Earth Sciences MSc

VU University Amsterdam - Fac. der Aard- en Levenswetenschappen - M Earth Sciences - 2015-2016

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.

The year schedule can be found at the FALW-website.
Further information about the MSc programme Earth Sciences.
A complete programme description can be found at the FALW-website.

Index

Expired programme components Earth Sciences

The course programme components presented in the list below will no longer be part of the examination programme in academic year 2014-2014.

Courses:

Name	Period	Credits	Code
Assessing the Landscape		3.0	AM_450404
Imaging the Earth Surface		3.0	AM_450403

MSc 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

Programme components:

- Earth Sciences specific content
- Education specific content

Earth Sciences specific content

Programme components:

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

Courses:

Name	Period	Credits	Code
Human Geography II	Ac. Year (September)	12.0	AM_1051

Research project (choose one)

Courses:

Name	Period	Credits	Code
Research Project Earth Sciences and Economics	Ac. Year (September)	18.0	AM_1103
Research Project Solid Earth	Ac. Year (September)	27.0	AM_450200

Elective courses MSc Earth Sciences

Courses:

Name	Period	Credits	Code
3D Seismic Interpretation and Production Geology	Period 1	6.0	AM_450316
Advanced Geochronology	Period 5	3.0	AM_450171
Advanced Inorganic Geochemistry	Period 5	3.0	AM_450172
Advanced Tectonics	Period 5	6.0	AM_1173
Capita Selecta Geology and Geochemistry	Period 4	6.0	AM_1174
Catchment Response Analysis	Period 1	6.0	AM_450003
Causes and Consequences of Environmental Change	Period 1	6.0	AM_1049
Climate and Policy	Period 3	6.0	AM_450188
Climate Modelling	Ac. Year (September), Period 3	6.0	AM_450004
Diagenesis of Sedimentary Rocks	Period 5	3.0	AM_450169
Ecohydrology	Period 1	6.0	AM_450014
Environmental Remote Sensing		6.0	AM_450145
Geothermal Energy		6.0	AM_450409
Global Biogeochemical Cycles	Ac. Year (September), Period 4	6.0	AM_450332
Groundwater Microbiology and Geochemistry (Geomicrobiology)	Ac. Year (September)	6.0	AM_450132
Human Geography II	Ac. Year (September)	12.0	AM_1051
Magmatic Processes	Period 4	6.0	AM_450189
Man and Climate	Period 4	3.0	AM_450187

Metamorphism and P-T Evolution	Period 4	6.0	AM_450176
Modern Climate and Geo-ecosystems	Period 1	6.0	AM_1124
Petroleum Geology of the North Sea	Period 2	7.0	AM_450317
Planetary Science	Period 1+2	6.0	AM_450273
Practical: Paleoclimate Change and Environmental Impacts	Period 4	6.0	AM_1144
Precambrian Geology	Period 4	3.0	AM_450164
Reflection Seismic for Geologists	Period 4	6.0	AM_450170
Science and Communication	Period 1	6.0	AM_470587
Science Journalism	Period 2	6.0	AM_471014
Sediment Petrography of Heavy Minerals	Period 3	3.0	AM_450058
Sedimentary Environments and Climate Archives	Period 1	6.0	AM_450330
Sustainable Energy Analysis	Period 1	6.0	AM_468018
Unsaturated Zone and Near Surface Hydrological Processes	Period 2	6.0	AM_450021
Volcanism	Period 3	3.0	AM_450061

Education specific content

Programme components:

- Leraar voorbereidend hoger onderwijs Aardrijkskunde, Overgangsregels
- Leraar voorbereidend hoger onderwijs Aardrijkskunde verplicht
- Master Leraar voorbereidend hoger onderwijs Aardrijkskunde vanaf 2015

Leraar voorbereidend hoger onderwijs Aardrijkskunde, Overgangsregels

Courses:

Name	Period	Credits	Code
Educational and Pedagogical Studies I	Period 1+2	6.0	O_MLADEPI
Research I	Period 1+2+3	3.0	O_MLVPOOI
Teaching Methodology Geography I	Period 1+2	3.0	O_MLVDAKI
Teaching Practice I	Period 1+2+3	15.0	O_MLPRAKI

Leraar voorbereidend hoger onderwijs Aardrijkskunde verplicht

Courses:

Name	Period	Credits	Code
Educational and Pedagogical Studies II	Period 1+2	3.0	O_MLADEPII
Research II	Period 1+2+3	6.0	O_MLVPOOII
Specialisation	Period 2+3	3.0	O_MLVERD
Teaching Methodology Geography II	Period 1+2	6.0	O_MLVDAKII
Teaching Practice II	Period 1+2+3	15.0	O_MLPRAKII

Master Leraar voorbereidend hoger onderwijs Aardrijkskunde vanaf 2015

Courses:

Name	Period	Credits	Code
Didactiek 1	Period 1, Period 4	6.0	O_MLDIDAC_1
Didactiek 2	Period 2+3, Period 5+6	6.0	O_MLDIDAC_2
Didactiek 3	Period 4+5+6	9.0	O_MLDIDAC_3
Peergroup 1	Period 1+2+3, Period 4+5+6	0.0	O_MLPEERGR_1
Peergroup 2	Period 3+4+5	0.0	O_MLPEERGR_2
Praktijk 1	Period 1, Period 4	6.0	O_MLPRAK_1
Praktijk 2	Period 2+3, Period 5+6	9.0	O_MLPRAK_2
Praktijk 3	Period 4+5+6	15.0	O_MLPRAK_3
Praktijk onderzoek 1	Period 3, Period 6	3.0	O_MLPROZ_1
Praktijk onderzoek 2	Period 4+5+6	6.0	O_MLPROZ_2

MSc Earth Sciences, specialization 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.

Programme components:

- 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

Courses:

Name	Period	Credits	Code
Decision Making Processes	Period 2	6.0	AM_450402
Empirical Methods for Spatial Policy	Period 2	6.0	AM_450401
Exploring Earth Processes and Resources	Period 4	6.0	AM_450405
Imaging and Assessing Landscapes	Period 4	6.0	AM_1183
Master Thesis Earth Sciences and Economics	Period 3+4+5+6	24.0	AM_1150
Microeconomic Foundation of Spatial Policy	Period 1	6.0	AM_450400
Project Environmental Impact Assessment	Period 3	6.0	AM_450406
Research Project Earth Sciences and Economics	Ac. Year (September)	18.0	AM_1103
Water and Policy	Period 1	6.0	AM_468023

Choose one of these courses

Courses:

Name	Period	Credits	Code
Economics of Climate Change	Period 4	6.0	E_STR_ECC
Geothermal Energy		6.0	AM_450409

Earth Sciences oriented course components, choose at least 6 EC

Courses:

Name	Period	Credits	Code
Ecohydrology	Period 1	6.0	AM_450014
Geothermal Energy		6.0	AM_450409
Modern Climate and Geo-ecosystems	Period 1	6.0	AM_1124

Petroleum Systems for Earth and Economics	Period 1	6.0	AM_450408

Economics oriented course components, choose at least 6 EC

Courses:

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

Choose 18 EC of these courses

Courses:

Name	Period	Credits	Code
Building Bridges between Science and Society		6.0	AMU_0010
Climate and Policy	Period 3	6.0	AM_450188
Ecosystem Management		6.0	AMU_0011
Energy Governance	Period 3	6.0	AM_1155
Man and Climate	Period 4	3.0	AM_450187
Reflection Seismic for Geologists	Period 4	6.0	AM_450170
Sedimentary Environments and Climate Archives	Period 1	6.0	AM_450330
Spatial Processes in Ecology	Ac. Year (September)	6.0	AMU_0009
Sustainable Energy Analysis	Period 1	6.0	AM_468018

Elective courses MSc Earth Sciences

Courses:

Name	Period	Credits	Code
3D Seismic Interpretation and Production Geology	Period 1	6.0	AM_450316
Advanced Geochronology	Period 5	3.0	AM_450171
Advanced Inorganic Geochemistry	Period 5	3.0	AM_450172

Advanced Tectonics	Period 5	6.0	AM_1173
Capita Selecta Geology and Geochemistry	Period 4	6.0	AM_1174
Catchment Response Analysis	Period 1	6.0	AM_450003
Causes and Consequences of Environmental Change	Period 1	6.0	AM_1049
Climate and Policy	Period 3	6.0	AM_450188
Climate Modelling	Ac. Year (September), Period 3	6.0	AM_450004
Diagenesis of Sedimentary Rocks	Period 5	3.0	AM_450169
Ecohydrology	Period 1	6.0	AM_450014
Environmental Remote Sensing		6.0	AM_450145
Geothermal Energy		6.0	AM_450409
Global Biogeochemical Cycles	Ac. Year (September), Period 4	6.0	AM_450332
Groundwater Microbiology and Geochemistry (Geomicrobiology)	Ac. Year (September)	6.0	AM_450132
Human Geography II	Ac. Year (September)	12.0	AM_1051
Magmatic Processes	Period 4	6.0	AM_450189
Man and Climate	Period 4	3.0	AM_450187
Metamorphism and P-T Evolution	Period 4	6.0	AM_450176
Modern Climate and Geo-ecosystems	Period 1	6.0	AM_1124
Petroleum Geology of the North Sea	Period 2	7.0	AM_450317
Planetary Science	Period 1+2	6.0	AM_450273
Practical: Paleoclimate Change and Environmental Impacts	Period 4	6.0	AM_1144
Precambrian Geology	Period 4	3.0	AM_450164
Reflection Seismic for Geologists	Period 4	6.0	AM_450170
Science and Communication	Period 1	6.0	AM_470587
Science Journalism	Period 2	6.0	AM_471014
Sediment Petrography of Heavy Minerals	Period 3	3.0	AM_450058
Sedimentary Environments and Climate Archives	Period 1	6.0	AM_450330
Sustainable Energy Analysis	Period 1	6.0	AM_468018
Unsaturated Zone and Near Surface Hydrological Processes	Period 2	6.0	AM_450021
Volcanism	Period 3	3.0	AM_450061

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

Programme components:

- Elective courses MSc Earth Sciences
- MSc Earth Sciences, specialisation Earth Surface Processes, Climate and Records, year 1
- MSc Earth Sciences, specialisation Earth Surface Processes, Climate and Records, year 2

Elective courses MSc Earth Sciences

Courses:

Name	Period	Credits	Code
3D Seismic Interpretation and Production Geology	Period 1	6.0	AM_450316
Advanced Geochronology	Period 5	3.0	AM_450171
Advanced Inorganic Geochemistry	Period 5	3.0	AM_450172
Advanced Tectonics	Period 5	6.0	AM_1173
Capita Selecta Geology and Geochemistry	Period 4	6.0	AM_1174
Catchment Response Analysis	Period 1	6.0	AM_450003
Causes and Consequences of Environmental Change	Period 1	6.0	AM_1049
Climate and Policy	Period 3	6.0	AM_450188
Climate Modelling	Ac. Year (September), Period 3	6.0	AM_450004
Diagenesis of Sedimentary Rocks	Period 5	3.0	AM_450169
Ecohydrology	Period 1	6.0	AM_450014
Environmental Remote Sensing		6.0	AM_450145
Geothermal Energy		6.0	AM_450409
Global Biogeochemical Cycles	Ac. Year (September), Period 4	6.0	AM_450332
Groundwater Microbiology and Geochemistry (Geomicrobiology)	Ac. Year (September)	6.0	AM_450132
Human Geography II	Ac. Year (September)	12.0	AM_1051
Magmatic Processes	Period 4	6.0	AM_450189
Man and Climate	Period 4	3.0	AM_450187
Metamorphism and P-T Evolution	Period 4	6.0	AM_450176
Modern Climate and Geo-ecosystems	Period 1	6.0	AM_1124

Petroleum Geology of the North Sea	Period 2	7.0	AM_450317
Planetary Science	Period 1+2	6.0	AM_450273
Practical: Paleoclimate Change and Environmental Impacts	Period 4	6.0	AM_1144
Precambrian Geology	Period 4	3.0	AM_450164
Reflection Seismic for Geologists	Period 4	6.0	AM_450170
Science and Communication	Period 1	6.0	AM_470587
Science Journalism	Period 2	6.0	AM_471014
Sediment Petrography of Heavy Minerals	Period 3	3.0	AM_450058
Sedimentary Environments and Climate Archives	Period 1	6.0	AM_450330
Sustainable Energy Analysis	Period 1	6.0	AM_468018
Unsaturated Zone and Near Surface Hydrological Processes	Period 2	6.0	AM_450021
Volcanism	Period 3	3.0	AM_450061

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

Programme components:

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

Compulsory courses year 1 spec. ESP

Courses:

Name	Period	Credits	Code
Basics in Geographical Information Systems	Period 5	3.0	AM_450226
From Source to Sink: Chemical and Physical Cycles	Period 2	6.0	AM_450146
Global Biogeochemical Cycles	Ac. Year (September), Period 4	6.0	AM_450332
High Resolution Archives	Period 2	6.0	AM_450331
Modern Climate and Geo-ecosystems	Period 1	6.0	AM_1124
Practical: Paleoclimate Change and Environmental Impacts	Period 4	6.0	AM_1144

