams. Attendance of the practicals is compulsory. By the end of the course, students present the team results in an oral presentation as well as in a report. The results from the presentation and report contribute the remaining 50% to the final score.

Toetsvorm
The final mark is made up by 50% from the results of the exam which will cover the topics presented during course.
The Report on the practical exercises (A/B) should be handed in at the end of the course. Together with the oral presentation, it contributes another 50 % to the final result. Reports must be handed in immediately before or after the oral presentation.

Literatuur
All materials will be digitally provided through Canvas.

Overige informatie
Teaching staff: John Verbeek plus guest lecturers

Reflective Practice Internship Science Communication

Vakcode	AM_1163 ()
Periode	Ac. Jaar (september)
Credits	30.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. J.F.H. Kupper
Niveau	600

Doel vak
The internship is a compulsory part of the Master's programme. The aims of the internship are:
• Learn to independently apply and expand your practical science communication skills in one particular area of the field (writing, multi-media, facilitation, policy and strategy development, content design, etc.).
• Critical self-assessment and reflection on acquired science communication competencies in the field.
• Conduct scientific research independently: assess scientific information, design a research project, apply scientific methods, collect data, report and discuss findings.

• Present and discuss about internship and research outcomes.
• Learn to cooperate with researchers and practitioners of various disciplines.
• Gain an impression of a potential future field of career.

Inhoud vak
When you are enrolled in the VU Science Communication specialization or the UvA Major Science Communication you need to conduct one internship (30 ECTS, 5 months). One of the two possible formats is the Reflective Practice Internship (RPI). The complete and up-to-date information about the internship can be found in the SC internship guide line on Canvas (science communication community).

Onderwijsvorm
Work-based placement

Toetsvorm
Written report and oral presentation.
Within six weeks after the start of the master internship, an interim evaluation will take place to assess whether there is a reasonable chance of the placement being brought to a successful completion.
The internship is supervised and assessed by two lecturers. Both lecturers are members of the academic staff at VU University Amsterdam. The day-to-day supervision can be carried out by a trainee research assistant (AIO), postdoc or researcher.

Doelgroep
Students MSc Earth science year 2

Overige informatie
Participation in this compulsory component is only permitted if the student meets the relevant requirements for admission. These requirements are detailed in the Internship guidelines of Earth science (on
Canvas) and in the Academic and Examination Regulations.
The work-based placement is subject to the FALW document: “Student placement (internship) and literature regulations”. These regulations require detailed written agreements between supervisors and student that specify the conditions for the Master research project. This agreement should be sent for approval by the science communication co-ordinator at least two weeks before the planned start of the work-based placement. If the proposal is of sufficient quality, you can start your internship. If not, you’ll need to adapt your proposal and send it for approval again. You can only start your internship after your research design has been approved.
The placement may be extended by 6 EC, subject to conditions that can be found in the FALW document “Student placement (internship) and literature regulations”. The student must send a request for extension to the Earth science Examination Board.
Information on Master internships is made available on Canvas.

Regional and Urban Economics

Vakcode	E_STR_RUE (60442140)
Periode	Periode 2
Credits	6.0
Voertaal	Engels

Faculteit	School of Business and Economics
Coördinator	prof. dr. H.L.F. de Groot
Examinator	prof. dr. H.L.F. de Groot
Docent(en)	prof. dr. H.L.F. de Groot, prof. dr. J. Rouwendal
Lesmethode(n)	Hoorcollege
Niveau	400

Doel vak
The aim of this course is to provide students with an advanced introduction in the field of regional and urban economics. Students learn the theoretical and empirical methods applied in the field, and get a good understanding of the fundamental questions that are addressed in the field and the current state of affairs in the literature. They are trained to critically read and properly understand contributions in the leading journals in the field. At a more specific level, after having taken this course, students have a good understanding of the New Economic Geography Model, are familiar with the theoretical foundations of agglomeration economies and their empirical relevance, understand the theoretical foundations of and can apply spatial interaction modelling, are familiar with regional growth theories, understand the function of regional labour and housing markets, and have a good understanding of the determinants of urban structures.

Inhoud vak
This course covers advanced topics in theoretical and empirical research on regional and urban economics. Key issues are location and potential reasons for clustering of economic activity, spatial interaction (migration, trade, FDI and commuting), patterns of regional economic convergence and divergence, the role of geographic factors in explaining regional economic growth performance, the impact of (spatial) externalities of knowledge production, urban size and growth, urban land use, housing markets and the functioning of regional labour markets. The topics are addressed from a theoretical as well as an empirical perspective.

Onderwijsvorm
Lectures and Tutorials

Toetsvorm
Written exam (70 percent; individual assessment) and Assignments (30 percent; group assessment). A minimum grade of 5.0 for the exam is required.

Literatuur
• Brakman, S., J.H. Garretsen and C. van Marrewijk (2009): The New Introduction to Geographical Economics, Cambridge University Press, Cambridge.
• Ciccone, A. and R.E. Hall (1996): ‘Productivity and the Density of Economic Activity’, American Economic Review, 86, pp. 54-70.
• Gallup, J.L., J.D. Sachs and A.D. Mellinger (1999): ‘Geography and Economic Development’, International Regional Science Review, 22, pp. 179-232.
• Glaeser, E.L. and M.E. Kahn (2003): ‘Sprawl and Urban Growth’, in: J.V. Henderson and J.-F. Thisse (eds), Handbook of Urban and Regional Economics, Volume 4, Chapter 56, Elsevier, Amsterdam.
• Glaeser, E.L., H.D. Kallal, J.A. Scheinkman and A. Shleifer

(1992): ‘Growth in Cities’, Journal of Political Economy, 100, pp. 1126-1151.
• Krugman, P. (1991): ‘History and Industry Location: The Case of the US Manufacturing Belt’, American Economic Review, 81, pp. 80-83.

Research Internship Science Communication

Vakcode	AM_1162 ()
Periode	Ac. Jaar (september)
Credits	30.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. J.F.H. Kupper
Niveau	600

Doel vak
The internship is a compulsory part of the Master’s programme. The aims of the internship are:
• Learn to independently apply and expand your practical science communication skills in one particular area of the field (writing, multi-media, facilitation, policy and strategy development, content design, etc.).
• Critical self-assessment and reflection on acquired science communication competencies in the field.
• Conduct scientific research independently: assess scientific information, design a research project, apply scientific methods, collect data, report and discuss findings.
• Present and discuss about internship and research outcomes.
• Learn to cooperate with researchers and practitioners of various disciplines.
• Gain an impression of a potential future field of career.

Inhoud vak
When you are enrolled in the VU Science Communication specialization or the UvA Major Science Communication you need to conduct one internship (30 ECTS, 5 months). One of the two possible formats is the full Research Internship. The complete and up-to-date information about the internship can be found in the SC internship guide line on Canvas (science communication community).

