Earth Sciences MSc

Vrije Universiteit Amsterdam - Fac. der Aard- en Levenswetenschappen - M Earth Sciences - 2013-2014

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 2013 - 2014 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 .

Inhoudsopgave

Expired programme components Earth Sc.

Courses:

Name	Period	Credits	Code
Master Thesis Archaeometry (M-variant)	Ac. Year (September)	27.0	AM_450299
Master Thesis Landscape Archaeology (M-variant)		27.0	AM_450297
Sustainability and Growth	Period 1	6.0	AM_468011

MSc Earth Sciences, spec. Applied Environmental Geosciences

Programme components:

- MSc Earth Sciences, specialisation AEG, year 1
- MSc Earth Sciences, specialisation AEG, year 2

MSc Earth Sciences, spec. AEG, first year

Opleidingsdelen:

- optional courses year 1
- compulsory courses year 1

optional courses year 1

Vakken:

Naam	Periode	Credits	Code
Climate Modelling	Periode 3	6.0	AM_450004
Environmental Remote Sensing	Periode 3	6.0	AM_450145
Field Course Netherlands (Measurements Techniques)	Periode 5	3.0	AM_450126
Palaeo-ecology/Palynology	Periode 3	3.0	AM_450054
Sediment Petrography of Heavy Minerals	Periode 3	3.0	AM_450058

compulsory courses year 1

Vakken:

Naam	Periode	Credits	Code
Basics in Geographical Information Systems	Periode 5	3.0	AM_450226
From Source to Sink: Chemical and Physical Cycles	Periode 2	6.0	AM_450146
High Resolution Archives	Periode 2	6.0	AM_450331
Modern Climate Systems	Periode 1	3.0	AM_450185
Modern Geo-ecosystems	Periode 1	3.0	AM_450313
Practical: Palaeoclimate Change and Environmental Impacts	Periode 4	3.0	AM_450266
Research Project Applied Environmental Geosciences	Ac. Jaar (september)	24.0	AM_450267
Sedimentary Environments and Climate Archives	Periode 1	6.0	AM_450330

MSc Earth Sciences, spec. AEG, second year

Opleidingsdelen:

- optional courses year 2
- compulsory courses year 2

optional courses year 2

Vakken:

Naam	Periode	Credits	Code
Applied Geographical Information Systems	Periode 2	3.0	AM_450227
Aquatic Ecology	Periode 1	6.0	AM_450137
Catchment Response Analysis	Periode 1	6.0	AM_450003
Climate and Policy	Periode 3	6.0	AM_450188
Ecohydrology	Periode 2	6.0	AM_450014
Global Biogeochemical Cycles	Periode 4	6.0	AM_450332
Groundwater Hydraulics	Periode 2	6.0	AM_450009
Historical Geography	Periode 1	6.0	AM_450292
Hydrochemistry	Periode 4	6.0	AM_450052
Hydrological Systems and Water Management	Periode 1	3.0	AM_1012
Man and Climate: From Hominids to Modern Civilisation	Periode 4	3.0	AM_450187
Science Journalism	Periode 2	6.0	AM_471014

Sustainability and Growth	Periode 1	6.0	AM_468011
Sustainable Land Management	Periode 3	6.0	AM_1015

compulsory courses year 2

Vakken:

Naam	Periode	Credits	Code
Master Thesis Applied Environmental Geosciences	Ac. Jaar (september)	27.0	AM_450268
Research Project Applied Environmental Geosciences	Ac. Jaar (september)	24.0	AM_450267
Scotland Excursion	Periode 6	3.0	AM_450354

MSc ES spec. Education

Programme components:

- Earth Sciences specific content
- second year (onderwijscentrum)

Earth Sciences specific content

Opleidingsdelen:

- Research project (choose one)
- optional modules

Vakken:

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

Research project (choose one)

Vakken:

Naam	Periode	Credits	Code
Research Project Applied Environmental Geosciences	Ac. Jaar (september)	24.0	AM_450267
Research Project Paleoclimatology and Geo-ecosystems	Ac. Jaar (september)	27.0	AM_450202

Research Project Solid Earth	Ac. Jaar (september)	27.0	AM_450200

optional modules

Vakken:

Naam	Periode	Credits	Code
Advanced Geochronology	Periode 5	3.0	AM_450171
Advanced Inorganic Geochemistry	Periode 5	3.0	AM_450172
Capita Selecta Structural Geology and Tectonics	Periode 4	3.0	AM_450144
Diagenesis of Sedimentary Rocks	Periode 5	3.0	AM_450169
Historical Geography	Periode 1	6.0	AM_450292
Low Temperature Deformations of Rocks and Regions	Periode 5	3.0	AM_450180
Magmatic Processes	Periode 4	6.0	AM_450189
Metamorphism and P-T Evolution	Periode 4	6.0	AM_450176
Microstructures in Tectonites	Periode 4	6.0	AM_450158
Palaeo-ecology/Palynology	Periode 3	3.0	AM_450054
Planetary Science	Periode 1+2	6.0	AM_450273
Practical Subsurface Evaluation Workshop	Periode 3	2.0	AM_450277
Precambrian Geology	Periode 4	3.0	AM_450164
Reflection Seismic for Geologists	Periode 4	6.0	AM_450170
Sediment Petrography of Heavy Minerals	Periode 3	3.0	AM_450058
Sustainable Land Management	Periode 3	6.0	AM_1015
Unsaturated Zone and Near Surface Hydrological Processes	Periode 4	6.0	AM_450021
Volcanism	Periode 3	3.0	AM_450061

second year (onderwijscentrum)

Opleidingsdelen:

- Leraar voorbereidend hoger onderwijs Aardrijkskunde verplicht

Leraar voorbereidend hoger onderwijs Aardrijkskunde verplicht

Vakken:

Naam	Periode	Credits	Code
Algemene didactiek en Pedagogiek I	Semester 1, Semester 2	6.0	O_MLADEPI
Algemene Didactiek en Pedagogiek II	Semester 1, Semester 2	3.0	O_MLADEPII
Praktijk I	Semester 1, Semester 2	15.0	O_MLPRAKI
Praktijk II	Semester 1, Semester 2	15.0	O_MLPRAKII
Professionele ontwikkeling en onderzoek I	Semester 1, Semester 2	3.0	O_MLVPOOI
Professionele ontwikkeling en onderzoek II	Semester 1, Semester 2	6.0	O_MLVPOOII
Vakdidactiek Aardrijkskunde fase I	Semester 1, Semester 2	3.0	O_MLVDAKI
Vakdidactiek Aardrijkskunde fase II	Semester 1, Semester 2	6.0	O_MLVDAKII
Verdieping	Semester 1, Semester 2	3.0	O_MLVERD

MSc Earth Sciences, specialisation Earth Sciences and Economics

Programme components:

- MSc Earth Sciences, specialisation ES&E, Theme Climate and Geo- ecosystems
- MSc Earth Sciences, specialisation ES&E, Theme Energy
- MSc Earth Sciences, specialisation Earth Sciences and Economics,compulsory modules for all themes
- MSc Earth Sciences, specialisation ES&E,Theme Water and Ecology

MSc Earth Sciences, spec. Earth Sciences and Economics - Theme Climate and Geo-ecosystems

Opleidingsdelen:

- compulsory courses
- choose at least one of these courses

compulsory courses

Vakken:

Naam	Periode	Credits	Code
Climate and Policy	Periode 3	6.0	AM_450188

Man and Climate: From Hominids to Modern Civilisation	Periode 4	3.0	AM_450187
Modern Climate Systems	Periode 1	3.0	AM_450185
Modern Geo-ecosystems	Periode 1	3.0	AM_450313

choose at least one of these courses

Vakken:

Naam	Periode	Credits	Code
Sedimentary Environments and Climate Archives	Periode 1	6.0	AM_450330
Water and Policy	Periode 1	6.0	AM_468023

MSc Earth Sciences, spec. Earth Sciences and Economics - Theme Energy

Opleidingsdelen:

- optional course Theme Energy year 1
- choose at least 2 of these courses
- choose at least 1 of these courses
- compulsory modules

optional course Theme Energy year 1

Vakken:

Naam	Periode	Credits	Code
Geothermal Energy	Periode 5	6.0	AM_450409

choose at least 2 of these courses

Vakken:

Naam	Periode	Credits	Code
Energy System Transitions	Periode 3	6.0	AM_468019
Reflection Seismic for Geologists	Periode 4	6.0	AM_450170
Sustainable Energy Analysis	Periode 1	6.0	AM_468018

choose at least 1 of these courses

Vakken:

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

compulsory modules

Vakken:

Naam	Periode	Credits	Code
Petroleum Systems for Earth and Economics	Periode 1	6.0	AM_450408

MSc Earth Sciences, spec. Earth Sciences and Economics, compulsory modules for all themes

Vakken:

Naam	Periode	Credits	Code
Assessing the Landscape	Periode 4	3.0	AM_450404
Decision Making Processes	Periode 3	6.0	AM_450402
Empirical Methods for Spatial Policy	Periode 2	6.0	AM_450401
Exploring Earth Processes and Resources	Periode 4	6.0	AM_450405
Imaging the Earth Surface	Periode 4	3.0	AM_450403
Master Thesis Earth Sciences and Economics	Ac. Jaar (september)	27.0	AM_450407
Microeconomic Foundation of Spatial Policy	Periode 1	6.0	AM_450400
Project Environmental Impact Assessment	Periode 5	6.0	AM_450406
Research Project Earth Sciences and Economics	Ac. Jaar (september)	18.0	AM_1103

MSc Earth Sciences, spec. Earth Sciences and Economics - Theme Water and Ecology

Opleidingsdelen:

- compulsory modules
- choose at least 3 of these courses
- choose at least 1 of these courses

compulsory modules

Vakken:

Naam	Periode	Credits	Code
Soil and Environment	Periode 2	6.0	AM_1030

choose at least 3 of these courses

Vakken:

Naam	Periode	Credits	Code
Aquatic Ecology	Periode 1	6.0	AM_450137
Ecohydrology	Periode 2	6.0	AM_450014
Spatial Processes in Ecology and Evolution	Periode 1	6.0	AM_1039-UvA
Water and Policy	Periode 1	6.0	AM_468023

choose at least 1 of these courses

Vakken:

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

MSc Earth Sciences, spec. Palaeoclim. and Geo-ecosystems

Opleidingsdelen:

- MSc Earth Sciences, spec. Palaeo, first year
- MSc Earth Sciences, spec. Palaeo, second year

MSc Earth Sciences, spec. Palaeo, first year

Vakken:

Naam	Periode	Credits	Code
Climate Modelling	Periode 3	6.0	AM_450004
From Source to Sink: Chemical and Physical Cycles	Periode 2	6.0	AM_450146
Global Biogeochemical Cycles	Periode 4	6.0	AM_450332
High Resolution Archives	Periode 2	6.0	AM_450331
Man and Climate: From Hominids to Modern Civilisation	Periode 4	3.0	AM_450187
Modern Climate Systems	Periode 1	3.0	AM_450185
Modern Geo-ecosystems	Periode 1	3.0	AM_450313
Practical: Palaeoclimate Change and Environmental Impacts	Periode 4	3.0	AM_450266
Research Project Paleoclimatology and Geo-ecosystems	Ac. Jaar (september)	27.0	AM_450202
Sedimentary Environments and Climate Archives	Periode 1	6.0	AM_450330

MSc Earth Sciences, spec. Palaeo, second year

Opleidingsdelen:

- optional modules
- compulsory courses year 2

optional modules

Vakken:

Naam	Periode	Credits	Code
Environmental Remote Sensing	Periode 3	6.0	AM_450145
Historical Geography	Periode 1	6.0	AM_450292
Palaeo-ecology/Palynology	Periode 3	3.0	AM_450054
Sediment Petrography of Heavy Minerals	Periode 3	3.0	AM_450058
Soil and Environment	Periode 2	6.0	AM_1030
Sustainable Land Management	Periode 3	6.0	AM_1015
Unsaturated Zone and Near Surface Hydrological Processes	Periode 4	6.0	AM_450021

compulsory courses year 2

Vakken:

Naam	Periode	Credits	Code
Climate and Policy	Periode 3	6.0	AM_450188
Master Thesis Paleoclimatology and Geo-ecosystems	Ac. Jaar (september)	24.0	AM_450201
Research Project Paleoclimatology and Geo-ecosystems	Ac. Jaar (september)	27.0	AM_450202
Scotland Excursion	Periode 6	3.0	AM_450354

MSc ES spec. Science Communication

Programme components:

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

Earth Sciences content

Opleidingsdelen:

- Research project (choose one)
- optional modules

Research project (choose one)

Vakken:

Naam	Periode	Credits	Code
Field Research Project Geosciences of Basins and Lithosphere	Ac. Jaar (september)	24.0	AM_450195
Research Project Applied Environmental Geosciences	Ac. Jaar (september)	24.0	AM_450267
Research Project Archaeometry	Ac. Jaar (september)	27.0	AM_450296
Research Project Paleoclimatology and Geo-ecosystems	Ac. Jaar (september)	27.0	AM_450202
Research Project Solid Earth	Ac. Jaar (september)	27.0	AM_450200

optional modules

Vakken:

Naam	Periode	Credits	Code
Advanced Geochronology	Periode 5	3.0	AM_450171
Advanced Inorganic Geochemistry	Periode 5	3.0	AM_450172
Capita Selecta Structural Geology and Tectonics	Periode 4	3.0	AM_450144
Diagenesis of Sedimentary Rocks	Periode 5	3.0	AM_450169
Historical Geography	Periode 1	6.0	AM_450292
Low Temperature Deformations of Rocks and Regions	Periode 5	3.0	AM_450180
Magmatic Processes	Periode 4	6.0	AM_450189
Metamorphism and P-T Evolution	Periode 4	6.0	AM_450176
Microstructures in Tectonites	Periode 4	6.0	AM_450158
Palaeo-ecology/Palynology	Periode 3	3.0	AM_450054
Planetary Science	Periode 1+2	6.0	AM_450273
Practical Subsurface Evaluation Workshop	Periode 3	2.0	AM_450277
Precambrian Geology	Periode 4	3.0	AM_450164
Reflection Seismic for Geologists	Periode 4	6.0	AM_450170
Sediment Petrography of Heavy Minerals	Periode 3	3.0	AM_450058
Sustainable Land Management	Periode 3	6.0	AM_1015
Unsaturated Zone and Near Surface Hydrological Processes	Periode 4	6.0	AM_450021
Volcanism	Periode 3	3.0	AM_450061

Science Communication content

Opleidingsdelen:

- Optional modules Science Communication
- Compulsory components Science Communic.

Optional modules Science Communication

Vakken:

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

Compulsory components Science Communic.

Vakken:

Naam	Periode	Credits	Code
Qualitative and Quantitative Research Methods	Periode 1	6.0	AM_470582
Science and Communication	Periode 1	6.0	AM_470587

MSc Earth Sciences, specialisation Solid Earth

Programme components:

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

optional courses year 1

Vakken:

Naam	Periode	Credits	Code
Advanced Geochronology	Periode 5	3.0	AM_450171
Advanced Inorganic Geochemistry	Periode 5	3.0	AM_450172
Diagenesis of Sedimentary Rocks	Periode 5	3.0	AM_450169
Geothermal Energy	Periode 5	6.0	AM_450409
Low Temperature Deformations of Rocks and Regions	Periode 5	3.0	AM_450180