Scotland Excursion	Period 6	3.0	AM_450354
Sedimentary Environments and Climate Archives	Period 1	6.0	AM_450330

Choose one of these courses

Courses:

Name	Period	Credits	Code
Climate Modelling	Ac. Year (September), Period 3	6.0	AM_450004
Environmental Remote Sensing		6.0	AM_450145

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

Programme components:

- 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

Courses:

Name	Period	Credits	Code
Catchment Response Analysis	Period 1	6.0	AM_450003
Causes and Consequences of Environmental Change	Period 1	6.0	AM_1049
Climate and Policy	Period 3	6.0	AM_450188
Ecohydrology	Period 1	6.0	AM_450014
Environmental Remote Sensing		6.0	AM_450145
Groundwater Hydraulics	Ac. Year (September)	6.0	AM_450009
Hydrochemistry	Ac. Year (September)	6.0	AM_450052
Hydrological Systems and Water Management	Ac. Year (September)	3.0	AM_1012
Man and Climate	Period 4	3.0	AM_450187
Precambrian Geology	Period 4	3.0	AM_450164
Science Journalism	Period 2	6.0	AM_471014
Sediment Petrography of Heavy Minerals	Period 3	3.0	AM_450058

Unsaturated Zone and Near Surface Hydrological Processes	Period 2	6.0	AM_450021

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

MSc Earth Sciences, specialisation Geology and Geochemistry

Programme components:

- Elective courses MSc Earth Sciences
- MSc Earth Sciences, specialisation Solid Earth, compulsory courses year 1
- MSc Earth Sciences, specialisation Solid Earth, compulsory courses year 2

Elective courses MSc Earth Sciences

Courses:

Name	Period	Credits	Code
3D Seismic Interpretation and Production Geology	Period 1	6.0	AM_450316
Advanced Geochronology	Period 5	3.0	AM_450171
Advanced Inorganic Geochemistry	Period 5	3.0	AM_450172
Advanced Tectonics	Period 5	6.0	AM_1173
Capita Selecta Geology and Geochemistry	Period 4	6.0	AM_1174
Catchment Response Analysis	Period 1	6.0	AM_450003
Causes and Consequences of Environmental Change	Period 1	6.0	AM_1049
Climate and Policy	Period 3	6.0	AM_450188
Climate Modelling	Ac. Year (September), Period 3	6.0	AM_450004
Diagenesis of Sedimentary Rocks	Period 5	3.0	AM_450169
Ecohydrology	Period 1	6.0	AM_450014
Environmental Remote Sensing		6.0	AM_450145
Geothermal Energy		6.0	AM_450409
Global Biogeochemical Cycles	Ac. Year (September), Period 4	6.0	AM_450332
Groundwater Microbiology and Geochemistry (Geomicrobiology)	Ac. Year (September)	6.0	AM_450132

Human Geography II	Ac. Year (September)	12.0	AM_1051
Magmatic Processes	Period 4	6.0	AM_450189
Man and Climate	Period 4	3.0	AM_450187
Metamorphism and P-T Evolution	Period 4	6.0	AM_450176
Modern Climate and Geo-ecosystems	Period 1	6.0	AM_1124
Petroleum Geology of the North Sea	Period 2	7.0	AM_450317
Planetary Science	Period 1+2	6.0	AM_450273
Practical: Paleoclimate Change and Environmental Impacts	Period 4	6.0	AM_1144
Precambrian Geology	Period 4	3.0	AM_450164
Reflection Seismic for Geologists	Period 4	6.0	AM_450170
Science and Communication	Period 1	6.0	AM_470587
Science Journalism	Period 2	6.0	AM_471014
Sediment Petrography of Heavy Minerals	Period 3	3.0	AM_450058
Sedimentary Environments and Climate Archives	Period 1	6.0	AM_450330
Sustainable Energy Analysis	Period 1	6.0	AM_468018
Unsaturated Zone and Near Surface Hydrological Processes	Period 2	6.0	AM_450021
Volcanism	Period 3	3.0	AM_450061

MSc Earth Sciences, specialisation Solid Earth, compulsory courses year 1

Courses:

Name	**Period**	**Credits**	**Code**
From Source to Sink: Chemical and Physical Cycles	Period 2	6.0	AM_450146
Introduction Field Excursion	Period 1	3.0	AM_450229
Mantle Properties in Lithosphere Development	Period 1	3.0	AM_450225
Orogenesis	Period 3	6.0	AM_450190
Petroleum Systems and Regional Geology	Period 1	3.0	AM_450179
Research Project Geology and Geochemistry	Ac. Year (September)	27.0	AM_1187
Sedimentary Basins	Period 2	6.0	AM_450154

MSc Earth Sciences, specialisation Solid Earth, compulsory courses year 2

Courses:

Name	Period	Credits	Code
Master Thesis Geology and Geochemistry	Ac. Year (September)	27.0	AM_1186
Research Project Geology and Geochemistry	Ac. Year (September)	27.0	AM_1187

MSc 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 .

Programme components:

- 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

Programme components:

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

Elective courses MSc Earth Sciences

Courses:

Name	Period	Credits	Code
3D Seismic Interpretation and Production Geology	Period 1	6.0	AM_450316
Advanced Geochronology	Period 5	3.0	AM_450171
Advanced Inorganic Geochemistry	Period 5	3.0	AM_450172
Advanced Tectonics	Period 5	6.0	AM_1173
Capita Selecta Geology and Geochemistry	Period 4	6.0	AM_1174
Catchment Response Analysis	Period 1	6.0	AM_450003
Causes and Consequences of Environmental Change	Period 1	6.0	AM_1049
Climate and Policy	Period 3	6.0	AM_450188
Climate Modelling	Ac. Year (September), Period 3	6.0	AM_450004
Diagenesis of Sedimentary Rocks	Period 5	3.0	AM_450169
Ecohydrology	Period 1	6.0	AM_450014
Environmental Remote Sensing		6.0	AM_450145
Geothermal Energy		6.0	AM_450409
Global Biogeochemical Cycles	Ac. Year (September), Period 4	6.0	AM_450332
Groundwater Microbiology and Geochemistry (Geomicrobiology)	Ac. Year (September)	6.0	AM_450132
Human Geography II	Ac. Year (September)	12.0	AM_1051
Magmatic Processes	Period 4	6.0	AM_450189
Man and Climate	Period 4	3.0	AM_450187
Metamorphism and P-T Evolution	Period 4	6.0	AM_450176
Modern Climate and Geo-ecosystems	Period 1	6.0	AM_1124
Petroleum Geology of the North Sea	Period 2	7.0	AM_450317
Planetary Science	Period 1+2	6.0	AM_450273
Practical: Paleoclimate Change and Environmental Impacts	Period 4	6.0	AM_1144
Precambrian Geology	Period 4	3.0	AM_450164
Reflection Seismic for Geologists	Period 4	6.0	AM_450170
Science and Communication	Period 1	6.0	AM_470587
Science Journalism	Period 2	6.0	AM_471014
Sediment Petrography of Heavy Minerals	Period 3	3.0	AM_450058
Sedimentary Environments and Climate Archives	Period 1	6.0	AM_450330

Sustainable Energy Analysis	Period 1	6.0	AM_468018
Unsaturated Zone and Near Surface Hydrological Processes	Period 2	6.0	AM_450021
Volcanism	Period 3	3.0	AM_450061

Research project (choose one)

Courses:

Name	Period	Credits	Code
Research Project Earth Sciences and Economics	Ac. Year (September)	18.0	AM_1103
Research Project Solid Earth	Ac. Year (September)	27.0	AM_450200

MSc Earth Sciences, specialisation Science Communication, Science Communication content

Programme components:

- Optional modules Science Communication
- Compulsory components Science Communic.

Optional modules Science Communication

Courses:

Name	Period	Credits	Code
Communication, Organization and Management	Period 2	6.0	AM_470572
Science in Dialogue	Period 2	6.0	AM_1002
Science Journalism	Period 2	6.0	AM_471014
Science Museology	Period 3	6.0	AM_470590

Compulsory components Science Communic.

Courses:

Name	Period	Credits	Code
Science and Communication	Period 1	6.0	AM_470587

3D Seismic Interpretation and Production Geology

Course code	AM_450316 ()
Period	Period 1
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	prof. dr. J.J.G. Reijmer
Examinator	prof. dr. J.J.G. Reijmer
Teaching method(s)	Seminar
Level	400

Course objective
Introduce 3D Seismic interpretation as a subsurface exploration and production tool to find hydrocarbons. Give an overview of workflows in subsurface modelling and highlight dependencies between seismic interpretation and hydrocarbon production.

Course content
Introduction: seismic interpretation as a step in subsurface modelling for exploration and production of hydrocarbons / Fundamentals of the seismic method / Storage and display of seismic data / Introduction to Petrel software / Simple horizon interpretation
Volume attributes as aid in structural and stratigraphic interpretation / Structural styles / Interpretation of fault planes in 3D / Links to Framework Modelling / 3D visualisation techniques
Seismic resolution / Tying seismic and well data / Techniques for interpretation of continuous reflections / Jump correlation across faults / Techniques for improving interpretability
Large-scale depositional geometries and controlling processes / Interpretation techniques for unconformities and lap surfaces / Direct Hydrocarbon Indicators
Seismic attributes for prediction of reservoir quality and fluid fill / Depth conversion
Introduction to reservoir geology/core description/well correlation/facies interpretation
Building of a static reservoir model in Petrel/ horizon modelling/property modelling/geostatistics
Anatomy of a reservoir/static&dynamic modelling/ FDP/drilling a well

Form of tuition
Lectures on specific topics
Hands-on 3D seismic interpretation using PC-based software
Feed-back sessions with presentations by participants
Exercises on numerical steps in interpretation

Type of assessment
Written Examination 40%; oral presentation 20%; practical 40%

Remarks
Course will be given as a 3 week block course at Shell research in Rijswijk. Course has a limited capacity.

Advanced Geochronology

Course code	AM_450171 ()
Period	Period 5
Credits	3.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	prof. dr. J.R. Wijbrans
Examinator	prof. dr. J.R. Wijbrans
Teaching staff	prof. dr. J.R. Wijbrans, dr. K.F. Kuiper
Teaching method(s)	Seminar
Level	500

Course objective
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

Course content
- 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).

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

Type of assessment
Essay – presentation – poster

Course reading
Selection literature for individual essay and presentation projects to be announced on Blackboard.

Entry requirements
BSc Geology

Recommended background knowledge
Petrology, structural geology, tectonics courses at the BSc level.

Target group

1st year MSc Earth Science Solid Earths.

Remarks
Course teachers include dr. Klaudia Kuiper and dr. J.M. O'Connor, University of Erlangen.

Advanced Inorganic Geochemistry

Course code	AM_450172 ()
Period	Period 5
Credits	3.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	prof. dr. G.R. Davies
Examinator	prof. dr. G.R. Davies
Teaching staff	dr. P.Z. Vroon, prof. dr. G.R. Davies, prof. dr. W. van Westrenen
Teaching method(s)	Study Group
Level	500

Course objective
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.

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

Form of tuition
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

Type of assessment
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%).

Course reading
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.

Entry requirements
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.

Recommended background knowledge
The Mantle Properties in Lithosphere Development and Magmatic Processes courses provide useful backgrounds in isotope geochemistry.

Target group
Second year MSc students in Earth Sciences.

Remarks
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 Tectonics

Course code	AM_1173 ()
Period	Period 5
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	prof. dr. W. van Westrenen
Examinator	prof. dr. W. van Westrenen
Teaching method(s)	Seminar
Level	400

Assessing the Landscape

Course code	AM_450404 ()
Credits	3.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen

Coordinator	dr. E. Koomen
Examinator	dr. E. Koomen
Teaching staff	drs. E. Koomen
Teaching method(s)	Seminar, Computer lab, Excursion
Level	400

Course objective
The landscape is the visible result of human interaction with its physical surroundings. This course introduces the concept of landscape, discuss various ways to classify and value landscapes and show how such values can be mapped and analysed. 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.

Course content
The following topics are included in this course:
• Introduction to the landscape concept and course outline: 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?

Form of tuition
The course consists of five lectures (of two hours) and several non-supervised practical assignments. 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. In total this course is expected to take about 20 hours per week.

Type of assessment
The assessment will be based on a written final examination (50%) and the marks for the practical assignments (50%). For each of these components students should at least obtain a mark of 5.

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

Entry requirements
This course is linked to the preceding Imaging the Earth Surface course (450403). A working knowledge of GIS, as is obtained there, is essential

for the practical assignments in this subject.

Recommended background knowledge
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
• Barends, S. et al. (2005) Het Nederlandse landschap. Een historisch-geografische benadering. 9e druk, Matrijs, Utrecht.