Onderwijsvorm
Work-baed placement

Toetsvorm
Written report and oral presentation.
Within six weeks after the start of the master internship, an interim evaluation will take place to assess whether there is a reasonable chance of the placement being brought to a successful completion.
The internship is supervised and assessed by two lecturers. Both lecturers are members of the academic staff at VU University Amsterdam. The day-to-day supervision can be carried out by a trainee research assistant (AIO), postdoc or researcher.

Doelgroep
Students Earth science year 2

Overige informatie
Participation in this compulsory component is only permitted if the student meets the relevant requirements for admission. These requirements are detailed in the Internship guideline of science communication (on
Canvas) and in the Academic and Examination Regulations.
The work-based placement is subject to the FALW document: “Student placement (internship) and literature regulations”. These regulations require detailed written agreements between supervisors and student that specify the conditions for the Master research project. This agreement should be sent for approval by the science communication internship or master co-ordinator
at least two weeks before the planned start of the work-based placement.
If the proposal is of sufficient quality, you can start your internship.
If not, you’ll need to adapt your proposal and send it for approval again. You can only start your internship after your research design has been approved.
The placement may be extended by 6 EC, subject to conditions that can be found in the FALW document “Student placement (internship) and literature regulations”. The student must send a request for extension to the earth science Examination Board.
Information on Master internships is made available on Canvas.

Research methods for analyzing complex problems

Vakcode	AM_1182 ()
Periode	Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	drs. D.H.J. Lynch
Examinator	A. van Luijn MSc
Docent(en)	J.W. Schuijer, drs. ir. A. Fraaije, A.E. Bunders MSc, drs. ir. F. Vogels
Lesmethode(n)	Hoorcollege, Werkcollege, Computerpracticum, Deeltoets extra zaalcapaciteit
Niveau	400

Doel vak
The objectives of this course are:

- To understand the differences between beta- and gamma research;
- To acquire insight in and understanding of a real world research process, including knowledge of the character of complex societal issues and the needs, advantages and disadvantages of real world research;
- To acquire insight relevant research methods (both quantitative and qualitative) to adddress complex societal problems, their underlying theoretical concepts and their relative
strengths and weaknesses;
- Being able to apply these various research methods in a specific societal context;
- To interpret quantitative and qualitative findings;
- Being able to create an adequate research design for the investigation

of a specific complex societal problem.

Inhoud vak
Contemporary societies increasingly face complex social problems, such as climate change, HIV/ AIDS or ethnic and religious diversity. These complex problems involve a variety of social actors: policy-makers, professionals, NGOs, industries, science and, of course, the public at large. Addressing these complex issues demands an approach that investigates, analyzes and integrates the positions and knowledge of different actors.

This course offers an (advanced) introduction to various research methods used in real world research, including questionnaires, surveys, semi-structured
interviews, and focus groups. These methods are commonly used in research into complex problem contexts, communication and opportunities for intervention. Strengths and weaknesses of each research method and technique will be discussed, as well as its possibility to be applied in different societal contexts.

Onderwijsvorm
Research Methods for Analyzing Complex Problems is a parttime course of eight weeks (6 ECTS). The total study time is 160 hours. Tuition methods include lectures, workgroups, workshops, group project work and self-study.

The different elements have the following study time:
- lectures 20 hours
- workgroups and training 36 hours
- examination 3 hours
- project work & reading (self-study) Remaining hours

Please note that attendance to the workgroup sessions is compulsory. If you miss one workgroup, with a good reason, you will receive an additional assignment. If you miss more than one workgroup session it is no longer possible to pass the project part of the course.

Attendance to the lectures is highly recommended. In our experience, relying on self-study alone is insufficient to apply the theory of the lectures in the assignments of the workgroups, and to pass the exam.

Toetsvorm
The course grade is based on the group assignment 'research design' and the exam. Both aspects need to be graded 6.0 or higher.
Exam 50% of total grade
Group assignment 'research design' 50% of total grade

Literatuur
The literature of this course consists of selected scientific articles that are provided on Canvas, and the books:
- Verschuren, D.E. and Doorewaard, H. (2010). Designing a Research Project
(2nd edition)Eleven International Publishing, the Hague. ISBN 978-90-5931-572-3.
- Gray, D.E. (2014) Doing Research in the Real World (3rd edition)Sage Publications Ltd, United Kingdom. ISBN 978-1-4462-6019-7

An overview of the literature per lecture will be provided on Canvas.

Doelgroep
The course ‘Research Methods for Analyzing Complex Problems’ is a compulsory course for first year master students ‘Management, Policy Analysis and Entrepreneurship in Health and Life Sciences’. This course is also a compulsory course within the Science communication- and Societal differentiations of Health, Life and Natural Sciences Master programmes. It is an optional course for other Life Sciences Master program students at the VU University.

Intekenprocedure
VUnet

Overige informatie
Lectures are in English, part of the workgroups are in Dutch. The assignments are written in English.

Please note that attendance to the workgroup sessions is compulsory. If you miss one workgroup, with a good reason, you will receive an additional assignment. If you miss more than one workgroup session it is no longer possible to pass the project part of the course.

Attendance to the lectures is highly recommended. In our experience, relying on self-study alone is insufficient to apply the theory of the lectures in the assignments of the workgroups, and to pass the exam.

Contact:
Durwin Lynch (d.lynch@vu.nl)

Research Project Earth Sciences and Economics

Vakcode	AM_1103 ()
Periode	Ac. Jaar (september)
Credits	18.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. M.P. Bokhorst
Examinator	dr. M.P. Bokhorst
Niveau	400

Doel vak
First research on the integration of Earth Sciences and Economics. See Master Thesis Earth Sciences and Economics (AM_450407)

Inhoud vak
See Master Thesis Earth Sciences and Economics (AM_450407)

Onderwijsvorm
See Master Thesis Earth Sciences and Economics (AM_450407)

Toetsvorm
See Master Thesis Earth Sciences and Economics (AM_450407)

Literatuur

See Master Thesis Earth Sciences and Economics (AM_450407)

Aanbevolen voorkennis
All other subjects in the first year Earth Sciences and Economics program

Doelgroep
First year students MSc Earth Sciences, spec. ES&E

Intekenprocedure
See Master Thesis Earth Sciences and Economics (AM_450407)

Overige informatie
See Master Thesis Earth Sciences and Economics (AM_450407)

Research Project Earth Surface Processes, Climate and Records

Vakcode	AM_1149 ()
Periode	Ac. Jaar (september)
Credits	27.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. C.J. Beets
Examinator	dr. C.J. Beets
Docent(en)	dr. J. van Huissteden
Lesmethode(n)	Hoorcollege
Niveau	600

Doel vak
Learning to prepare and conduct a research project and to write a scientific report at the academic Master's level. In both practical conduct and writing the student should demonstrate his or her:
- advanced knowledge and understanding of the field, thus providing a basis or opportunity for originality in developing and applying ideas;
- problem solving abilities in new or unfamiliar environments within broader contexts;
- ability to integrate knowledge and to handle complexity;
- ability to clearly communicate conclusions, and the knowledge and rationale underpinning these, to specialist and non- specialist audiences.