Magmatic Processes	Periode 4	6.0	AM_450189
Metamorphism and P-T Evolution	Periode 4	6.0	AM_450176
Microstructures in Tectonites	Periode 4	6.0	AM_450158
Reflection Seismic for Geologists	Periode 4	6.0	AM_450170

compulsory courses year 1

Vakken:

Naam	Periode	Credits	Code
From Source to Sink: Chemical and Physical Cycles	Periode 2	6.0	AM_450146
Introduction Field Excursion	Periode 1	3.0	AM_450229
Mantle Properties in Lithosphere Development	Periode 1	3.0	AM_450225
Orogenesis	Periode 3	6.0	AM_450190
Petroleum Systems and Regional Geology	Periode 1	3.0	AM_450179
Research Project Solid Earth	Ac. Jaar (september)	27.0	AM_450200
Sedimentary Basins	Periode 2	6.0	AM_450154

optional courses year 2

Vakken:

Naam	Periode	Credits	Code
3D Seismic Interpretation and Production Geology	Periode 1	6.0	AM_450316
Advanced Inorganic Geochemistry	Periode 5	3.0	AM_450172
Capita Selecta Structural Geology and Tectonics	Periode 4	3.0	AM_450144
Ecohydrology	Periode 2	6.0	AM_450014
Historical Geography	Periode 1	6.0	AM_450292
Low Temperature Deformations of Rocks and Regions	Periode 5	3.0	AM_450180
Metamorphism and P-T Evolution	Periode 4	6.0	AM_450176
Microstructures in Tectonites	Periode 4	6.0	AM_450158

Palaeo-ecology/Palynology	Periode 3	3.0	AM_450054
Petroleum Geology of the North Sea	Periode 2	7.0	AM_450317
Planetary Science	Periode 1+2	6.0	AM_450273
Practical Subsurface Evaluation Workshop	Periode 3	2.0	AM_450277
Precambrian Geology	Periode 4	3.0	AM_450164
Unsaturated Zone and Near Surface Hydrological Processes	Periode 4	6.0	AM_450021
Volcanism	Periode 3	3.0	AM_450061

compulsory courses year 2

Vakken:

Naam	Periode	Credits	Code
Master Thesis Solid Earth	Ac. Jaar (september)	27.0	AM_450199
Research Project Solid Earth	Ac. Jaar (september)	27.0	AM_450200

MSc ES track Archaeometry

Opleidingsdelen:

- compulsory courses year 1
- compulsory courses year 2
- choose one
- optional modules

compulsory courses year 1

Vakken:

Naam	Periode	Credits	Code
Advanced Inorganic Geochemistry	Periode 5	3.0	AM_450172
Archaeometry III (Analytical Methods)	Ac. Jaar (september)	6.0	AM_450289
Basics in Geographical Information Systems	Periode 5	3.0	AM_450226
International Masterclass Geoarchaeology	Ac. Jaar (september)	10.0	AM_450191

compulsory courses year 2

Vakken:

Naam	Periode	Credits	Code
Applied Geographical Information Systems	Periode 2	3.0	AM_450227
Research Project Archaeometry	Ac. Jaar (september)	27.0	AM_450296

choose one

Vakken:

Naam	Periode	Credits	Code
Master Thesis Archaeometry (M-variant)	Ac. Jaar (september)	27.0	AM_450299
Master Thesis Archaeometry (O-variant)	Ac. Jaar (september)	27.0	AM_450300

optional modules

Vakken:

Naam	Periode	Credits	Code
Advanced Geophysical Prospection		3.0	AM_450293
Historical Geography	Periode 1	6.0	AM_450292
Magmatic Processes	Periode 4	6.0	AM_450189
Man and Climate: From Hominids to Modern Civilisation	Periode 4	3.0	AM_450187
Palaeo-ecology/Palynology	Periode 3	3.0	AM_450054
Perspectives on Ancient Landscapes	Periode 1	6.0	L_BAMAARC009
Sediment Petrography of Heavy Minerals	Periode 3	3.0	AM_450058
Sedimentary Environments and Climate Archives	Periode 1	6.0	AM_450330