Target group
The course is part of Master programme Earth and Economics, but open to others with an interest in the valuation of landscapes provided they possess the required knowledge listed below.

Remarks
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
Barends, S. et al. (2005) Het Nederlandse landschap. Een historisch-geografische benadering. 9e druk, Matrijs, Utrecht.

Basics in Geographical Information Systems

Course code	AM_450226 ()
Period	Period 5
Credits	3.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. ir. J. van Vliet
Examinator	dr. ir. J. van Vliet
Teaching method(s)	Computer lab
Level	400

Course objective
To build a high level of practical skills and experience in the use of professional GIS software for data collection, integration, visualization, database design, mapping and automated analysis and management for a couple of specific earth science related case studies.

Course content
This course consists of a theoretical part and a practical part. In the theoretical part the principles of GIS are explained (database management, data acquisition and integration, spatial analysis, Web-based GIS, Mobile GIS and visualization). The practical part focuses on the use of the software package ArcGIS and is mostly applied to earth scientific study themes. The student will be trained in the use of GIS and special attention will be paid to the use of mobile GIS systems.

Form of tuition
8 hours of lectures, 24 hours of practical (computer) exercises. Self study, including literature study.

Type of assessment
Written exam (ca. 50%) and practical computer exam (ca. 50%).

Course reading
Lecture notes, chapters from Longley et al., (2001) GIS and Science, John Wiley, selected articles

Recommended background knowledge
Advice regarding previous course taken: AB_!076: GIS and digital geographical data

Remarks
The course coordinator for this course can still be subject of change

Building Bridges between Science and Society

Course code	AMU_0010 ()
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen

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

Capita Selecta Geology and Geochemistry

Course code	AM_1174 ()
Period	Period 4
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	prof. dr. W. van Westrenen
Teaching method(s)	Seminar
Level	400

Course objective
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.

Course content
The course starts with a joint session in which an inventory is made of student interests, and in which students are coupled to staff members. A project plan is written in collaboration with the staff member, followed by an extensive literature review culminating in a written review report and an oral presentation in a joint session at the end of the course.

Form of tuition
Lecture (1) followed by separate meetings between student and staff member.

Type of assessment
(1) Written Report and (2) oral presentation, with written report making up 75 per cent of the final grade.

Course reading
Extensive literature review.

Entry requirements
None.

Target group
MSc Students in the Solid Earth track of the MSc Earth Sciences

Catchment Response Analysis

Course code	AM_450003 ()
Period	Period 1
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	drs. E.J. Moors
Examinator	drs. E.J. Moors
Teaching staff	drs. E.J. Moors
Teaching method(s)	Seminar, Computer lab
Level	400

Course objective
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 reader, 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.

Course content
The course consists of three main topics. We start with an overview of hydrodynamic and hydraulic theory that governs flow in open channels. This is followed by lectures on discharge measurement techniques,

catchment response analysis and runoff statistics. Topics are hill slope hydrology, hydrograph analysis, reservoir and flow routing and statistical methods to describe and quantify spatial and temporal variation in catchment runoff. 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.

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

Type of assessment
The assessment is through a written exam (75%) and assessment of the modelling workshop report (25%).

Course reading
Bishop et al. 2008. Aqua Incognita: the unknown headwaters, Hydrological Processes 22: 1239–1242. doi: 10.1002/hyp.7049.

A,.A. van der Griend and M.J. Waterloo (2013), Catchment Response Analysis. Course Reader, VU University, Amsterdam.

B.L. McGlynn, J.J. McDonnel and D.D. Brammer. A review of the evolving perceptual model of hillslope Flowpaths at the Maimai catchments, New Zealand. Journal of Hydrology 257 (2002) 1-26.

J. Seibert, 2002. HBV light version 2 User's Manual. Environmental Assessment SLU, Sweden.

Seibert, J. and M.J.P. Vis 2012. Teaching hydrological modeling with a user-friendly catchment-runoff-model software package, Hydrology and Earth System Sciences 16: 3315-3325, doi:10.5194/hess-16-3315-2012, 2012.

I. Tromp-van Meerveld and M. Weiler. Hillslope dynamics modeled with increasing complexity. Journal of Hydrology (2008) 361, 24-40.

Links to other papers are provided on Blackboard.

Entry requirements
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.

Recommended background knowledge
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).

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

Remarks
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

Course code	AM_1049 ()
Period	Period 1
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. A.J.A. van Teeffelen MSc
Examinator	dr. A.J.A. van Teeffelen MSc
Teaching staff	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 MSc, prof. dr. F.H.B. Biermann
Teaching method(s)	Lecture, Study Group, Computer lab, Seminar
Level	400

Course objective
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 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. have demonstrated skills, notably: writing, framing, presenting, and reviewing.
8. demonstrated a capacity to collaborate in interdisciplinary teams and contribute to a shared goal;

Course content
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: declining bluefin tuna populations; unforeseen effects of contaminants; human protein needs and disruption of the nitrogen cycle; and the invasion of the Wadden Sea by foreign species such as the Pacific oyster. 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.

Form of tuition
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 group activities, assignments undertaken in pairs, and the exam. Feedback opportunities are included in class activities as well as assessments.
Approximate time allocation:
• Class: 55 hours
• Reading and exam preparation: 50 hours
• Assignment & peer review: 35 hours
• Presentations: 25 hours

Type of assessment
• group activities (two presentations) worth 30% of the final grade
• assignment and peer review worth 30% of the final grade
• exam worth 40% of the final grade.

Course reading
Subject to revision – see course manual for final version.
Boersema, J. & L. Reijnders (eds.) 2009. Principles of Environmental

Sciences. Springer, Berlin. (available in PDF). Chapters 1, 5, 6, 7, 9, 10 (excl. 10.5.3 - 10.6.4), 11 (pp 192-204), 12 (pp 207211; 232-236), 13, 14.

Tietenberg, T.H. & L. Lewis. 2014. Environmental economics and policy. Pearson New International Edition. 6th Edition. Chapter 6 (pp 111136). Chapter 14 (pp 317342).

Target group
Students who have completed their bachelor's degree. Masters' students.

Remarks
Guest lecturers for selected topics:
Prof. Jeroen van den Bergh
Dr. Jaap Mulder
Prof. Arthur Petersen

Climate and Policy

Course code	AM_450188 ()
Period	Period 3
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	prof. dr. P.H. Pattberg
Examinator	prof. dr. P.H. Pattberg
Teaching staff	prof. dr. P.H. Pattberg
Teaching method(s)	Seminar
Level	400

Course objective
After studying this course, students should be able to define and explain key concepts of relevance to the climate change governance 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; be able to understand and analyze the key political challenges in the climate change regime, the common problems facing all countries, the coalitions in the regime, the North-South, North-North, South-South, European and domestic political issues; be able to explain and assess 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, analyze and form a judgment on the role of forestry in the climate change regime, and the various aspects of policy with respect to deforestation and land degradation; be able to define and explain the role of market mechanisms in the climate change regime, their advantages and disadvantages, and their potential in addressing the climate change problem; be able to integrate the information learnt thus far to assess and identify possible long term solutions to the climate change problem and the research questions that emerge from a study of the climate change regime; and 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.

Course content
International policy on human-induced climate change and its mitigation is a hotly debated subject. Current (international) 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. These close relations between earth system research and economic/political questions make this course an interesting subject for students with a bachelor's degree in different subjects . The course includes:
- an overview of the science of climate change, its impacts (IPCC Fifth Assessment Report) uncertainties, mitigation, adaptation; - climate change policy options at multiple levels of governance; - analysis of the political challenges in climate change and the positions of different countries and actors; - assessment of the international legal instruments including the Climate Change Convention and the Kyoto Protocol, - assessment of the economics of climate change including analysing the flexible mechanisms (Emission trading, Clean Development Mechanisms, Reducing Emissions from Deforestation and Forest Degradation) and options for Post Kyoto measures; and paper discussions on a topical area of climate governance.

Form of tuition
The course consists of 7-8 interactive lectures including class presentations and uses modern didactic approaches, films, and role play to help the students internalize many of the concepts and theoretical approaches developed.

Type of assessment
The students will be examined on the basis of a paper (50%) and a closed book written examination (50%). Students must get a grade of 5.5 in each to pass in the examination.

Course reading
Reader

Recommended background knowledge
Basic knowledge of social science concepts such as governance

Target group
Students with an interest in governance and policy

Climate Modelling

Course code	AM_450004 ()
Period	Ac. Year (September), Period 3
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	prof. dr. H. Renssen
Examinator	prof. dr. H. Renssen

Teaching staff	prof. dr. H. Renssen, prof. dr. A.J. Dolman, dr. D.M.V.A.P. Roche
Teaching method(s)	Seminar, Computer lab
Level	400

Course content
Geological archives show convincingly that the climate system experiences variability on a wide range of time-scales. For Quaternary studies, climate variations at the following time-scales are most important: glacials-interglacials, millennia and centuries-decades. This course focuses at the mechanisms behind these variations, thereby using climate models as a tool, i.e. numerical computer models in which the dynamics of the climate system 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) and of discussion meetings, in which students discuss the recent literature in detail. In this way the course considers case studies for the different time-scales and deals with recent developments in climate modelling. The following two questions are central to the course: 1) What is the driving mechanism behind climate change at a particular time-scale? 2) How can we optimise the combination of climate models and geological data in order to increase our understanding of climate evolution?

Form of tuition
Lectures, discussion meetings and computer exercises.

Type of assessment
Compulsory participation in discussion meetings, computer exercises, oral presentation and written exam.

Course reading
Lecture notes and selected papers (made available through Blackboard).

Remarks
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

Course code	AM_470572 ()
Period	Period 2
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	M.J. Kishna
Examinator	M.J. Kishna
Teaching staff	dr. H. Wels, prof. dr. F. Scheele, dr. M.B.M. Zweekhorst
Teaching method(s)	Lecture, Study Group
Level	500

Course objective
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

Course content
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. In addition, the students interview managers in health organisations and analyse these interviews using the newly acquired theoretical concepts. 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.

Form of tuition
Lectures: approximately 22 hours
Response lectures: 4 hours
Training workshops 12 hours
Self-study and writing project assignment: remaining hours.

Type of assessment
Written exam (60%;) and assessment of the interviews, case study analysis, and reports (40%). Grades of both parts must at least be 6 or higher.

Course reading
To be announced on Blackboard

Target group
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

Remarks
Attendance to training, workshops, interviews and discussions is indispensable

Decision Making Processes

Course code	AM_450402 ()
Period	Period 2
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	prof. dr. D. Huitema
Examinator	prof. dr. D. Huitema
Teaching staff	dr. S. Munaretto
Teaching method(s)	Seminar
Level	400

Course objective
The objective of the course is to provide a conceptual framework for understanding, evaluating and applying concepts about individual, organizational and societal decision making processes (DMP).
Specifically, the course aims to give students tools to be able to:
1. reflect on the mechanisms and dynamics of individual, group and societal decision making ;
2. evaluate the soundness and effectiveness of decision making processes;
3. distinguish between different groups of analysis tools for decision-making processes, and understand their underlying assumptions;
4. use some of the analytic tools in practice in different decision contexts;
5. familiarize with scientific literature in the field;
6. have robust skills in oral expression and argumentation in English.

Course content
Mechanisms of decision making, tools for decision making, evaluation of decision making processes

Form of tuition
The course is structured as a reading club of 10 thematic sessions of 3 hours each. Students will be split in groups. Per each session, on a rotation basis, one student will select the literature (3 texts) on a given topic in consultation with the teachers, another student will act as discussant of the session, and a third student will be the note taker. The teachers will also provide guidance on how to structure and conduct the discussion, and how to take notes that are useful for future revision of the material.

Type of assessment
The examination is based on the performance during reading club sessions (planning, organization, activity, discussion, note taking) (60% of the grade) and on an individual assignment (40% of the grade) for which the student will have to select a case study.

Course reading
The following books can be checked to retrieve texts from for the reading clubs, and they are also recommended additional reading material:

March J.G. A primer on decision-making (1994). How decisions happen. New York: The free press.

Kleindorfer, P. R., H. C. Kunreuther, et al. (1993). Decision Sciences. An Integrative Perspective. Cambridge: Cambridge University Press.

Stone, D. (1997). Policy Paradox: The Art of Political Decision Making. New York, W.W. Norton

Jaeger, C. C., O. Renn, et al. (1998). Decision analysis and rational action. Human Choice and Climate Change Volume 3: The Tools for Policy Analysis. S. Rayner and E. L. Malone. Columbus, OH, Battelle Press.
The course is taught in English.

Recommended background knowledge
Kleindorfer, P. R., H. C. Kunreuther, et al. (1993). Decision Sciences. An Integrative Perspective. Cambridge, Cambridge University Press.
Chapters: 1, 2, 6, 8, 9, 10

Target group
MSc students

Registration procedure
Through blackboard and an e-mail to the teachers, prof. Huitema (dave.huitema@vu.nl) and dr. Munaretto (stefania.munaretto@vu.nl)

Remarks
The course will be given in English, and all assignments will be in English.