Inhoud vak
Research project in the master's specialisation Earth Surface Processes: circa 2 weeks preparation, circa 8 weeks research, circa 7 weeks report. Next to this you need to attend 4 MSc presentations and give one yourself.

Onderwijsvorm
Fieldwork and/or lab analysis. Following field or lab research, the student must present and document his/her results in a report.

Toetsvorm
Written report. Grading is based on the report, methodology, research attitude and presentation

Vereiste voorkennis
All compulsary courses of the first master year; as noted in the OER at least 18 EC should be succesfully be acquired.

Overige informatie
The Research Project is subject to the school's Work placement and thesis regulations (stageregeling). These regulations require detailed written agreements between supervisors and student that specify the conditions for the Master thesis work placement or research project. This agreement should be put forward to the secretary of the examination board before the start of the work placement or research project.
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 Examination Board. Admission requirements are checked by the Examination Board on April 15th. Participants should register in time (preferably before March 1st) with the staff member/department in question and via the regular way.

Participation in the Earth Science Career Event (NL: Aardwetenschappelijke Loopbaandag), Friday February 13, 2015 at the VU main building, forms an integral part of this project. Attending this event will allow you to get in touch directly with students, alumni, and companies in the Earth Sciences, and can give you ideas for both your research project and MSc thesis.

Research Project Geology and Geochemistry

Vakcode	AM_1187 ()
Periode	Ac. Jaar (september)
Credits	27.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. W. van Westrenen
Niveau	600

Doel vak
Learning to prepare and conduct a research project and to write a scientific report thereof at the academic Master's level. In both practical conduct and writing the student should demonstrate his or her:
- advanced knowledge and understanding of the field, thus providing a basis or opportunity for originality in developing and applying ideas;
- problem solving abilities in new or unfamiliar environments within broader contexts;
- ability to integrate knowledge and to handle complexity;
- ability to clearly communicate conclusions, and the knowledge and rationale underpinning these, to specialist and non-specialist audiences.

Inhoud vak
Research project in the master's specialization Geology and Geochemistry:
approximately 2 weeks preparation, 8 weeks research, 8 weeks report writing. Possible topics offered by Geology and Geochemistry staff are normally presented around December.

Onderwijsvorm
Fieldwork or lab analysis or work placement. Following field or lab research or work placement, the student must present and document his/her results in a written report and present results orally.

Toetsvorm
Written report and oral presentation.

Vereiste voorkennis
This course is only accessible to students who have earned at least 12 EC in the master specialisation programme
concerned, as registered by the student administration on March 1st. Otherwise, admission is possible only when granted by the Examination Board.

Overige informatie
The Research Project Geology and Geochemistry is subject to the school's Work
placement and thesis regulations (in Dutch: stage- en scriptieregeling). These
regulations require detailed written agreements between supervisor and student that specify the conditions for the Research Project Geology and Geochemistry. These agreements are filled out online and then automatically sent to the track co-ordinator
(Prof dr Wim van Westrenen). After his OK, the work placement or research project can start.

Research Project Solid Earth

Vakcode	AM_450200 ()
Periode	Ac. Jaar (september)
Credits	27.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. W. van Westrenen
Examinator	prof. dr. W. van Westrenen
Lesmethode(n)	Werkcollege
Niveau	600

Doel vak
Learning to prepare and conduct a research project and to write a scientific report thereof at the academic Master's level. In both practical conduct and writing the student should demonstrate his or her:
advanced knowledge and understanding of the field, thus providing a basis or opportunity for originality in developing and applying ideas;
problem solving abilities in new or unfamiliar environments within broader contexts;
ability to integrate knowledge and to handle complexity;
ability to clearly communicate conclusions, and the knowledge and rationale underpinning these, to specialist and non-specialist audiences.

Inhoud vak

Research project in the master's specialisation Solid Earth:
approximately 2 weeks
preparation, 8 weeks research, 8 weeks report writing.

Onderwijsvorm
Fieldwork or lab analysis or work placement. Following field or lab research or work placement, the student must present and document his/her results in a written report and present results orally.

Toetsvorm
Written report and oral presentation.

Intekenprocedure
New subscriptions to this course are not advised, as the course has been superseded by the course Research Project Geology and Geochemistry (AM_1187)

Overige informatie
Please note that from the 2016-2017 Academic year onwards, students should replace this course with the Research Project Geology and Geochemistry (AM_1187).

The Research Project Solid Earth was 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 Solid Earth. This agreement should be put forward to the master co-ordinator (Prof dr Wim van Westrenen) before the start of the work placement or research project.

Science and Communication

Vakcode	AM_470587 ()
Periode	Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	P. Klaassen MA
Examinator	P. Klaassen MA
Docent(en)	dr. J.F.H. Kupper, dr. ir. M.G. van der Meij, P. Klaassen MA
Lesmethode(n)	Hoorcollege, Werkgroep
Niveau	500

Doel vak
a) Gain theoretical insight in the nature of science,
b) Gain theoretical insight in the nature of communication,
c) Gain theoretical insight in the relationship between science and society,
d) Gain insight in the role of science communication in this relationship,
e) Acquire knowledge of different theories and models of science communication,
f) Acquire knowledge of different strategies, media and activities for science communication,

g) Learn how to practically apply theoretical concepts from the field of science communication in communicating science,
h) Develop practical skills for science communication (especially writing and giving oral presentations).
i) Reflect on your own knowledge and competencies pertinent to your projected (ideal) role as science communicator.

Inhoud vak
Science is all around us and shapes our lives in many different ways. From the vaccines you need to get when traveling abroad to the smartphone you use on a daily basis, and from the public transportation you use to get to the university to the ingredients of your toothpaste: scientific knowledge is elemental to all of these. Simultaneously, society shapes the ways in which science and technology develop too. Science, technology and society influence each other continuously—or, to put it differently, they 'communicate'.

Students of the Science Communication specialization are expected to become experts in understanding and designing interactions between science and society. In order to make this interaction fruitful and valuable for both science and society, it is first of all important to gain theoretical knowledge about science, about communication and about science communication. Science and Communication provides students with the theoretical and conceptual foundations of the discipline of science communication. Thus, you will develop an in-depth understanding of communication processes at the core of several interfaces, including those between scientists from different disciplines, between different sciences and their stakeholders, and between science and the public.