MSc ES track Landscape Archaeology

Opleidingsdelen:

- optional courses year 1
- compulsory courses year 1
- compulsory courses year 2
- choose one

optional courses year 1

Vakken:

Naam	Periode	Credits	Code
Advanced Geophysical Prospection		3.0	AM_450293
Advanced Inorganic Geochemistry	Periode 5	3.0	AM_450172
Archaeometry III (Analytical Methods)	Ac. Jaar (september)	6.0	AM_450289
Climate Modelling	Periode 3	6.0	AM_450004
High Resolution Archives	Periode 2	6.0	AM_450331
Man and Climate: From Hominids to Modern Civilisation	Periode 4	3.0	AM_450187
Perspectives on Ancient Landscapes	Periode 1	6.0	L_BAMAARC009
Sedimentary Environments and Climate Archives	Periode 1	6.0	AM_450330
Volcanism	Periode 3	3.0	AM_450061

compulsory courses year 1

Vakken:

Naam	Periode	Credits	Code
Basics in Geographical Information Systems	Periode 5	3.0	AM_450226
Historical Geography	Periode 1	6.0	AM_450292
International Masterclass Geoarchaeology	Ac. Jaar (september)	10.0	AM_450191
Palaeo-ecology/Palynology	Periode 3	3.0	AM_450054
Research Project Landscape Archaeology	Ac. Jaar (september)	27.0	AM_450295

compulsory courses year 2

Vakken:

Naam	Periode	Credits	Code
Applied Geographical Information Systems	Periode 2	3.0	AM_450227

choose one

Vakken:

Naam	Periode	Credits	Code
Master Thesis Landscape Archaeology (M-variant)		27.0	AM_450297
Master Thesis Landscape Archaeology (O-variant)	Ac. Jaar (september)	27.0	AM_450298

3D Seismic Interpretation and Production Geology

Vakcode	AM_450316 ()
Periode	Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. J. de Jager
Docent(en)	dr. B.P. Zoetemeijer
Lesmethode(n)	Werkcollege

Doel vak
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.

Inhoud vak
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

Onderwijsvorm
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

Toetsvorm
Written Examination 40%; oral presentation 20%; practical 40%

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

Advanced Geochronology

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

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

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

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

Onderwijsvorm

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

Toetsvorm
Essay – presentation – poster

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

Vereiste voorkennis
BSc Geology

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

Doelgroep
1st year MSc Earth Science Solid Earths.

Overige informatie
Guest teachers include dr. J.M. O'Connor, University of Erlangen.

Advanced Geophysical Prospection

Vakcode	AM_450293 ()
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. S.K.A. Soetens
Docent(en)	dr. S.K.A. Soetens
Lesmethode(n)	Werkcollege
Niveau	400

Doel vak
Final attainment levels: students need to demonstrate that they can make an in depth presentation on the technological and methodological issues of a novel prospection technique. Moreover they have to attend all presentations of fellow students and synthesize two selected presentations.

Inhoud vak
It aims to provide better knowledge into known techniques and novel methods. The techniques covered in the course are aerial photography, photogrammetry, satellite remote sensing, 3D geophysical prospection (GPR, Automated Resistivity Profiling, etc.), 3D remote sensing using, LiDAR, DEM/DTM, AHN + very high spatial resolution satellite (VHSRS) systems. The possibilities of integration of combined data is reviewed in both commercial and open source GIS and other software.

Onderwijsvorm
Seminar

Toetsvorm
Synthesis of two fellow students'presentations: 30%
Presentation: 70%

Literatuur
The litaruture list is a dynamic list that will be contuniually updated. There is not a syllabus, but the the introduction lecture explains the practical details.