Diagenesis of Sedimentary Rocks

Course code	AM_450169 ()
Period	Period 5
Credits	3.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	prof. dr. J.J.G. Reijmer
Examinator	prof. dr. J.J.G. Reijmer
Teaching staff	prof. dr. J.J.G. Reijmer
Teaching method(s)	Seminar, Computer lab, Practical
Level	500

Course objective
• 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.

Course content
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.

Form of tuition
Classes and microscope practical

Type of assessment
Written exam (70%) report of prcatical (30%)

Course reading
Course notes and handout

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

Didactiek 1

Course code	O_MLDIDAC_1 ()
Period	Period 1, Period 4
Credits	6.0
Language of tuition	Dutch
Faculty	Fac. der Gedrags- en Bewegingswetensch.
Coordinator	C.L. Geraedts
Examinator	dr. A. Handelzalts
Teaching staff	drs. J.K.W. Riksen, drs. H.R. Goudsmit, drs. Y.G. Meindersma, ir. E.J.F. Scheringa, drs. W.S. Hoekstra, drs. C.D.P. van Oeveren, drs. S. Donszelmann, drs. B. Klein, drs. W. Jongejan, drs. L.J. van Well-van Grootheest, dr. H.B. Westbroek, C.L. Geraedts, drs. A. Krijgsman, dr. A.A. Kaal, dr. A. Handelzalts, drs. K.L. Schaap, W. Maas, F.L. de Vries MSc, drs. H. Stouthart, drs. I. Pauw
Teaching method(s)	Lecture, Study Group
Level	400

Didactiek 2

Course code	O_MLDIDAC_2 ()
Period	Period 2+3, Period 5+6
Credits	6.0
Language of tuition	Dutch

Faculty	Fac. der Gedrags- en Bewegingswetensch.
Coordinator	drs. B. Klein
Examinator	dr. A. Handelzalts
Teaching staff	drs. J.K.W. Riksen, drs. H.R. Goudsmit, drs. Y.G. Meindersma, ir. E.J.F. Scheringa, drs. W.S. Hoekstra, drs. C.D.P. van Oeveren, drs. S. Donszelmann, drs. B. Klein, drs. W. Jongejan, drs. L.J. van Well-van Grootheest, dr. H.B. Westbroek, C.L. Geraedts, drs. A. Krijgsman, dr. A.A. Kaal, dr. A. Handelzalts, drs. K.L. Schaap, W. Maas, F.L. de Vries MSc, drs. H. Stouthart, drs. I. Pauw
Teaching method(s)	Study Group, Lecture
Level	400

Didactiek 3

Course code	O_MLDIDAC_3 ()
Period	Period 4+5+6
Credits	9.0
Language of tuition	Dutch
Faculty	Fac. der Gedrags- en Bewegingswetensch.
Coordinator	drs. K.L. Schaap
Examinator	drs. K.L. Schaap
Teaching staff	drs. J.K.W. Riksen, drs. H.R. Goudsmit, drs. Y.G. Meindersma, ir. E.J.F. Scheringa, drs. W.S. Hoekstra, drs. C.D.P. van Oeveren, drs. S. Donszelmann, drs. B. Klein, drs. W. Jongejan, drs. L.J. van Well-van Grootheest, dr. H.B. Westbroek, C.L. Geraedts, drs. A. Krijgsman, dr. A.A. Kaal, dr. A. Handelzalts, drs. K.L. Schaap, W. Maas, F.L. de Vries MSc, drs. H. Stouthart, drs. I. Pauw
Teaching method(s)	Lecture, Study Group
Level	400

Ecohydrology

Course code	AM_450014 ()
Period	Period 1
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	prof. dr. A.J. Dolman
Examinator	prof. dr. A.J. Dolman
Teaching method(s)	Seminar, Computer lab
Level	400

Course objective
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.

Course content
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.

Form of tuition
The tuition consists of nine classroom lectures, a half-day student presentation session and a computer workshop (five half-days).

Type of assessment
Written test on lecture notes and selected literature (65%), attendance of workshops (15%), and a presentation to be given on a pre-determined topic (20%).

Course reading
Readers, scientific papers and handouts are provided during the course via Blackboard

Entry requirements
The student should be familiar with the subjects of the BSc course Introduction to Hydrology (450024) as detailed in the Introduction to Hydrology (2012) course reader by M.J. Waterloo, V.E.A. Post and K. Horner.

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

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

Remarks
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

Course code	E_STR_ECC ()
Period	Period 4
Credits	6.0
Language of tuition	English
Faculty	Fac. der Economische Wet. en Bedrijfsk.
Coordinator	dr. S. Poelhekke
Examinator	dr. S. Poelhekke
Teaching staff	prof. dr. R.S.J. Tol, dr. S. Poelhekke
Teaching method(s)	Lecture
Level	400

Course objective
Environmental problems can be of a local, a regional or a global nature. This course focuses on global issues. Two of the most important global environmental problems are the enhanced greenhouse effect and the relationship between international trade and the environment. This course aims to provide the student with a deeper insight in these issues, with a focus on environmental policy making in a globalizing world.

After having completed this course, you

- 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

Course content
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
- Trade the environment: pollution havens versus factor endowments
- International environmental agreements
- Economic impacts of climate change

- Climate change policy making: instruments and costs
- The economics of acidification and ozone depletion

The first 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 and the Sofia Protocol), but what are the incentives for countries to actually join the coalition? And what is the role of trade sanctions therein?

The last 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?

Type of assessment
essay
presentations
take home exam

Course reading
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.

Entry requirements
Microeconomics.

Ecosystem Management

Course code	AMU_0011 ()
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen

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

Educational and Pedagogical Studies I

Course code	O_MLADEPI ()
Period	Period 1+2
Credits	6.0
Language of tuition	Dutch
Faculty	Fac. der Gedrags- en Bewegingswetensch.
Coordinator	dr. A. Handelzalts
Examinator	dr. A. Handelzalts
Teaching staff	drs. J.K.W. Riksen, drs. H.R. Goudsmit, drs. Y.G. Meindersma, drs. W.S. Hoekstra, drs. C.D.P. van Oeveren, drs. S. Donszelmann, drs. B. Klein, drs. W. Jongejan, dr. H.B. Westbroek, C.L. Geraedts, drs. A. Krijgsman, dr. A.A. Kaal, drs. K.L. Schaap, W. Maas, F.L. de Vries MSc, drs. H. Stouthart, drs. I. Pauw
Teaching method(s)	Lecture
Level	500

Educational and Pedagogical Studies II

Course code	O_MLADEPII ()
Period	Period 1+2
Credits	3.0
Faculty	Fac. der Gedrags- en Bewegingswetensch.

Coordinator	dr. A. Handelzalts
Examinator	dr. A. Handelzalts
Teaching staff	drs. J.K.W. Riksen, drs. H.R. Goudsmit, drs. Y.G. Meindersma, drs. W.S. Hoekstra, drs. C.D.P. van Oeveren, drs. S. Donszelmann, drs. B. Klein, dr. T. Bosma, dr. H.B. Westbroek, C.L. Geraedts, drs. A. Krijgsman, dr. A.A. Kaal, drs. K.L. Schaap, W. Maas, F.L. de Vries MSc, drs. H. Stouthart, drs. I. Pauw
Teaching method(s)	Lecture, Seminar
Level	500

Empirical Methods for Spatial Policy

Course code	AM_450401 ()
Period	Period 2
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Examinator	dr. T. de Graaff
Teaching staff	dr. T. de Graaff
Teaching method(s)	Lecture, Study Group
Level	400

Course objective
At the end of this course the student understands the state of the art of empirical economic research methods in the domain of spatial planning, spatial economics and environmental policy. Moreover, the student is able to apply these methods in his/her own research, in particular in writing the Master thesis.

Course content
Key issues to be addressed are econometric methods (from OLS to discrete choice modelling), identification issues, evaluation techniques (including revealed and stated preference techniques, survey design), and spatial econometrics.

Form of tuition
Number of contact hours is 36 hours,

Type of assessment
Written exam (75%); assignments (25%).

Course reading
Stock and Watson, Introduction to Econometrics, Pearson Publ., 2012.
Syllabus (see blackboard)

Entry requirements
Mathematical Integration and Differentiation, Optimalisation, Matrixcalculus, Multivariat Regression Analysis, Time series analysis and Discrete Choice Models. This level can be reached by participating in the course ‘Methoden en technieken voor economisch onderzoek’ (450346, 6 EC), part of the Bachelor programme Aarde en economie (in Dutch).

Recommended background knowledge
Mathematical Integration and Differentiation, Optimalisation, Matrixcalculus, and Multivariate Regression Analysis. This level can be reached by participating in the course ‘Methoden en technieken voor economisch onderzoek’ (450346, 6 EC), part of the Bachelor programme Aarde en economie (in Dutch).

Energy Governance

Course code	AM_1155 ()
Period	Period 3
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	prof. dr. P.H. Pattberg
Examinator	prof. dr. P.H. Pattberg
Teaching method(s)	Seminar
Level	400

Environmental Economics

Course code	E_STR_EEC (60442040)
Period	Period 2
Credits	6.0
Language of tuition	English
Faculty	Fac. der Economische Wet. en Bedrijfsk.
Coordinator	dr. G.C. van der Meijden
Examinator	dr. G.C. van der Meijden
Teaching staff	dr. G.C. van der Meijden
Teaching method(s)	Lecture
Level	400

Course objective
The course aims to learn students that 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 air pollution and overexploitation of natural resources. Moreover, students will be capable of explaining which policy instruments can be used by the government to tackle environmental problems that arise in a market economy. Finally, students will be taught how renewable resources (such as forestries 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.

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 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:
• are able to describe the most important interactions between the economy and the environment, and their relationship with sustainable development.
• 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
• 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 fisheries and forestries, 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
• can 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 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.
• can explain the theoretic measures of 'willingness to pay' (WTP) and 'willingness to accept' (WTA) to obtain a monetary valuation of environmental changes
• are able to use stated preference methods (e.g., contingent valuation) and 'revealed preference' methods (e.g., travel cost model) to determine the WTA and WTP for environmental changes
• 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

Course content
The following topics will be dealt with in the course:
- interaction between the economy and the environment
- sustainable development
- welfare economics and market failures
- 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'

- 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.

Form of tuition
Lectures, tutorials, assignments, student presentations, and group discussions.

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

Course reading
- Hanley, Nick, Jason F. Shogren and Ben White (2007), Environmental Economics in Theory and Practice. Palgrave Macmillan, 2nd Ed.
- Additional articles from the economics literature, to be announced on Blackboard

Recommended background knowledge
Advanced microeconomics.

Environmental Remote Sensing

Course code	AM_450145 ()
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	prof. dr. R.T. van Balen
Examinator	prof. dr. R.T. van Balen
Teaching method(s)	Seminar, Computer lab
Level	400

Course objective
This course will make the student more familiar with remote sensing and the main objectives of this course are: (i) To understand the fundamental characteristics of electromagnetic radiation and how this interacts with vegetation, soil, rock and water. (ii) To understand and master the methodology behind a large variety of remote sensing applications related to land surface observations, including a clear understanding of the limitations of these observations. (iii) To develop practical computer skills to use remote sensing products in environmental studies. During the lectures the physical basics and mathematical principles of remote sensing will be discussed. During the practical exercises we will use a suite of remote sensing-derived environmental data (i.e. geology, soil, water, and vegetation). The focus point of the course is dual; on the one side it will be focussed on the elementary knowledge and techniques and on the other site it will be focussed on the integration of several remote sensing. At the end of the course Environmental Remote Sensing the student should have:

• Knowledge of the basic principles of the electromagnetic spectrum

and the operation systems for satellite and airplane remote sensing (aerial photography, multi-spectral, and thermal scanning, microwave sensing) and the environmental applications;

• Understanding of the technology to derive reliable remote sensing products over land including vegetation products, water quality products, soil moisture, temperature and evapotranspiration.

• Knowledge of remote sensing data collection from different formats (i.e. hdf, .tif, .mat .nc) and the skills to use them in environmental studies.

• Adequate knowledge to criticize the quality of spatial data, to detect data errors, and to understand the usefulness of given datasets.

Course content
Remote sensing is a scientific technology that can be used to measure and monitor land surface processes from space. This course is designed to introduce students to:

• the fundamental characteristics of electromagnetic radiation, and;
• the interaction of electromagnetic radiation with materials such as vegetation, soil, rock, water, and the atmosphere, and;
• how this interaction can be used to study the Earth.

The lectures will focus on a large variety of remote sensing observations in different parts of the electromagnetic spectrum, each having its own application. Besides a thorough understanding of the theoretical basis, you will also learn how to use satellite data in both scientific and applied studies on scales ranging from detailed local case studies to global applications.

Form of tuition
16 hours of lectures, 24 hours of practical (computer) exercises and literature study

Type of assessment
Written Exam

Course reading
Readers, scientific papers and handouts are provided during the course via Blackboard

Recommended background knowledge
The student should have a good background knowledge of mathematics and physics at BSc level and basic knowledge of Geographical Information Systems.