Onderwijsvorm
Lectures (18 h)
Workgroups (15 h)
Home-study for group assignments (12 h)
Home-study for individual assignments/exam (100 h)

Toetsvorm
a) Participation. (10%)
This consists of the following:
- (small) individual assignments,
- a pitch presentation and
- a "job application".
All these are assessed as pass or fail. If you pass all of them, you have earned the first 10% of your final mark. For each one you fail, you have to do an alternative assignment.
Nota bene: if you fail your participation, this cannot be compensated with an alternative assignment!
b) A group assignment in which you develop a label to an exhibit at a science museum and write an accompanying essay. (10%)
c) A review of a science communication effort of your own choosing (an exhibit at a science center or museum, a public lecture, a (popular) science book, et cetera...). (10%)
d) "TED-talk" in which you present the research you did (e.g. for your Bsc thesis or (first) Msc internship). (20%)
e) Exam. (50%)

To pass, your grades for assignments (a), (b) and (e) have to be 6 or higher. Assignments (b), (c) and (d) are all mandatory, but grades for these individual components can be compensated by other grades.

Resit:
In case your weighed average of (a) to (e) (with sufficient grades for (a), (b) and (e)!) is not sufficient, you have to take a resit. This can either consist of a second attempt at (c) or (d), or a re-exam.

Literatuur
Academic articles. Direct links to articles will be provided on Canvas.

Doelgroep
The course Science and Communication is a compulsory course for students of the Master specialisation Science Communication (Wetenschapscommunicatie) and is a prerequisite for the internship. Science and Communication is an optional course for students from other master programs in the health and life sciences.

Science in Dialogue

Vakcode	AM_1002 ()
Periode	Periode 2
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. J.F.H. Kupper
Examinator	dr. J.F.H. Kupper
Docent(en)	dr. J.F.H. Kupper
Lesmethode(n)	Werkgroep, Hoorcollege, Werkcollege
Niveau	500

Doel vak
To gain knowledge of and insight into:
- the basic concepts and issues in the understanding of science-society interactions, both from a science and technology studies and communication science perspective
- the nature and course of interpersonal and group communication processes relevant to the formal and informal dialogue between science and society
- the nature and form of dialogical science communication, aimed at reflective learning and mutual understanding

To acquire or improve:
- individual skills for effective interpersonal communication
- individual skills for the design and facilitation of the science-society dialogue

Inhoud vak
This course examines the public character of scientific controversy and focuses on the communicative aspects of a fruitful science-society dialogue. At the dawn of the 21st century, science, and particularly fields that combine science and engineering such as nanotechnology and synthetic biology, holds a great promise for the progress of our societies. At the same time, these developments are controversial. They lead to a variety of concerns related to risks, benefits and wider moral issues. Nanotechnology creates materials with novel characteristics that help us, but may also contain risks for health and environment. Synthetic biology develops new biological systems that may be very

useful, but radically change the nature and meaning of life. Clearly, advances in science do not always match the needs, desires and expectations of society. On the other hand, parts of society might not always appreciate the nature and scope of scientific findings. For a fruitful relationship between science and society, a constructive science-society dialogue is necessary.
This course offers advanced lectures on the basic concepts and issues of dialogical science communication: communication, learning, dialogue, understanding, controversy, democracy. A series of workshops and small group assignments presents communicative tools and spaces such as discussion games, science theatre and multimedia platforms that can be used to design and facilitate science-society interactions. Training workshops will focus on improving the students' individual communication and facilitation skills. The students' individual learning curve as a science communicator and facilitator is self-evaluated by means of a refle ction report.
Every course week is completed with a mini-exam.

Onderwijsvorm
Lectures (14h), Workgroups (28h), Training workshops (24h), Dialogue presentations (12h), Selfstudy
(remaining hours)

Toetsvorm
Group assignment (50%), Take home exam (30%), Reflection report (20%).
All assignments must be passed (grade > 6).

Literatuur
Is announced on Canvas one month before start of the course

Doelgroep
Optional course in the MSc specialization Science Communication

Overige informatie
Independence and a cooperative attitude is expected. Attendance to training workshops is mandatory.

Science Journalism

Vakcode	AM_471014 ()
Periode	Periode 2
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. J.F.H. Kupper
Examinator	dr. J.F.H. Kupper
Docent(en)	dr. J.F.H. Kupper
Lesmethode(n)	Hoorcollege, Werkgroep, Computerpracticum
Niveau	500

Doel vak
To acquire knowledge of and insight into:
- the concepts, models and issues of science journalism according to contemporary scientific literature
- the criteria for effective science journalism with respect to diverse

media
- the representation of science in the media
- the role of science journalism in the use of scientific knowledge in society

To acquire skills in:
- writing popular scientific texts for different genres such as news, background and interview
- science reporting using videos
- designing science communication for different media such as newspaper, radio and internet

Orientation to the professional practice of science journalism

Inhoud vak
This course teaches the basic principles of science journalism. A series of interactive lectures reviews both the practical as well as the theoretical aspects of science journalism. Topics that are discussed are the translation of science to a language that is both compelling and understandable, the role of journalism in the interaction between science and society, images of science in the media and the ethics of science journalism. The interactive lectures invite you to take your own defendable position with regard to these issues.
Guest lectures provide insight into the professional practice of science journalists. The guest speakers work as freelancer, editor or producer at diverse science media, such as newspapers (NRC, Volkskrant), magazines (NWT), internet (Noorderlicht) and radio (Labyrint).
Finally, the course trains specific skills that you need as a science journalist, such as popular writing, popular science videos, interviewing, conceptual analysis
and program design.

Onderwijsvorm
Lectures and seminars on theory and practice of science journalism and writing skill training (36h). Considerable time is set aside for performing science journalism in assignments (108h). The assignments are assessed by lecturers and fellow students (peer-review process). Self study (remaining hours).

Toetsvorm
Several individual assignments (60%), several small group assignments (40%). All assignments must be passed (grade > 6).

Literatuur
Announced on Canvas one month before start of the course

Doelgroep
All Master students with a Beta-Bachelor degree. Students taking this course as part of their C-specialisation within FALW or FEW will have precedence over other students. Students from other faculties and or universities need to get formal consent from the course coördinator (Frank Kupper) before enrolment.

Overige informatie
Course is taught in Dutch. More information: f.kupper@vu.nl.

Science Museology

Vakcode	AM_470590 ()
Periode	Periode 3
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	A. van Luijn MSc
Examinator	dr. ir. M.G. van der Meij
Docent(en)	dr. B.J. Regeer, dr. ir. M.G. van der Meij
Lesmethode(n)	Hoorcollege, Werkgroep, Werkcollege, Veldwerk
Niveau	500

Doel vak
- Analyze and understand the role of museum exhibits in the field of science communication.
- Analyze and understand the role of science communication concepts in the context of science museums.
- Synthesize theoretical notions of science communication and exhibit design into ideas for an exhibit experience and exhibit content.
- Create and conduct a qualitative user research method in science museum settings.
- Integrate the user research outcomes into the exhibit experience and exhibit content.
- Reflect on working for an external commissioner.