Vereiste voorkennis
This course builds on knowledge from the course "Geoarchaeological prospection techniques" (AM_450104).

Aanbevolen voorkennis
Bachelor course AB_450104 (Geoarcheologische prospectietechnieken) or comparable demonstrated knowledge.

Doelgroep
Archeologists with specific interest in prospective archaeology, geologists, geophysicists, geochemists, geographers with a specific interest in novel geospatial detection techniques.

Overige informatie
Richard de Jeu and Alfred Wagtendonk may appear as guest lecturers.

Advanced Inorganic Geochemistry

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

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

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

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

also includes a visit to the laboratories of the Rijksmuseum.

In addition, at the start of the course students are divided into groups of two. Each group will be allowed to choose one of the topics covered in the course. Each member of each group has 10 days to individually prepare:(1) a 200-word abstract on the paper / topic (i.e. what is the problem or controversy; what data are used).(2) a 3-page essay on the topic that discusses the major arguments in the subject region.(3) a Powerpoint presentation on the topic (maximum length 15 minutes, maximum 15 slides).You will then provide feedback on the performance of your colleague, and jointly prepare a final presentation.

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

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

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

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

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

Doelgroep
Second year MSc students in Earth Sciences.

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

Algemene didactiek en Pedagogiek I

Vakcode	O_MLADEPI ()
Periode	Semester 1, Semester 2
Credits	6.0
Voertaal	Nederlands
Faculteit	Faculteit der Psychologie en Pedagogiek

Coördinator	ir. E.J.F. Scheringa
Docent(en)	drs. W.S. Hoekstra, drs. S. Donszelmann, drs. B. Klein, drs. W. Jongejan, C.L. Geraedts
Lesmethode(n)	Hoorcollege
Niveau	500

Doel vak
De student kan algemene onderwijskundige en pedagogische inzichten op het terrein van (activerende) didactiek (rol van ontwerper), communicatie in de klas (rol van uitvoerder) en gedrag- en leerproblemen (verdiepende module) vertalen naar de eigen lespraktijk.

Inhoud vak
Deze module kent 4 onderdelen:
- de startweek (1 ects), waarin de student kennis maakt met de opleiding, met het basisinstrumentarium van een docent en de eigen startcompetenties in kaart brengt;
- colleges ten aanzien van de rol van Ontwerper en de rol van Uitvoerder;
- colleges over gedrag- en leerproblemen, waarin problematiek en aanpak van meest gangbare gedrag- en leerproblemen aan bod komen.

Onderwijsvorm
Colleges (hoorcolleges en werkgroepen)

Toetsvorm
- beoordeling van het portfolio
- tentamen over de colleges gedrag- en leerproblemen

Literatuur
Een literatuurlijst wordt verstrekt aan het begin van de opleiding

Vereiste voorkennis
Dit vak is alleen te volgen als onderdeel van de universitaire lerarenopleiding

Overige informatie
Voor alle onderdelen (startweek, rollen, verdiepende module) geldt een aanwezigheidsplicht

Algemene Didactiek en Pedagogiek II

Vakcode	O_MLADEPII ()
Periode	Semester 1, Semester 2
Credits	3.0
Voertaal	Nederlands
Faculteit	Faculteit der Psychologie en Pedagogiek
Coördinator	drs. B. Klein
Docent(en)	drs. H.R. Goudsmit, drs. B. Klein, dr. T. Bosma
Lesmethode(n)	Hoorcollege, Werkcollege
Niveau	500

Doel vak
De student kan:
1. leerlingen, als individu en als lid van de groep, ondersteunen en stimuleren in hun verdere persoons- en identiteitsontwikkeling;
2. de voorbeeldfunctie ten opzichte van leerlingen vormgeven en daarop reflecteren;
3. leerlingen helpen bij de voorbereiding op hun rol in de samenleving als actief participerend burger;
4. deze en eerdere verworven competenties aantonen in een showcaseportfolio