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

Exploring Earth Processes and Resources

Course code	AM_450405 ()
Period	Period 4
Credits	6.0

Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	prof. dr. A.J. Dolman
Examinator	prof. dr. A.J. Dolman
Teaching staff	prof. dr. H. Doust
Teaching method(s)	Seminar, Computer lab
Level	400

Course objective
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.

Course content

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.

Form of tuition
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

Type of assessment
Written exam (50%), Scientific Paper (30 %), and oral presentation (20 %)

Course reading
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.

Recommended background knowledge
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.

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

From Source to Sink: Chemical and Physical Cycles

Course code	AM_450146 ()
Period	Period 2
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. M. ter Voorde
Examinator	dr. M. ter Voorde
Teaching staff	dr. M. ter Voorde
Teaching method(s)	Seminar, Computer lab
Level	400

Course objective
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.

Course content
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.

Form of tuition
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)

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

Course reading
• 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 Blackboard

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

Geothermal Energy

Course code	AM_450409 ()
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. M.P. Bokhorst
Examinator	dr. M.P. Bokhorst
Teaching method(s)	Lecture, Computer lab
Level	500

Course objective
• 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.

Course content
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.

Form of tuition
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.

Type of assessment
The final mark is made up of assignments (10%), a presentation, an excursion(10) and a 1-page abstract of relevant paper(s) (10%) and case studies (70%).

The practicals and case studies will cover the topics presented during the course.

Course reading
All materials will be digitally provided through Blackboard

Entry requirements
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

Course code	AM_450332 ()
Period	Ac. Year (September), Period 4
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	prof. dr. G.R. van der Werf
Examinator	prof. dr. G.R. van der Werf
Teaching staff	dr. J. van Huissteden
Teaching method(s)	Computer lab, Lecture
Level	400

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

Course content
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 a more 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) the arctic region, and 7) disturbances including deforestation and forest fires.

Form of tuition
12 Lectures, assistance with essay writing

Type of assessment
Written exam (50%) and essay (50%)

Course reading
W.H. Schlesinger: Biogeochemistry: An analysis of Global Change, 3th edition (Academic Press), lecture notes and literature made available during the course.

Target group
MSc students Earth Sciences, Hydrology, Environment and Resource management

Groundwater Hydraulics

Course code	AM_450009 ()
Period	Ac. Year (September)
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Teaching method(s)	Seminar
Level	400

Course objective
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.

Form of tuition
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.

Recommended background knowledge
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.

Target group
Students in the Hydrology Master

Groundwater Microbiology and Geochemistry (Geomicrobiology)

Course code	AM_450132 ()
Period	Ac. Year (September)
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	U. Nunes da Rocha

Examinator	U. Nunes da Rocha
Level	400

Course objective
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.

Course content
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.

Form of tuition
~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).

Type of assessment
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%).

Course reading
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).

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

Remarks
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

Course code	AM_450331 ()
Period	Period 2
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. C.J. Beets
Examinator	dr. C.J. Beets
Teaching staff	dr. C.J. Beets
Teaching method(s)	Seminar, Computer lab
Level	400

Course objective
• 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.

Course content
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

Form of tuition
Classes, Literature discussion, and computer practicals

Type of assessment
Literature discussion essay (50%) report of computer practical (50%)

Course reading
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)

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

Human Geography II

Course code	AM_1051 ()
Period	Ac. Year (September)
Credits	12.0
Language of tuition	Dutch
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	J.A. van der Schee
Examinator	J.A. van der Schee
Teaching method(s)	Seminar
Level	400

Hydrochemistry

Course code	AM_450052 ()
Period	Ac. Year (September)
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Teaching method(s)	Seminar, Computer lab, Practical
Level	400

Course objective
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.

Course content
Hydro(geo)chemistry is essential for solving problems related with (ground)water quality and ecohydrology. The following topics are included: sampling and analysis of (ground)water; thermodynamics and kinetics of hydrogeochemical processes; reactive properties of hydrogeological systems; dissolution and precipitation of minerals; carbonate chemistry; 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.

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

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

Course reading
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.

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

Target group
Hydrology Master students

Hydrological Systems and Water Management

Course code	AM_1012 ()
Period	Ac. Year (September)
Credits	3.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	drs. W.J.A. Stuijfzand
Examinator	drs. W.J.A. Stuijfzand
Teaching staff	drs. W.J.A. Stuijfzand
Teaching method(s)	Study Group, Lecture
Level	400

Course objective
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.

Course content
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.

Form of tuition
Lectures (~24 contact hours), practical exercises (8 hours), literature study (60 hours).

Type of assessment
Written examination (100%)

Course reading
a) Hydrochemistry and Hydrology of the coastal dune area of the Western Netherlands. Available via Stuyfzand (25 €).
b) Syllabus (from Blackboard).
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.

Entry requirements
450024 (Inleiding Hydrologie)

Recommended background knowledge
Advice regarding previous courses taken: AB_450024: Inleiding Hydrologie.

Remarks
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

Course code	AM_1183 ()
Period	Period 4
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. E. Koomen
Examinator	dr. E. Koomen
Teaching staff	dr. E. Koomen
Teaching method(s)	Lecture, Computer lab, Excursion
Level	400

Course objective
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 discuss 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 describes 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.

Course content
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?

Form of tuition
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.

Type of assessment
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 at least obtain a mark of 5.5.

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

Entry requirements
This course assumes that students have a working knowledge of GIS basics. A catch-up opportunity based on distance learning will 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.

Recommended background knowledge
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.

Target group
The course is part of the Master programme Earth and Economics for whom the landscape is their natural research habitat, but it is open to all others with an interest in the mapping and valuation of landscapes

provided they possess the required knowledge listed below.

Imaging the Earth Surface

Course code	AM_450403 ()
Credits	3.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	V. Pinto Nunes Nogueira Diogo MSc
Examinator	V. Pinto Nunes Nogueira Diogo MSc
Teaching staff	prof. dr. H.J. Scholten
Teaching method(s)	Seminar, Computer lab, Excursion
Level	400

Course objective
The aim of the Imaging the Earth Surface course is to give an overview of GIS-based methods to map the surface of the earth. The course introduces classic and novel approaches to collect data that describes the way humans interact with the earth surface. Specific attention is paid to new ways to map human activity. Upon finalisation students will be able to understand the quality issues involved in collecting and using spatial data from a variety of traditional and novel sources. In addition they are able set up and execute a mapping exercise while applying relevant visualisation concepts.

Course content
The following topics will be 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.

Form of tuition
The course will consist of 4 lectures (of two hours) and 4 unsupervised practicals. To finalise the assignments students will have to spend time in addition to the scheduled lectures and practicals. In total this course is expected to take about 20 hours per week.

Type of assessment
The assessment will be based on a written final examination (50%), practical assignments (25%) and exam assignment (25%). For each of these components students should at least obtain a mark of 5.

Course reading
The relevant literature consists of scientific papers and book chapters in English that will be listed and made available in Blackboard at the start of the course.

Entry requirements
This course assumes that students have a working knowledge of GIS basics. A catch-up opportunity based on distance learning will be

provided for students lacking this knowledge. Please consult teaching staff prior to the course when this applies to you. Please note that you have to make sure your GIS-knowledge is up to date before the course starts.

Recommended background knowledge
This course assumes that students have a working knowledge of GIS basics. Please note that you have to make sure your GIS-knowledge is up to date before the course starts.

Target group
The course is part of Master programme Earth and Economics, but open to others with an interest in methods to map the earth surface and the way humans interact with it, provided they possess the recommended prerequisites.

Remarks
The practical GIS-skills obtained in this course are essential to the Assessing the Landscape course (450404) that runs in parallel.

Introduction Field Excursion

Course code	AM_450229 ()
Period	Period 1
Credits	3.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. F.M. Brouwer
Examinator	dr. F.M. Brouwer
Teaching staff	dr. F.M. Brouwer, prof. dr. J.J.G. Reijmer
Teaching method(s)	Fieldwork
Level	400

Course objective
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.

Course content
The excursion follows a transect through the Southern, Eastern and Western Alps. 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 extended discussions during the evenings. 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.

Form of tuition
7-10 day field programme and evening sessions

Type of assessment
Active participation in the field surveys and discussions / presentations during the evening sessions Information written down in the field note books will be evaluated and their overall evaluation will be part of the exam (20%). A written examination is scheduled after our return to Amsterdam.

Course reading
Excursion guide and possibly selected additional publications from the scientific literature

Entry requirements
Completed Solid Earth BSc programme

Target group
Compulsory for students starting MSc Geosciences of Basins and Lithosphere and MSc Earth Sciences - Solid Earth stream

Remarks
Admission is only granted to bachelor students who have earned at least 150 EC in the bachelor's programme. Admission requirements are checked by the examination board on July 1st. Participants should register in time (before July 1st) using VUnet and should notify the responsible staff by e-mail. 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 before May 1st.

Magmatic Processes

Course code	AM_450189 ()
Period	Period 4
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. P.Z. Vroon
Examinator	dr. P.Z. Vroon
Teaching staff	dr. P.Z. Vroon, prof. dr. G.R. Davies, prof. dr. W. van Westrenen, dr. J.M. Koornneef
Teaching method(s)	Seminar
Level	500

Course objective
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.

Course content
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.

Form of tuition
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

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

Course reading
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.

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

Recommended background knowledge
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 Blackboard.

Target group
First year MSc students in Earth Sciences

Man and Climate

Course code	AM_450187 ()
Period	Period 4
Credits	3.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen

Coordinator	prof. dr. H. Renssen
Examinator	prof. dr. H. Renssen
Teaching staff	prof. dr. H. Renssen, dr. A.M.J. de Kraker
Teaching method(s)	Seminar
Level	500

Course objective
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, Inconvenient Truth).

Course content
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. Adaptation, resilience and perception are therefore studied in the context of the Medieval Warm Epoch, Little Ice and present Global Warming.

Form of tuition
Seminars and study group (20 h), reading literature (44 h), preparing for the exam (20 h)

Type of assessment
Written exam

Course reading
Differs per instructor and will be announced one month before the course will start.

Mantle Properties in Lithosphere Development

Course code	AM_450225 ()
Period	Period 1
Credits	3.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen

Coordinator	prof. dr. W. van Westrenen
Examinator	prof. dr. W. van Westrenen
Teaching staff	dr. P.Z. Vroon, prof. dr. G.R. Davies, prof. dr. W. van Westrenen
Teaching method(s)	Seminar
Level	400

Course objective
The main aim of this course is to make you appreciate that heat and its transport provide a fundamental link between processes at the Earth's surface (such as large-scale deformation, orogenesis, basin and lithosphere formation, and rifting), and processes in the deeper parts of the Earth (such as convection and partial melting). An additional practical aim is to improve your communication and writing skills.

Course content
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 observed seismic structure of the mantle. (3) Discuss the role of these and the importance of water in lithosphere-mantle interactions (specifically at rifting and subduction zones).

Form of tuition
Lectures with associated class and home work exercises; preparation of a student paper and its oral presentation wherein a critical assessment of two competing models is discussed. The course counts for 3 ECTS = 80 SBU, which are divided between the different components of this course in the following way (1) 6 * 3 hour lectures = 54 SBU, (2) Preparing resentation and 1-page abstract = 16 SBU (3) Two homework exercises = 10 SBU, total 80 SBU = 3 ECTS

Type of assessment
The final mark you are given for this course consists of the following components: (1) Two homework exercises (25%); Presentation and 1-page abstract (35%); Written exam (40%)

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

Recommended background knowledge
Students should have a basic understanding of global geophysics, mineralogy and petrology, as presented in the textbook of Klein and Philpotts (2013) Earth Materials.

Target group
First year MSc students Earth Sciences, track Solid Earth

Master Thesis Earth Sciences and Economics

Course code	AM_1150 ()
Period	Period 3+4+5+6
Credits	24.0

Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. M.P. Bokhorst
Examinator	dr. M.P. Bokhorst
Level	500

Course objective
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.

Course content
Finding a thesis topic and doing research independently.

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

Type of assessment
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.

Course reading
Relevant literature found by the student and first supervisor.

Entry requirements
The full first year program of Earth Sciences and Economics

Recommended background knowledge
All other subjects in the program of Earth Sciences and Economics

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

Registration procedure
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.

Remarks
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.

Master Thesis Geology and Geochemistry

Course code	AM_1186 ()
Period	Ac. Year (September)
Credits	27.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Level	600

Course objective
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.

Course content
Research project or work placement (traineeship) in the master's specialisation Solid Earth with a volume of 27 EC (18 weeks) and related master thesis report.

Form of tuition
Research project or work placement/traineeship.

Type of assessment
Written report and oral presentation

Entry requirements
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.

Remarks
The Master thesis is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the Master thesis work placement 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 departmental lecturers and is made available on the departmental pages of the Faculty website.