Inhoud vak
This course is about the role of science museums/centers, zoos and natural history museums in science communication. You will get familiar with theories of science communication in museum settings, and will be introduced to different styles of communication, different approaches to exhibit design & development, and different methods of research and evaluation of exhibitions.
Lecturers give insight into the role and work of (1) science communicators in museums and science centers, (2) researchers in the field of museology, and/or (3) professionals in informal science & technology learning environments.
Through individual and group assignments you are encouraged to combine theory and practice, working step-by-step towards an exhibit design. The group assignments are commissioned by museums and science centers, such as NEMO, Museon, Naturalis, Delft Science Centre, or Artis.

Onderwijsvorm
Lectures
Workgroups
Workshops
Home-study for group assignments
Home-study for individual assignments
Field work

Toetsvorm
Group assignments (45%), final presentation (15%), and individual assessment(s) (40%). For all assignments and assessments a pass-grade must be obtained.

Literatuur

Academic articles. Direct links to articles will be provided on Canvas before the beginning of the course.

Vereiste voorkennis
It is possible to follow the course as an elective course outside of one of the science communication master specialisations of FALW/FEW. In that case, additional reading may be asked from students, depending on the student's educational background.

Aanbevolen voorkennis
We recommend to follow this course, at least, after having done the course Science & Communication.
We ask non-SC students to read Van Dam, F., De Bakker, L, & Dijkstra, A.M. (2014). Wetenschapscommunicatie, een kennisbasis. Boom Lemma uitgevers. ISBN: 978-94-6236-424-0. Chapters: 1, 2, 3, 4, 5 en 6. For English introduction literature, please contact the teaching staff.

Doelgroep
Optional course in the Science Communication master specialisation of most of the two-year master programs of the FALW and FEW faculties. Master students from other universities in any scientific field are welcome as well. Additional reading may be required.

Overige informatie
Guest lectures from and excursions to for instance NEMO, Artis, Naturalis, NorthernLight, or Museon, etc.

Scotland Excursion

Vakcode	AM_450354 ()
Periode	Periode 6
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. M.A. Prins
Examinator	dr. M.A. Prins
Docent(en)	dr. M.A. Prins, dr. N.N.L. Van der Putten
Lesmethode(n)	Veldwerk
Niveau	400

Doel vak
To highlight the history of the Earth’s crust during the early Paleozoicum. To study the Scottish climate history over the last 15 ka and its impact on the geomorphology, raised bog ecosystems and sedimentary environments.

Inhoud vak
During this excursion (10-12 days) the most relevant aspects of the Scottish geology and geomorphology, Late Quaternary climate history and the evolution of life during the early Paleozoicum be highlighted. The geomorphology at various locations in and around the Scottish highlands will be used to demonstrate the impact of former glaciations on the landscape. A variety of terrestrial and marine sections form the base to illustrate the most important aspects of the Late Quaternary paleoclimatic (marine and terrestrial) evolution in Scotland (NW

Europe). Traces of early life forms and the evolution thereof will be discussed in the context of a changing environment through geological time.

Onderwijsvorm
Excursion: observing and describing geomorphological land forms, sedimentary profiles; drawing conclusion with respect to climate change, fluvial and glacial activity, and human impact.

Toetsvorm
Oral presentations in the field (and/or hotel) of relevant scientific papers and visited excursion sites.

Vereiste voorkennis
First year of the MSc 'Earth Surface Processes,Climate and Archives' must be completed and a total of 18 ects must have been registered.

Doelgroep
Master students 'Earth Surface Processes,Climate and Archives'.

Intekenprocedure
You should have subscribed before December 9, 2017.

Overige informatie
This course takes place every other year. Next excursion will be in June 2018.

Sediment Petrography of Heavy Minerals

Vakcode	AM_450058 ()
Periode	Periode 3
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. C. Kasse
Examinator	dr. C. Kasse
Docent(en)	dr. C. Kasse
Lesmethode(n)	Werkcollege
Niveau	400

Doel vak
Study of heavy minerals as a tool to establish the Quaternary lithostratigraphy of the Netherlands and abroad and to establish the provenance of the sediments.

Inhoud vak
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. Interpretation of heavy mineral assemblages regarding the provenance of the sediment and the Quaternary lithostratigraphy and paleogeographical development of the Netherlands.

Onderwijsvorm
Depending on the number of students. 10x3 hours of lectures/practical courses or self study

Toetsvorm
Oral examination and determination of heavy minerals under the microscope by the
student (90%); presentation (10%)

Literatuur
Mange, M.A. & H.F.W. Maurer 1992 Heavy minerals in colour. Chapman & Hall, London, 147 pp.

Boenigk, 1983 Schwermineralanalyse, Ferdinand Enke Publishers, Stuttgart, 158 pp.

Vereiste voorkennis
Bachelor in Earth Sciences

Doelgroep
Master students Earth Sciences

Overige informatie
This optional course is offered every two years. The next course takes place in 2017 - 2018 depending on the number of students

Sedimentary Basins

Vakcode	AM_450154 ()
Periode	Periode 2
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. K. Ogata
Examinator	dr. K. Ogata
Docent(en)	dr. K. Ogata
Lesmethode(n)	Lezing, Computerpracticum, Hoorcollege
Niveau	400

Doel vak
The main goal of the course is to provide students the skills to analyze and interpret data on sedimentary basins and derive quantitative reconstruction of their tectono-sedimentary evolution. In order to do so, the student should be able to:
- Combine different data sets to understand tecto-sedimentary processes controlling the evolution of sedimentary basins.
- Combine class material with significant, compiled literature material.
- To work in small interdisciplinary groups.
- To present the results of his/her work in oral and written form.

Inhoud vak
The main topics addressed in this course are:
- the tectonic processes influencing their structural-stratigraphic framework and the formation setting;

- the classification and subdivision schemes of basinal systems and their diagnostic characteristics;
- the physical processes controlling their distribution, infilling, and preservation;
- principles of physical and sequence stratigraphy of siliciclastic and carbonate sedimentary systems.

A limited number of real-world sedimentary basins (siliciclastic and carbonate settings) from various tectonic settings will be addressed and used to test in practice the theoretical knowledge.

Onderwijsvorm
Frontal lectures (l), class seminars (s) and practicals (pra), collective exercises and reading assignments of selected primary literature on specific regional examples.
Contact hours per student: 2

Toetsvorm
Final written exam (E): 70%
Student presentations (Pres), practicals (Prac) and/or assignments (A): 20%
Class participation: 10%
The tectonic and stratigraphical/sedimentological parts count 50% each.

It is not possible to compensate one component with another.

Literatuur
Required books:
- Allen, P.A. and Allen, J.R. (2004). Basin Analysis. Blackwell Publishing. ISBN: 978-0-632-05207-3

Additional books:
- Catuneanu, O. (2006), Principles of Sequence Stratigraphy, Elsevier
- Schlager, W. (2005). Carbonate Sedimentology and Sequence Stratigraphy, SEPM, Concepts in Sedimentology and Paleontology, v. 8. ISBN: 1-56576-116-2.
- James, N.P. & Dalrymple, R.W. (2010). Facies Models 4. Geological Association of Canada; ISBN-13: 978-1-897095-50-8; ISSN: 1208-2260, 586 pages, full colour.

Other relevant literature will be provided.

Aanbevolen voorkennis
Stratigraphy, sedimentology, structural geology and tectonics at Bachelor's level

Overige informatie
This course focuses on the background, origin and evolution of sedimentary basins in space and time, with the main aim is to understand how such systems develop and fill, and how they and their contents can be used for a variety of applied purposes.

Sedimentary Environments and Climate Archives

Vakcode	AM_450330 ()
Periode	Periode 1
Credits	6.0

Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. F.J.C. Peeters
Examinator	dr. F.J.C. Peeters
Docent(en)	dr. F.J.C. Peeters, dr. C.J. Beets, dr. C. Kasse
Lesmethode(n)	Excursie, Werkcollege, Hoorcollege
Niveau	400

Doel vak
To learn and understand how environmental and climate changes are recorded in marine, coastal and terrestrial depositional environments,and to understand the recording process as a function of the dynamics of these environments.

Inhoud vak
The course deals with the sedimentology, geochemistry and stratigraphy of marine, coastal, fluvial, lacustrine and eolian palaeoclimate records. The focus is on those processes relevant for understanding how climate/environmental change is recorded in the different palaeoclimate archives. In addition, the susceptibility of key aspects of those environments to climate- change impacts will be addressed. Marine and terrestrial palaeoclimate records receive equally attention.

Onderwijsvorm
Lectures, literature study, group discussions and a field excursion to Southern Limburg.

Toetsvorm
Written exam and report of the field excursion to southern Limburg.

Literatuur
Lecture notes, selected papers.

Aanbevolen voorkennis
Bachelor courses: Terrestrial environments (450097), Climate Science (450240); Master courses: Modern Climate Systems (450185), Modern Geo-ecosystems

Doelgroep
AM_ES 1, AM_ES-ESE 1, AM_ES-EDU 1, AM_ES-SC 1, AM_ES-ESP 1

Sociale geografie II

Vakcode	AM_1051 ()
Periode	Ac. Jaar (september)
Credits	12.0
Voertaal	Nederlands
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	drs. J.B. Penninx
Examinator	drs. J.B. Penninx
Lesmethode(n)	Werkcollege
Niveau	400

Doel vak
Dit studieonderdeel is vooral bedoeld voor wie aardrijkskundedocent wil worden of zich breder wil oriënteren op sociale geografie. Via literatuurstudie, eigen onderzoek en ontwerpactiviteiten verdiepen studenten hun geografische kennis en geografische vaardigheden op het gebied van sociale geografie.
Eindtermen:
1. Studenten verdiepen hun geografisch wereldbeeld en inzicht in geografische vraagstukken aan de hand van literatuur en colleges
2. Studenten combineren geografische kennis en geografische vaardigheden in het ontwerpen van een regionaal- geografische excursie.
3. Studenten combineren geografische kennis en geografische vaardigheden in het schrijven van een vakpublicatie die gebaseerd is op eigen geografisch onderzoek.

Inhoud vak
Verdieping van het vak sociale geografie op een wijze die voorsorteert voor het eerstegraads leraarschap aardrijkskunde maar ook bruikbaar is voor hen die een baan ambiëren in het brede terrein van geografie voor educatie en communicatie of hun algemene geografische kennis willen verbreden. Er is aandacht voor geografische concepten, benaderingen en subdisciplines. Ook het structureren van geografische kennis is een belangrijk onderdeel. Naast kennisverwerving wordt er geoefend met het schrijven van een geografische publicatie en het verrichten van een doelgroep gericht geografisch onderwijsproduct in de vorm van een excursie.

Onderwijsvorm
Het vak vereist veel zelfstandigheid van de studenten.
Het omvat:
Literatuurstudie in zelfstudie 110 uur
Hoor-werkcolleges 22 contacturen
Een tentamen 4 uur
Een regionaal-geografische excursie ontwerpen 100 uur
Een vakpublicatie over regionaal geografisch onderzoek 100 uur
Begeleiding vindt plaats via gerichte colleges en werkbesprekingen.
Totaal 336 uur (12 EC)

Toetsvorm
Schriftelijk open boek tentamen over de literatuur en de colleges (40%), een zelf ontworpen regionaal-geografische excursie (30%) en het schrijven van een vakpublicatie over een regionaal-geografisch onderzoek (30%).

Literatuur
1. Pater, B. (2014), De ontdekking van de geografie hoofdstuk 1, 5 en 8
2. Driessen, M. (2011) Het verloren dorp; China aan het begin van de 21e eeuw. Amsterdam: Uitgeverij Wereldbibliotheek, 190 pp.
3. Taylor PJ & Flint C (2007) Political geography: world-economy, nation-state and locality. Hoofdstukken 1, 2 en een derde naar keuze.
4. Paul Knox & Steven Pinch (2010) Urban social geography, Pearson/Prentice Hall: Essex. Hoofdstuk 2, 3, en 8.
5. IRGEE en Geografie 2010-2014) een selectie van artikelen, ca. 100 pp.
6. Lambert & Jones (2013) Debates in Geography Education, London: Routledge. Twee nader op te geven hoofdstukken.

Vereiste voorkennis
Sociale geografie I afgerond hebben

Aanbevolen voorkennis
Het blad Geografie lezen.

Doelgroep
Master studenten Aarde & Economie en Aardwetenschappen. Verplicht voor studenten die eerstegraads docent aardrijkskunde willen worden. Andere geïnteresseerden zijn welkom.