Metamorphism and P-T Evolution

Course code	AM_450176 ()
Period	Period 4
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. F.M. Brouwer
Examinator	dr. F.M. Brouwer
Teaching staff	prof. dr. J.R. Wijbrans, dr. F.M. Brouwer
Teaching method(s)	Seminar
Level	500

Course objective
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.

Course content
Metamorphic phase equilibria, their variance and calculation; theoretical (chemographic) analysis of assemblages and reactions; element distribution between minerals; recognition of stable assemblages and of reactions in rocks. Role of fluid phases. Metamorphism of pelitic sediments, carbonate rocks and mafic (igneous) rocks. Geothermobarometry and PT-paths. 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.

Form of tuition
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. Written student paper on a selected subject and accompanying presentation.
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).

Type of assessment
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 student paper and presentation each make up 12.5% of the final mark whilst the remaining 40% is for the written examination.

Course reading
Textbook: Winter (2010) An introduction to igneous and metamorphic petrology, Prentice Hall. Or the 1st edition from 2001.

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 Blackboard-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.

Target group
First year MSc Earth Sciences students in the Solid Earth track; second year students are welcome to take this course as well.

Remarks
This course fits well within the lithosphere orientation of Solid Earth, 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.

Microeconomic Foundation of Spatial Policy

Course code	AM_450400 ()
Period	Period 1
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. M.G. Lijesen
Examinator	dr. M.G. Lijesen
Teaching staff	dr. C.L. Behrens, dr. M.G. Lijesen, prof. dr. H.L.F. de Groot
Teaching method(s)	Lecture, Study Group
Level	400

Course objective
The general aim of this course is to provide you with the micro-economic analytical tools to understand, evaluate and perform policy oriented applied research in the broadly defined field of spatial economics. The focus of this course will be on analytical skills and roughly consists of three main clusters of topics: general micro economics, welfare economics and industrial organization.

This course has the following learning objectives:
1. The student is familiar with main microeconomic principles and concepts, and is able to analyze microeconomic problems in general, and in spatial, transport, environmental and natural resource applications in particular.
2. The student is familiar with the causes of market failure and able to evaluate the need and desirability of government policy, in particular in the context of spatial, transport, environmental and natural resource problems.
3. The student has a basic knowledge of New Economic Geography and its relation with spatial microeconomics.
4. The student is familiar with advanced methods to evaluate

alternative policies, including public investments.

Course content
Key issues to be addressed are welfare maximization, policy responses to market failures and the economic treatment of exhaustible resources.

Form of tuition
There will be one lecture each week (6 in total) in which the focal point is on the teachers' explanation of the essential material. Two tutorials each week will be devoted to discussion of problem sets. Active participation of the students is expected in all lectures: class discussions and making small exercises to better comprehend the material will be part of all lectures.

Lectures: 12 hours
workshops: 24 hours
Self study: 136 hours

Type of assessment
Written exam (75 %) and assignments (25 %)

Course reading
Mandatory literature
The lecture slides and workshop exercises are also part of the mandatory literature.

Baldwin, R.E. and Paul Krugman, 2004, Agglomeration, integration and tax harmonization, European Economic Review 48(1), 1-23, also available at http://www.nber.org/papers/w9290.pdf

Gollier, C., and M.L. Weitzman, 2010, How should the distant future be discounted when discount rates are uncertain?, Economics Letters, 107, 350-3

Hausman, J.A., 1981, Exact Consumer's Surplus and Deadweight Loss, American Economics Review, (71), 662-76

Requate, T., 1993, Pollution control in a Cournot duopoly via taxes or permits, Journal of Economics, 58(3), 255-91.

Ulph, A.M. and G.M. Folie, 1980, Exhaustible resources and cartels: an intertemporal Nash-COurnot model, Canadian Journal of Economics 13(4), 645-58

Reference textbooks
Chiang, A.C. and K. Wainwright (2005) Fundamental methods of Mathematical Economics (4th edition) McGraw-Hill, Irwin

Varian, Hal R. (2005) Intermediate Microeconomics: A modern Approach. 7th edition. New York: W.W. Norton

Recommended background knowledge
Bachelor degree in Earth Science and Economics. Otherwise: Intermediate microeconomics, at the level of Varian's text (Varian, Hal R. (2005): Intermediate Microeconomics: A modern Approach. 7th edition. New York: W.W. Norton). Or, where less formal training has been acquired, a working knowledge of mathematical micro economics.

Modern Climate and Geo-ecosystems

Course code	AM_1124 ()
Period	Period 1
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. G.M. Ganssen
Examinator	dr. G.M. Ganssen
Teaching method(s)	Excursion, Seminar
Level	400

Course objective
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.

Course content
-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

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

Type of assessment
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)

Course reading
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.

Entry requirements
Some basic knowledge of the climate system, interest in climate change

Target group
Students from the geo and environmental study areas

Registration procedure
Subscription via BB

Orogenesis

Course code	AM_450190 ()
Period	Period 3
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	prof. dr. J.R. Wijbrans
Examinator	prof. dr. J.R. Wijbrans
Teaching staff	prof. dr. J.R. Wijbrans, dr. F.M. Brouwer
Teaching method(s)	Seminar, Computer lab, Education
Level	400

Course objective
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.

Course content
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).

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

Type of assessment
Exam (50%), Reports (20%), Essay – presentation – poster (20%)

Course reading
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 Blackboard.

Entry requirements
BSc Geology

Recommended background knowledge
Petrology, structural geology, tectonics courses at the BSc level.

Target group
1st year MSc Earth Science Solid Earths

Peergroup 1

Course code	O_MLPEERGR_1 ()
Period	Period 1+2+3, Period 4+5+6
Credits	0.0
Language of tuition	Dutch
Faculty	Fac. der Gedrags- en Bewegingswetensch.
Coordinator	dr. A. Handelzalts
Examinator	dr. A. Handelzalts
Teaching method(s)	Study Group
Level	400

Peergroup 2

Course code	O_MLPEERGR_2 ()
Period	Period 3+4+5
Credits	0.0
Language of tuition	Dutch
Faculty	Fac. der Gedrags- en Bewegingswetensch.
Coordinator	dr. A. Handelzalts
Examinator	dr. A. Handelzalts
Teaching method(s)	Study Group

Petroleum Geology of the North Sea

Course code	AM_450317 ()

Period	Period 2
Credits	7.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	prof. dr. J.J.G. Reijmer
Examinator	prof. dr. J.J.G. Reijmer
Teaching staff	prof. dr. J. de Jager
Teaching method(s)	Lecture
Level	500

Course objective
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.

Course content
Different lecturers from the university of Utrecht and the VU University 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.

Form of tuition
Lectures, project work, student presentation, and field study.

Type of assessment
Evaluation of project work, student presentation and written examination.

Course reading
The lecturers will make extensive literature lists available.

Remarks
This course is only accessible to graduate students (with bachelor's degree).

Petroleum Systems and Regional Geology

Course code	AM_450179 ()
Period	Period 1
Credits	3.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	prof. dr. J.J.G. Reijmer
Examinator	prof. dr. J.J.G. Reijmer
Teaching staff	prof. dr. H. Doust
Teaching method(s)	Seminar
Level	400

Course objective
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.

Course content
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).

Form of tuition
Lectures, practical examples worked by students.

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

Course reading
Syllabus can be obtained from the lecturer. Powerpoint presentation material is posted on Blackboard.

Remarks
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

Course code	AM_450408 ()
Period	Period 1
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	prof. dr. J.J.G. Reijmer
Examinator	prof. dr. J.J.G. Reijmer
Teaching method(s)	Computer lab, Lecture
Level	400

Course objective
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

Course content
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.

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

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

Course reading
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.

Entry requirements
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.

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

Planetary Science

Course code	AM_450273 ()
Period	Period 1+2
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	prof. dr. W. van Westrenen
Examinator	prof. dr. W. van Westrenen
Teaching staff	dr. P.Z. Vroon, prof. dr. G.R. Davies, prof. dr. W. van Westrenen, prof. dr. B.H. Foing
Teaching method(s)	Seminar
Level	500

Course objective
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.

Course content
A series of lectures will examine the bodies that make up our solar system, how they differentiated and over what timescale they were geologically active. Contrast will be made between styles of volcanism and types of atmospheres on the different planets and moons. The role of water in shaping both internal and external structures of planetary bodies will be examined. The course will include a discussion of astrobiology and exoplanetary science. The course will conclude with a visit to ESTEC where there will be presentations to and from ESTEC staff.

Form of tuition
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

Type of assessment
The final mark for this course consists of the following components: Written exam (50%), Individual poster and presentation at ESTEC (25%), Group poster and presentation at ESTEC (25%).

Course reading
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.

Recommended background knowledge
Background in geology / geochemistry is not required, but is recommended.

Target group
Second year MSc students with a natural science background

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

Practical: Paleoclimate Change and Environmental Impacts

Course code	AM_1144 ()
Period	Period 4
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. M.A. Prins
Examinator	dr. M.A. Prins
Teaching staff	dr. S.J.P. Bohncke, dr. M.A. Prins
Teaching method(s)	Reading, Practical, Study Group, Excursion

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

Course content
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 a terrestrial sediment core/section will be investigated, and an excursion to Texel is anticipated to study modern sedimentary environments. 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.

Form of tuition
- 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.

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

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

Recommended background knowledge
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)

Target group
Master students Earth Sciences

Praktijk 1

Course code	O_MLPRAK_1 ()
Period	Period 1, Period 4
Credits	6.0
Language of tuition	Dutch
Faculty	Fac. der Gedrags- en Bewegingswetensch.
Coordinator	dr. A. Handelzalts
Examinator	dr. A. Handelzalts
Teaching staff	drs. J.K.W. Riksen, drs. H.R. Goudsmit, drs. Y.G. Meindersma, ir. E.J.F. Scheringa, drs. W.S. Hoekstra, drs. C.D.P. van Oeveren, drs. S. Donszelmann, drs. L.J. van Well-van Grootheest, dr. H.B. Westbroek, C.L. Geraedts, drs. A. Krijgsman, dr. A.A. Kaal, dr. A. Handelzalts, drs. K.L. Schaap, W. Maas, F.L. de Vries MSc, drs. H. Stouthart, drs. I. Pauw
Teaching method(s)	Study Group
Level	400

Praktijk 2

Course code	O_MLPRAK_2 ()
Period	Period 2+3, Period 5+6
Credits	9.0
Language of tuition	Dutch
Faculty	Fac. der Gedrags- en Bewegingswetensch.
Coordinator	dr. A. Handelzalts
Examinator	dr. A. Handelzalts
Teaching staff	drs. J.K.W. Riksen, drs. H.R. Goudsmit, drs. Y.G. Meindersma, ir. E.J.F. Scheringa, drs. W.S. Hoekstra, drs. C.D.P. van Oeveren, drs. S. Donszelmann, dr. H.B. Westbroek, C.L. Geraedts, drs. A. Krijgsman, dr. A.A. Kaal, dr. A. Handelzalts, drs. K.L. Schaap, W. Maas, F.L. de Vries MSc, drs. H. Stouthart, drs. I. Pauw
Teaching method(s)	Study Group
Level	400

Praktijk 3

Course code	O_MLPRAK_3 ()
Period	Period 4+5+6
Credits	15.0
Language of tuition	Dutch
Faculty	Fac. der Gedrags- en Bewegingswetensch.
Coordinator	dr. A. Handelzalts
Examinator	dr. A. Handelzalts
Teaching staff	drs. J.K.W. Riksen, drs. H.R. Goudsmit, drs. Y.G. Meindersma, ir. E.J.F. Scheringa, drs. W.S. Hoekstra, drs. C.D.P. van Oeveren, drs. S. Donszelmann, dr. H.B. Westbroek, C.L. Geraedts, drs. A. Krijgsman, dr. A.A. Kaal, dr. A. Handelzalts, drs. K.L. Schaap, W. Maas, F.L. de Vries MSc, drs. H. Stouthart, drs. I. Pauw
Level	400

Praktijk onderzoek 1

Course code	O_MLPROZ_1 ()
Period	Period 3, Period 6
Credits	3.0
Language of tuition	Dutch
Faculty	Fac. der Gedrags- en Bewegingswetensch.
Coordinator	dr. H.B. Westbroek
Examinator	dr. H.B. Westbroek

Teaching staff	drs. J.K.W. Riksen, drs. H.R. Goudsmit, drs. Y.G. Meindersma, ir. E.J.F. Scheringa, dr. M. Meeter, drs. W.S. Hoekstra, 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, drs. A. Krijgsman, dr. J.M.H. Swennen, dr. A.A. Kaal, dr. A. Handelzalts, drs. K.L. Schaap, W. Maas, F.L. de Vries MSc, drs. H. Stouthart, drs. I. Pauw
Teaching method(s)	Study Group, Lecture
Level	400

Praktijk onderzoek 2

Course code	O_MLPROZ_2 ()
Period	Period 4+5+6
Credits	6.0
Language of tuition	Dutch
Faculty	Fac. der Gedrags- en Bewegingswetensch.
Coordinator	dr. H.B. Westbroek
Examinator	dr. A. Handelzalts
Teaching staff	drs. J.K.W. Riksen, drs. H.R. Goudsmit, drs. Y.G. Meindersma, ir. E.J.F. Scheringa, dr. M. Meeter, drs. W.S. Hoekstra, 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. J.M.H. Swennen, dr. A.A. Kaal, dr. A. Handelzalts, drs. K.L. Schaap, W. Maas, F.L. de Vries MSc, drs. H. Stouthart, drs. I. Pauw
Teaching method(s)	Lecture, Seminar
Level	400

Precambrian Geology

Course code	AM_450164 ()
Period	Period 4
Credits	3.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	prof. dr. J.R. Wijbrans
Examinator	prof. dr. J.R. Wijbrans
Teaching staff	prof. dr. J.R. Wijbrans, dr. P.Z. Vroon
Teaching method(s)	Seminar
Level	500

Course objective
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.