Overige informatie
Nadere informatie bij Joost Penninx - j.b.penninx@vu.nl

Spatial Processes in Ecology

Vakcode	AMU_0009 ()
Periode	Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen

Inhoud vak
This is an UvA course. For the course description, please visit http://studiegids.uva.nl/

Sustainable Energy Analysis

Vakcode	AM_468018 ()
Periode	Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. B. van der Kroon MSc
Examinator	dr. B. van der Kroon MSc
Docent(en)	dr. J.E. Blasch
Lesmethode(n)	Werkcollege, Hoorcollege
Niveau	400

Doel vak
The unit is designed to familiarize students with the basic principles of sustainable energy and to equip them with the knowledge and tools that will help them both to understand the main determinants of sustainable energy generation and use and to critically evaluate the range of policy options to accelerate the energy transition.
After following this course, students should be able to:
• Understand the basic technical and economic principles underlying todays energy production, distribution and consumption around the globe and have an idea of the possible pathways into a sustainable energy future
• understand the economic, social and environmental challenges related to the energy transition process and critically discuss possible solutions and strategies for the de-carbonization challenge

• Know about a diverse set of policy instruments and strategies that can be implemented to support the energy transition process
• Able to make judgment about which principles, policy instruments and approaches are likely to be most efficient, equitable and/or effective in addressing the energy transition
• Critically reflect on sustainable energy innovations
• Demonstrate a capacity to operate in a multidisciplinary team and constructively contribute to the development of a shared project
• Understand the main components of a successful business model and can apply this in designing a business plan for a novel energy service or product
• Ability to synthesize information into a pitch for a non-academic audience

Inhoud vak
Energy is central to nearly every major challenge and opportunity the world faces today. Be it for jobs, security, climate change mitigation, food production or increasing incomes, access to clean and sustainable energy for all is essential (UN, 2015). The transition towards an affordable, reliable, and sustainable energy system can be accelerated by investing in renewable energy resources, prioritizing energy efficient practices, and adopting clean energy technologies and infrastructure. Sustainable Energy Challenges “SEC” introduces students to key aspects of the energy transition from a socio-economic perspective. Besides a brief introduction into the technological aspects of the energy transition, the lectures will focus on the economic, societal and political conditions for sustainable energy generation, distribution and use.

The course is built on a series of 10 lectures and seminars by the lecturers and selected guest speakers. The unit will be a combination of theory and evidence-based discussions, relating theoretical arguments with recent experiences in the domain of the transition to sustainable energy.

The course is built on 4 main blocks.
1. Technological perspectives (greening energy production and use)
2. Economic perspectives (energy markets)
3. Policy framework for the energy transition (climate and energy policy instruments)
4. Thematic session on topics such as:
- Consumer behavior
- Energy for the South
- Mobility

Next to the (guest) lectures, the course contains a six-week assignment carried out in groups of 4-5 students. In this group assignment students will work on developing a business plan for a renewable energy product or service.

Onderwijsvorm
The course is worth 6 ECTS credits which corresponds to 168 hours of work per student.

The course comprises two sets of activities. The first takes place in classes, where information is presented through lectures, presentations, debates, seminars etc. The second includes assessments where student’s ability to achieve the course’s objectives is tested. Assessment involves group activities (presentation and a written assignment), and

the exam. Feedback opportunities are included through group meetings as well as assessments.

Approximate time allocation:
• Class: 28 hours
• Reading and exam preparation: 70 hours
• Assignment: 60 hours
• Presentations: 10 hours

Toetsvorm
Type of assessment:
• Group assignment (A) and Group presentation (Pres) worth 40% of the final grade
• Written exam (E) worth 60% of the final grade
• Minimum grade to pass the course: 5.5. It is not possible to compensate one component with another
• It is compulsory to attend the group presentation session

Literatuur
See course manual on Canvas

Tectonic Geomorphology

Vakcode	AM_450146 ()
Periode	Periode 2
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. M. ter Voorde
Examinator	dr. M. ter Voorde
Docent(en)	dr. M. ter Voorde
Lesmethode(n)	Werkcollege, Computerpracticum
Niveau	400

Doel vak
After having attended this course, the student should have gained knowledge and understanding about
- The interplay of (physical) mechanisms responsible for landscape evolution
- The relative importance and the mutual interaction between these processes
- The methods to put constraints on these processes from geological data, and the strength and limitations of these methods
as well as the skills to
- Read and critically assess significant literature about these subjects
- Actively participate in (oral) discussions about these subjects
- Judge research methods applied on this subject critically on their merits and weak points
- Compare and/or combine the results of different studies.

This implies that the course is not mainly focused on acquiring new knowledge, but especially on using, integrating and reflecting on the things you may have learned before.

Inhoud vak
This course deals with the parameters regulating the production, transfer and storage of sediments and solutes from their sources to their sinks, addressing short-term and long-term landscape evolution and sustainability. It covers the linked processes of tectonics, weathering, erosional systems (fluvial, glacial, marine) and climate changes, including ‘real-world’ examples on the SE Netherlands, the Ardennes, the Pyrenees and western Scandinavia, as well as the methods to constrain these processes (e.g. provenance studies and thermochronology). Lecturers from a variety of disciplines will teach the student how to view these topics from various backgrounds.

Onderwijsvorm
Lectures, exercises, literature study. A selected set of papers will be used for a 'PhD- defense'-role play. In addition, numerical modelling of topography development will be carried out by the students.
Aantal contact-uren: 45 (inclusief tentamen)

Toetsvorm
Exam (45%), essay (20%), computer-practicum report (10%) PhD-defense-"game"(25%).

Literatuur
• Book:
Tectonic Geomorphology, D.W. Burbank and R.S. Anderson, 2nd edition, 2011. John Wiley & Sons, 320 pp.

Additional papers, which will be made available via Canvas

Doelgroep
Masterstudents GBL, Earth Sciences Solid Earth, Earth Sciences AEG, Earth Sciences Paleoclimate and Geo-ecosystems

Transport Economics

Vakcode	E_STR_TREC (60432050)
Periode	Periode 2
Credits	6.0
Voertaal	Engels
Faculteit	School of Business and Economics
Coördinator	dr. A.J.H. Pels
Examinator	dr. A.J.H. Pels
Docent(en)	dr. A.J.H. Pels, dr. V.A.C. van den Berg
Lesmethode(n)	Hoorcollege, Werkcollege
Niveau	400

Doel vak
The aim of this course is to provide students with an advanced knowledge of contemporary transport economics, considering both intra-city transport (e.g. congested road traffic, urban transit) and inter-city transport (notably aviation). Students

- learn theoretical and empirical methods applied in the field of transport economics and in related fields, such as transport planning.
- get a good understanding of the fundamental policy questions that are

addressed in the field, and the methods with which these are addressed.
- learn the current state of affairs in the literature.
are trained to critically read and properly understand contributions in the leading journals in the field.

Inhoud vak
This course covers advanced topics in theoretical and empirical research on urban transport economics. Key issues are value of time and reliability; cost
functions and scale economies for various modes; congestion analysis in static and dynamic formulations; network equilibrium and optimum for deterministic and stochastic network models; first-best and second-best pricing in static and dynamic networks; investment analysis under first-best and second-best pricing; industrial organization aspects of intra-city (e.g. roads and transit) and inter-city (e.g. airports and airlines) transport; public transport and maritime topics. The topics are addressed from a theoretical as well
as an empirical perspective.

Toetsvorm
written interim examination: 70 percent
assignments: 30 percent (paper review tutorial 10 percent, network optimization tutorial 10 percent, methods tutorial 10 percent)

Literatuur
- Small, K.A. and E.T. Verhoef, The Economics of Urban Transportation. Routledge, 2007.
- Additional literature for more specialized topics will be announced at the start of the course.