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

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

Type of assessment
Essay – presentation – poster

Course reading
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 Blackboard.

Entry requirements
BSc Geology

Recommended background knowledge
Petrology, sedimentology, structural geology courses.at the BSc level.

Target group
2nd year MSc Earth Sciences.

Remarks
Guest teachers include Prof. Dr. C.W. Passchier (University of Mainz), prof. Dr. R. Hengeveld (emeritus professor Animal Ecology, VU University), dr. P.Mason (Utrecht University).

Project Environmental Impact Assessment

Course code	AM_450406 ()
Period	Period 3
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. M.P. Bokhorst
Examinator	dr. M.P. Bokhorst
Teaching method(s)	Seminar, Computer lab, Excursion
Level	400

Course objective
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.

Course content
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.

Form of tuition
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.

Type of assessment
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.

Course reading
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.

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

Reflection Seismic for Geologists

Course code	AM_450170 ()
Period	Period 4
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	prof. dr. J.J.G. Reijmer
Examinator	prof. dr. J.J.G. Reijmer
Teaching method(s)	Seminar, Computer lab
Level	500

Course objective
The participant is expected to collect sufficient understanding of the fundamentals and the limitations of the applications of reflection seismology as a tool to predict the structure and geology in the shallow to deeper (100's to 1000's of metres) subsurface. The aim is to derive the evolution of sedimentary basins and underlying crust by using seismostratigraphic and structural interpretation of seismic lines. In particular, the participant will learn:
the application of technical and methodological principles of reflection seismology to real situations;
the basic principles linking geology and reflection seismology, including an introduction to petrophysics;
seismic workstation skills for seismic interpretation, and
how to extract reliable information on sequence stratigraphy and structure from seismic reflection and well log data.

Course content
Assuming a basic knowledge of the principles of reflection seismology, this course provides a modular programme with hands-on experience on interpreting seismic lines 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. The course will use in part similar methodologies used in hydrocarbon exploration and development. The course is constructed in 5 parts:
Part 1 Introduction to seismics. The introduction will cover the technical and methodological broadband principles of reflection seismology. Note that this section will build on already existing Applied Geophysics course knowledge;
Part 2 Introduction to 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;
Part 3 Seismic sequence stratigraphy. Learning seismostratigraphy will mean in practice how to extract stratigraphic, sedimentological and basin evolution information from seismic data. This information is used as a tool in exploration and basin analysis to derive regional analysis of sedimentary basin-fills with a view towards constructing models for gross lithology prediction. It is recommended that students

remind themselves the principles and methodology of sequence stratigraphy, already acquired during their BSc courses;
Part 4 Seismic structural interpretation. This section will provide students with the knowledge of interpreting deformation structures at various scales;
Part 5 Interpretation on workstation. This section gives the students the opportunity to work on case studies by using standard workstation methodologies for seismic interpretation. Students will learn how to handle, visualize and interpret 2D and 3D seismic data using a standard industrial software package;
Part 6 Integrating wells with seismics for seismostratigraphy, deriving basin evolution. The section will give students the chance to start from reflection seismic and correlative well interpretation to derive the evolution of sedimentary basins at local and regional scale.;
Part 7 Advanced seismic interpretation This section will give students the opportunity to work with advanced methodologies of seismic interpretation specific for petroleum exploration.

Form of tuition
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 one-two textbooks. Therefore, understanding the handouts is essential. Our advice is to attend the oral lessons during class hours.
Practical lesson; the bulk of this course is made up by a large number of practical exercises and a few case studies. You will have to hand in at the end of the course a part of these for evaluation purposes, as noted by the staff. Make sure you understand which are those exercises and case studies needed for evaluation. The thumb rule: this is individual work, unless otherwise specifically noted.

Type of assessment
The final mark is made up by 50% the practical exercises and case studies handed in at the end of the course and 50% the final examination. The practical exercises and case studies must be handed in no later than one day prior to the final examination. The exam will cover the topics presented during course. It is typically organized in blocks of questions from every part of the course AND 2 - 5 data sets (seismic lines) which you will be asked to interpret in terms of specific issues.

Course reading
All materials will be digitally provided through Blackboard.

Remarks
Teaching staff: John Verbeek

Regional and Urban Economics

Course code	E_STR_RUE (60442140)
Period	Period 2
Credits	6.0
Language of tuition	English
Faculty	Fac. der Economische Wet. en Bedrijfsk.
Coordinator	prof. dr. H.L.F. de Groot
Examinator	prof. dr. H.L.F. de Groot

Teaching staff	prof. dr. H.L.F. de Groot, prof. dr. J. Rouwendal
Teaching method(s)	Lecture
Level	400

Course objective
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.

Course content
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.

Form of tuition
Lectures and Tutorials

Type of assessment
Written interim examination (75 percent) and Assignments (25 percent)

Course reading
• 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 I

Course code	O_MLVPOOI ()
Period	Period 1+2+3
Credits	3.0
Language of tuition	Dutch
Faculty	Fac. der Gedrags- en Bewegingswetensch.
Coordinator	dr. A. Handelzalts
Examinator	dr. A. Handelzalts
Teaching staff	drs. J.K.W. Riksen, drs. H.R. Goudsmit, drs. Y.G. Meindersma, drs. I. Pauw, drs. W.S. Hoekstra, drs. C.D.P. van Oeveren, drs. S. Donszelmann, drs. W. Jongejan, dr. H.B. Westbroek, C.L. Geraedts, drs. A. Krijgsman, prof. dr. J.J. Beishuizen, dr. A.A. Kaal, drs. K.L. Schaap, W. Maas, F.L. de Vries MSc, drs. H. Stouthart
Teaching method(s)	Lecture, Seminar
Level	500

Research II

Course code	O_MLVPOOII ()
Period	Period 1+2+3
Credits	6.0
Faculty	Fac. der Gedrags- en Bewegingswetensch.
Coordinator	dr. H.B. Westbroek
Examinator	dr. H.B. Westbroek
Teaching staff	drs. W. Jongejan, dr. T. Bosma, dr. H.B. Westbroek, dr. A.A. Kaal, dr. A. Handelzalts, W. Maas
Teaching method(s)	Lecture, Seminar
Level	500

Research Project Earth Sciences and Economics

Course code	AM_1103 ()
Period	Ac. Year (September)
Credits	18.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. M.P. Bokhorst
Examinator	dr. M.P. Bokhorst
Level	400

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

Course content
See Master Thesis Earth Sciences and Economics (AM_450407)

Form of tuition
See Master Thesis Earth Sciences and Economics (AM_450407)

Type of assessment
See Master Thesis Earth Sciences and Economics (AM_450407)

Course reading
See Master Thesis Earth Sciences and Economics (AM_450407)

Recommended background knowledge
All other subjects in the first year Earth Sciences and Economics program

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

Registration procedure
See Master Thesis Earth Sciences and Economics (AM_450407)

Remarks
See Master Thesis Earth Sciences and Economics (AM_450407)

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

Course code	AM_1187 ()
Period	Ac. Year (September)
Credits	27.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Level	600

Course objective
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.

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

Form of tuition
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.

Type of assessment
Written report and oral presentation.

Entry requirements
This course is only accessible to students who:
have earned their bachelor's degree, and;
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.

Remarks
Research Project G&G is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the Research Project 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.

Research Project Solid Earth

Course code	AM_450200 ()
Period	Ac. Year (September)
Credits	27.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	prof. dr. W. van Westrenen
Examinator	prof. dr. W. van Westrenen
Teaching method(s)	Seminar
Level	600

Course objective
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.

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

Form of tuition
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.

Type of assessment
Written report and oral presentation.

Entry requirements
This course is only accessible to students who:
have earned their bachelor's degree, and;
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.

Remarks
The Research Project Solid Earth is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the Research Project 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

Course code	AM_470587 ()
Period	Period 1
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	P. Klaassen MA
Examinator	P. Klaassen MA
Teaching staff	dr. B.J. Regeer, dr. J.F.H. Kupper, drs. ir. M.G. van der Meij, P. Klaassen MA
Teaching method(s)	Lecture, Study Group
Level	500

Course objective
- Gain theoretical insight in the relationship between science and society,
- Gain insight in the role of science communication in this relationship,
- Acquire knowledge of different theories and models of science communication,
- Acquire knowledge of different strategies, media and activities for science communication,
- Learn how to apply theoretical concepts to real-life examples,
- Development of practical skills for science communication (e.g. writing, discussing).

Course content

Science is all around us and shapes our lives in many different ways. From the vaccines you need for travelling abroad, to the technological devices you use on a daily basis. At the same time, society shapes the development of science and technology. Science and society influence each other continuously; they communicate. Students of Science Communication are expected to become experts in understanding and designing interaction between science and society. In order for this interaction to be fruitful and valuable for both science and society, it is important to gain in-depth knowledge about the theoretical basis of the field of science communication and understand communication processes at the core of several interfaces; e.g. the communication between scientists from different disciplines, between different sciences and their stakeholders, and between science and the public. This course provides a broad basis in the field of science communication by addressing the main areas of science communication and by discussing and challenging several core concepts within this field. Students are invited to explore some issues in greater depth and active participation in lectures and workgroups is required.

Form of tuition
Lectures (22 h)
Workgroups (18 h)
Home-study for group assignments (8 h)
Home-study for individual assignments/exam (90h)

Type of assessment
Individual assignments (30%), group assignment (10%), examination (60%). For all parts a pass grade needs to be obtained.

Course reading
Academic articles. Direct links to articles will be provided on BlackBoard one month before the beginning of the course.

Target group
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

Course code	AM_1002 ()
Period	Period 2
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. J.F.H. Kupper
Examinator	dr. J.F.H. Kupper
Teaching staff	dr. J.F.H. Kupper
Teaching method(s)	Study Group, Lecture, Seminar
Level	500

Course objective
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

Course content
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.

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

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

Course reading
Is announced on blackboard one month before start of the course

Target group

Optional course in the MSc specialization Science Communication

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

Science Journalism

Course code	AM_471014 ()
Period	Period 2
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. J.F.H. Kupper
Examinator	dr. J.F.H. Kupper
Teaching staff	dr. J.F.H. Kupper
Teaching method(s)	Lecture, Study Group, Computer lab
Level	500

Course objective
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

Course content
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.

Form of tuition
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).

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

Course reading
Announced on Blackboard one month before start of the course

Target group
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.

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

Science Museology

Course code	AM_470590 ()
Period	Period 3
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. B.J. Regeer
Examinator	dr. B.J. Regeer
Teaching staff	dr. B.J. Regeer, drs. ir. M.G. van der Meij
Teaching method(s)	Lecture, Study Group, Seminar, Fieldwork
Level	500

Course objective
- Gain insight in the role of museum exhibits in the field of science communication.
- Gain insight in the role of science communication concepts in the context of science museums.
- Apply qualitative research methods to design, conduct, and report on a user research project in museum settings.
- Apply theoretical notions of science communication and exhibit design to advise development of exhibit experience and content design.
- Gain experience in working for an external commissioner.

Course content
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.
Guest speakers and lecturers give insight into their profession (1) as science communicators in museums and science centers, (2) as researchers in the field of museology, and/or (3) as 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 (part of) an exhibition (re-)design. The group assignments are commissioned by museums and science centers, such as NEMO, Museon, Naturalis, Delft Science Centre, and Artis.

Form of tuition
Lectures
Workgroups
Workshops
Home-study for group assignments
Home-study for individual assignments
Field work

Type of assessment
Group assignment (50%), presentation (poster and oral) (10%), and individual exam(s) (40%). For the assignments, presentations and all exams a pass-grade must be obtained.

Course reading
Academic articles. Direct links to articles will be provided on Blackboard one month before the beginning of the course.

Entry requirements
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 required depending on the student's background.

Target group
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.

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

Scotland Excursion

Course code	AM_450354 ()
Period	Period 6
Credits	3.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. S.J.P. Bohncke
Examinator	dr. S.J.P. Bohncke
Teaching staff	dr. S.J.P. Bohncke, dr. M.A. Prins, dr. S.R. Troelstra
Teaching method(s)	Fieldwork

Level	400

Course objective
To highlight the history of the earth’s crust during the early Paleozoicum. Familiarise with the Scottish climate history over the last 15 ka and its impact on the geomorphology, raised bog ecosystems and sedimentary environments.

Course content
During this excursion (10-12 days) the most relevant aspects of the Scottish geomorphology, the evolution of life and climate history will 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 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 time.

Form of tuition
Excursion: observing and descibing geomorphological land forms; drawing conclusion with respect to climate, fluvial activity and human impact.

Type of assessment
Oral presentations during the excursion on topics visited and discussed the previous
day.

Entry requirements
First year of the MSc 'Landscape dynamics,Climate and Archives' must be completed.

Target group
Master students 'Landscape dynamics,Climate and Archives'

Registration procedure
You should have subscribed before the end of December

Remarks
This course takes place every other year. Next excursion will be in June 2016.

Sediment Petrography of Heavy Minerals

Course code	AM_450058 ()
Period	Period 3
Credits	3.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. C. Kasse
Examinator	dr. C. Kasse
Teaching staff	dr. C. Kasse
Teaching method(s)	Seminar

Level	400

Course objective
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.

Course content
The study of optical characteristics of heavy minerals under the microscope. The study of the heavy mineral characteristics (relief, color, pleochroism, etc.) in slides from the mono-mineral collection. Recognition and determination of heavy minerals from unconsolidated deposits. Interpretation of heavy mineral assemblages regarding the provenance of the sediment and the Quaternary lithostratigraphy of the Netherlands.

Form of tuition
10x3 hours of lectures and practical courses

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

Course reading
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.

Entry requirements
Bachelor in Earth Sciences

Remarks
This optional course is offered every two years. The next course takes place in 2015 - 2016.

Sedimentary Basins

Course code	AM_450154 ()
Period	Period 2
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	prof. dr. J.J.G. Reijmer
Examinator	prof. dr. J.J.G. Reijmer
Teaching staff	prof. dr. J.J.G. Reijmer
Teaching method(s)	Reading, Computer lab, Lecture
Level	400

Course objective
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 use quantitative computer models to assess the importance of factors controlling basin forming processes
• To work in small interdisciplinary groups.
• To present the results of his/her work in oral and written form.

Course content
This course focuses on the origin and evolution of sedimentary basins in space and time. The main topics addressed are:
• the tectonic processes controlling vertical movements (subsidence in particular);
• the phenomena taking place in the source areas where clastic sediments are produced;
• the sediment production and transport patterns within carbonate sedimentary systems and
• the physical processes controlling the transport and 3D distribution, deposition, and preservation of these sediments in the basin.
• Principles of sequences stratigraphy

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.

Form of tuition
Combination teaching, practical projects and self-study of publications.
Contact hours:
Lectures: 30
Practicals: 24
Total: 54

Type of assessment
Assessment will take place on the basis of results from the exam and from the practicals. The tectonic and sedimentological parts count 50% each.
Within the tectonic part, the exam counts for 50%, the two practicals for 25% each.
The sedimentological part the exam counts for 50% and the five practicals for 10% each.

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

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 on Blackboard

Sedimentary Environments and Climate Archives

Course code	AM_450330 ()
Period	Period 1
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. F.J.C. Peeters
Examinator	dr. F.J.C. Peeters
Teaching staff	dr. F.J.C. Peeters, dr. C. Kasse, dr. S.J.P. Bohncke, dr. M.A. Prins
Teaching method(s)	Excursion, Seminar
Level	400

Course objective
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.

Course content
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.

Form of tuition
Lectures, literature study, group discussions.

Type of assessment
Written exam and report of the field excursion to Zuid-Limburg.

Course reading
Lecture notes, selected papers.

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

Target group
Course is part of the Master program Earth Surface Processes, Climate and Archives; Master students Earth and Environmental Geoscience; Master students in Paleoclimatology.

Spatial Processes in Ecology

Course code	AMU_0009 ()
Period	Ac. Year (September)
Credits	6.0
Language of tuition	English

Faculty	Fac. der Aard- en Levenswetenschappen

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

Specialisation

Course code	O_MLVERD ()
Period	Period 2+3
Credits	3.0
Faculty	Fac. der Gedrags- en Bewegingswetensch.
Coordinator	dr. A. Handelzalts
Examinator	dr. A. Handelzalts
Teaching staff	drs. J.K.W. Riksen, drs. H.R. Goudsmit, drs. Y.G. Meindersma, drs. W.S. Hoekstra, drs. S. Donszelmann, dr. H.B. Westbroek, C.L. Geraedts, drs. A. Krijgsman, drs. K.L. Schaap, W. Maas, F.L. de Vries MSc, drs. H. Stouthart, drs. I. Pauw, drs. C.D.P. van Oeveren
Teaching method(s)	Seminar,
Level	500

Sustainable Energy Analysis

Course code	AM_468018 ()
Period	Period 1
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	B. van der Kroon MSc
Examinator	B. van der Kroon MSc
Teaching method(s)	Seminar, Lecture
Level	400

Course objective
The unit is designed to familiarize students with the basic principles of sustainable energy analysis and equip them with the tools that will help them both to understand the main determinants of their use/diffusion and to critically evaluate the range of policy options to tackle related problems.
After following this course, students should be able to:

- Make use of scientific information about major energy resources and conversion processes in order to assess the social, economic and environmental impacts of existing and new technologies in the energy sector.
- Apply this scientific information in the widely different context of industrialised, emerging and least developed nations.
- Evaluate the sustainability implications of different energy technology choices in a comprehensive and balanced way.

- Assess the potential and implications of using biomass, wind, water and solar re-sources to replace fossil fuels for both rich and poor energy users.

Course content
Energy technology plays a central role on the road towards sustainable development. Energy is the engine of economic growth and therefore a key prerequisite for development. But at the same time it is causing persistent environmental problems. Assessing energy technology in the light of the long-term transition towards sustainability requires a basic understanding of available energy resources and conversion processes including their environmental impacts and opportunities for performance improvement. The potential role and impact of energy technologies are strongly dependent on the stage of economic development of the nation and sector where it will be applied.

The course introduces students to key concepts of sustainable energy analysis and technology choice. The unit will be a combination of theory and evidence/discussion, relating theoretical arguments with recent experiences in the domain of energy use. The module will focus both on renewable as well as non-renewable energy, and will analyse energy technologies in the context of both developed and developing countries.

Some of the topics dealt with in this course are:
- Economic feasability of renewable energy
- Sustainable biofuels
- Smart energy cities
- Smart mobility
- Energy use in developing countries
- Business models for energy access

Form of tuition
Lectures, team assignment and workshop
25 hs for the Dragon’s Den assignment and 195 hs for lectures.

Type of assessment
A written exam (80%) and a team presentation on the assignment (20%).

Course reading
Reader with open source literature

Teaching Methodology Geography I

Course code	O_MLVDAKI ()
Period	Period 1+2
Credits	3.0
Language of tuition	Dutch
Faculty	Fac. der Gedrags- en Bewegingswetensch.
Coordinator	drs. I. Pauw
Examinator	drs. I. Pauw
Teaching staff	drs. I. Pauw
Level	500

Teaching Methodology Geography II

Course code	O_MLVDAKII ()
Period	Period 1+2
Credits	6.0
Faculty	Fac. der Gedrags- en Bewegingswetensch.
Coordinator	drs. I. Pauw
Examinator	drs. I. Pauw
Teaching staff	drs. I. Pauw
Teaching method(s)	Seminar
Level	500

Teaching Practice I

Course code	O_MLPRAKI ()
Period	Period 1+2+3
Credits	15.0
Faculty	Fac. der Gedrags- en Bewegingswetensch.
Coordinator	ir. E.J.F. Scheringa
Examinator	ir. E.J.F. Scheringa
Level	500

Teaching Practice II

Course code	O_MLPRAKII ()
Period	Period 1+2+3
Credits	15.0
Faculty	Fac. der Gedrags- en Bewegingswetensch.
Coordinator	ir. E.J.F. Scheringa
Examinator	ir. E.J.F. Scheringa
Level	500

Transport Economics

Course code	E_STR_TREC (60432050)
Period	Period 4
Credits	6.0
Language of tuition	English
Faculty	Fac. der Economische Wet. en Bedrijfsk.
Coordinator	dr. A.J.H. Pels
Examinator	dr. A.J.H. Pels
Teaching staff	dr. A.J.H. Pels
Teaching method(s)	Lecture
Level	400

Course objective
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.

Course content
This course covers advanced topics in theoretical and empirical research on urban transport economics. Key issues are demand analysis; 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; and industrial organization aspects of intra-city (e.g. roads and transit) and inter-city (e.g. airports and airlines) transport. The topics are addressed from a theoretical as well as an empirical perspective.

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

Course reading
- 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.

Recommended background knowledge
Microeconomics for spatial policy or a similar course

Unsaturated Zone and Near Surface Hydrological Processes

Course code	AM_450021 ()
Period	Period 2
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	S.F. Stofberg MSc
Examinator	S.F. Stofberg MSc
Teaching staff	S.F. Stofberg MSc
Teaching method(s)	Computer lab, Seminar
Level	400

Course objective
The main objective of this course is to provide basic insight into the hydrological processes operating within the unsaturated zone as a whole, and near the surface in particular. This hydrological knowledge forms the basis for determining recharge rates, plant available water, runoff ratios, etc. It requires fundamental theoretical and practical knowledge on soil properties and the physics of soil water movement.

Course content
At the end of this course students should be able to:
• Discuss soil characteristics in relation to soil water movement and storage
• Discuss the processes that determine the storage and movement of water in the unsaturated zone, and how this affects and is affected by other hydrological processes
• Describe the various measurement techniques to determine the storage and movement of water in and through the unsaturated zone
• Produce a simple hydrological model to analyse and describe the movement of water through the unsaturated zone and analyse how this is affected by soil properties
• Discuss the objectives, advantages and limitations of hydrological models for the unsaturated zone
• Have obtained an awareness of how vegetation and land management affect soil erosion and water quality

Form of tuition
The course consists of a set of lectures supplemented with practicals.

Type of assessment
Written examination.

Target group
Hydrology MSc students and other earth sciences related MSc programs

Volcanism

Course code	AM_450061 ()
Period	Period 3
Credits	3.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. P.Z. Vroon
Examinator	dr. P.Z. Vroon
Teaching staff	dr. P.Z. Vroon
Teaching method(s)	Seminar, Computer lab
Level	500

Course objective
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.

Course content
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.

Form of tuition
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

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

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

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

Water and Policy

Course code	AM_468023 ()
Period	Period 1
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	prof. dr. J.C.J.H. Aerts
Examinator	prof. dr. J.C.J.H. Aerts
Teaching staff	prof. dr. J.C.J.H. Aerts, dr. R. Lasage, prof. dr. D. Huitema, dr. H. de Moel
Teaching method(s)	Lecture, Computer lab
Level	400

Course objective
The objective of this course is to understand how water related processes such as floods and droughts influence our society and what role water management plays in addressing and tackling these issues. This course aims to provide students a multi-disciplinary understanding of water management, including the physical dimensions of the hydrological cycle and coastal proceses,
the policy, law and long term trends such as climate change and land use change. It puts emphasis on the uncertainty of future trends and how risk management methods can be helpful for water managers for dealing with these uncertainties.

Key goals for students to reach at the end of the course are:
• To understand the complexity of various water related issues (e.g. scarcity, floods, and droughts) and to assess the economic and social impacts
• To learn what kind of measures can be taken to alleviate water related problems and what kind of positive and negative effect these measures have on different users.
• To be able to systematically approach a complex and integrated water related issue and properly interpret data and information about this issue.

Course content
Water managers see themselves confronted with a continuous stream of increasingly credible scientific information on the potential magnitude of population growth, economic activities and climate change that increase the risk related to the earth hydrological system. It is expected that floods and droughts will increasingly affect societies and economies and new approaches in water management are needed to deal with these challenges. Furthermore, developing adequate water policies that can be used in practice is a difficult issue and is the result of a complex and long-lasting process from the national through 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. Uncertainty in future trends further puts new challenges to water management and risk based techniques can be helpful in dealing with these uncertainties. Finally, water management increasingly needs to cooperate with spatial planners, especially in large cities, to address increasing risk from storm surges and sea level rise.

Form of tuition
This course consists of several sessions going into different subjects related to water management. These sessions will consist of lectures by the professors with interactive discussion; two practical assignments, and student presentations. Apart from these sessions, you will team up in pairs of two students to write papers on water related issues and adaptation in cities, which will be peer-reviewed by other students.
Activity Hours
1 Attending and contributing to sessions (12 times 3 hrs) 36 hours
2 Readings associated with lectures 28 hours
4 Paper: literature review (32 hours), writing (24 hours), peer review (8 hours) 64 hours
5 Exam preparation 40 hours
TOTAL 168 hours

Type of assessment
Written exam (50%), essay (40%) and peer-review (10%)

Course reading
The literature for this course consists of various academic papers and chapters. These papers will be published 3 days before the lecture

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