Aanbevolen voorkennis
Microeconomics for urban, transport and environment economics or a similar course

Volcanism

Vakcode	AM_450061 ()
Periode	Periode 3
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. P.Z. Vroon
Examinator	dr. P.Z. Vroon
Docent(en)	dr. P.Z. Vroon
Lesmethode(n)	Werkcollege, Computerpracticum
Niveau	500

Doel vak
Modern volcanology is balanced between the descriptive and quantitative, and both of these aspects of the science will be emphasized in this course. There are three basic goals for this class:
(1) We want to understand how volcanoes work: the process part;
(2) We want to be able to reconstruct unseen volcanic eruptions from the deposits they leave in the field;
(3) We will want to know as much as possible about the hazards volcanoes

form to people.

An additional practical aim of this course is to improve your computer skills with Microsoft Excel. To this end I have designed some exercises which will show you how to use Microsoft Excel in it's most powerful form: visual basic for applications (VBA). This will be a practical during the third lecture.

Inhoud vak
Introduction to volcanic explosions and their products; Magma properties: viscosity, density and volatiles; Non-explosive volcanic eruptions; Magmatic fragmentation and pyroclastic textures; Eruption columns and the interpretation of pyroclastic deposits; Volcanic hazards.

Onderwijsvorm
This course consists of 7 lectures in which several subjects related to volcanology will be discussed. Each lecture is accompanied by a review paper or chapter from a book that gives an overview of the topics discussed – you will get more out of the lectures if you read these papers beforehand.
In addition to following the lectures you will be asked to complete homework exercises. These should be handed in before the start of the exam. These exercises are designed to clarify aspects of the lecture topics, and are also meant to provide a link between the different lectures. During Lecture 3, the use of Microsoft Visual Basic for Applications is explained, which is required for some of the exercises

Toetsvorm
The final mark for this course consists of the following components: (1) homework exercises (25%); written exam (75%).

Literatuur
Encyclopedia of Volcanoes (Sigurdsson et al., 2000). Academic Press, ISBN 0-12-643140-X.)

Doelgroep
Second year MSc students Earth Sciences, tracks Solid Earth, and Second year MSc students GBL.

Water Management

Vakcode	AM_468023 ()
Periode	Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. P. Scussolini
Examinator	dr. P. Scussolini
Docent(en)	prof. dr. J.C.J.H. Aerts, dr. R. Lasage, dr. H. de Moel, T.I.E. Veldkamp MSc
Lesmethode(n)	Hoorcollege, Computerpracticum
Niveau	400

Doel vak
The key objectives are: 1) to understand how water-related processes, such as floods and droughts, affect our society, and 2) elaborate on how water management can address these issues. For this, the course provides students with a multi-disciplinary view of water management, including the physical assessment, the practice and strategies, and the economic dimension of the matter. We will emphasise on the implications of long term trends, e.g., in climate and land use, and we will reason on the uncertainty about these trends and how risk analysis can assist the water manager in harnessing these uncertainties. More in detail, the goals for students are:
• To understand the complex interactions between various water-related issues (e.g., scarcity, floods, pollution) and natural and socio-economic dynamics.
• To be able to approach a complex water-related issue in a systematic and integrated manner, and to analytically interpret data and information about this issue.
• To critically select the most appropriate measures to alleviate water-related issues, evaluating their positive and negative effects on different stakeholders.

Inhoud vak
Several phenomena contribute to increase risks in the earth hydrological system: among them population growth, economic development and climate change. Water managers are confronted with a continuous stream of new scientific information on these phenomena. Floods and droughts are expected to increasingly affect societies and economies, and new approaches in water management are needed to deal with these challenges. Furthermore, the development of adequate water management strategies that can be used in practice is a difficult issue and is the result of a complex and long-lasting policy process from the national down to the local level. In this process, the science of the water- and socio-economic systems can play an important role by supplying policy-makers with answers on, e.g., the socio-economic effects of floods and droughts. Moreover, uncertainty in future trends add new challenges to water management, which can only be addressed by risk-based techniques. Finally, water managers nowadays need to cooperate with spatial planners, especially in large cities, to incorporate in planning adequate consideration of increasing risks, such as from storm surges and sea level rise.

Onderwijsvorm
The figure provided in the Study Manual shows the framework of the course, which reflects the principles of the Integrated Water Risk Management cycle. The lectures and the computer practicums cover each steps of IWRM. Some lectures are topic-specific, whereas most of them are cross-disciplinary, and will deal with more than one concept in the figure’s blocks. The course starts with explaining the water cycle, and the IWRM itself, and then moves on to deal with more detailed aspects of the physics of water systems, and how human systems interface with them. This framework also serves as the basis to structure and inspire the paper assignment on water in cities.
The course consists of several sessions, consisting of lectures by the experts fostering interactive discussion, two computer practicums, and student presentations. Further, you will team up in groups of two/three students to write a paper on water-related issues and adaptation in cities, which will be presented in the final two sessions (see details

in section 6).
This course has 6 credits, implying a study load of 168 hours. The table in the Study Manual presents a rough subdivision of the workload into the different course activities.
A considerable effort will be dedicated on developing your own case study. For this you'll have to perform a literature study, write a paper and perform a peer-review of a paper of other students.

Toetsvorm
The course will be assessed through: 1) a written, closed-book exam (60%); 2) a paper assignment (35%); 3) a peer review of another group's paper (5%).
The written exam will (likely) last 2 hours, and will be based on the compulsory readings and on the lectures. Also, questions related to insights learned during the computer practicums can be asked. Quantitative question may be asked, for which you'll need to bring a calculator. The written exam counts for 60% of the final grade.
For the paper assignment, groups of students investigate a water-related issue and its management in a city of their choice, and compose and present a paper. Paper and presentation will be evaluated as 35% of the final grade.
You will also individually perform a peer-review of the paper of another group, and you will be graded for the quality and the insights of your review, representing the 5% of the final grade.
Other small exercises, although not evaluated, are compulsory, these are:
• The exercise of the computer practicums. These need to be handed in via Canvas.
• The literature research exercise included in the lecture on flood risk.
• Presence and active contribution to all presentations.

Literatuur
The following table details the compulsory reading for this course. It is very advisable to familiarize with the readers before the lecture, and to do any preparatory exercises suggested in the Canvas. The compulsory reading contains information that can be tested at the exam. Some items are specified as "background reading", and they are meant mainly for students who want to learn more about specific subjects. All readings are either freely available from university computers and from home by using the VU proxy server, or are uploaded to the Canvas.

Doelgroep
MSc students Environment and Resource Management (ERM), MSc Hydrology; Earth Sciences and Economics(ESE).