Inhoud vak
Deze module kent 2 onderdelen:
- colleges ten aanzien van de rol van Pedagoog;
- het werken aan de rolopdrachten voor de rol van uitvoerder, ontwerper en pedagoog voor het showcaseportfolio;

Onderwijsvorm
Colleges (hoorcolleges en werkgroepen) en zelfstudie

Toetsvorm
- een tentamen betreffende de rol van Pedagoog
- beoordeling van het showcase portfolio, waarin de student de verworven competenties ten aanzien van alle rollen aantoont

Literatuur
Een literatuurlijst wordt verstrekt aan het begin van de opleiding, en staat op Blackboard bij de betreffende studieonderdeel

Vereiste voorkennis
Dit vak is alleen te volgen als onderdeel van de universitaire lerarenopleiding

Overige informatie
Voor de colleges geldt een aanwezigheidsplicht. Studenten die dit vooraf met de vakdidacticus/mentor overeengekomen zijn, kunnen in zelfstudie onderdelen afronden.

Applied Geographical Information Systems

Vakcode	AM_450227 ()
Periode	Periode 2
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. R.A.M. de Jeu
Docent(en)	dr. R.A.M. de Jeu
Lesmethode(n)	Computerpracticum, Werkgroep
Niveau	400

Doel vak
Geographical Information systems were first developed in the early 1960s, were they were no more than a set of innovative computer based applications for map data processing that were used in a small number of government agencies and universities only. Today GIS has become an

important field of academic study, one of the fastest growing sectors in the computer industry and, most important, an essential component of the information technology (IT) infrastructure of modern society.
This advanced course in GIS is developed to teach students how to use GIS in a research project. After completing this course, the student will be able to set up a GIS project individually. The student will learn how to make a reliable project plan, and how to present the results. Finally, the student will have familiarized his/herself with presenting research results in a compact and clear scientific poster and oral presentation, both in English.

Inhoud vak
This advanced course in GIS consists of a theoretical part and a specialization part, depending on the master profile. In the theoretical part the use of GIS in research is explained. The practical part focuses on the use of GIS in a chosen research project. The student will elaborate this small project into a scientific poster and a final oral presentation.

Onderwijsvorm
The course consists of 7 class meetings and 7 periods to work on your project in the computer lab. Each meeting starts with an introduction by the staff followed by group discussions, and feedback sessions. The project topics will be defined by the students and students will be working individually on their project. The staff has a list of proposed project, but the student is free to come up with their own project. The course is highly interactive and the students will be involved in the entire process from proposal to poster. In addition, they will be part of the review and evaluation process.

Toetsvorm
Scientific Poster (80 %), and oral presentation (20 %)

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

Aanbevolen voorkennis
Successful completion of Basics in Geographical Information Systems (AM_ 450226) is strongly advised.

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

Aquatic Ecology

Vakcode	AM_450137 ()
Periode	Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. J.E. Vermaat
Lesmethode(n)	Werkcollege, Practicum
Niveau	400

Doel vak
1. Acquire an understanding of the complexity and biotic richness of aquatic ecosystems and the importance of the medium, water, in shaping this.
2. Acquire an understanding of the links between aquatic ecology and water quality, and develop the capacity to interpret pattersn from the one into those of the other field
3. Be able to understand, summarise, and debate papers from the primary literature selected to deepen the subjects presented with help of the text book
4. Be able to design, carry out and report on a limited field study in the waters around Amsterdam and test a self-developed hypothesis

Inhoud vak
This is an introductory course to for earth scientists interested in water that want to enrich their expertise with ecology. It can also serve to add a view on aquatic habitats for ecologists that mainly have been exposed to terrestrial habitats so far. The subject is presented at a master's level with a focus on independent exploration in the field and primary literature. The course will be taught from a basic textbook, Dobson & Frid (2009), as starting point, with excursions to papers providing depth to the chapters.

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

Onderwijsvorm
1. plenary lectures (5 x 4 = 20 hrs). Lecture format: Vermaat discusses chapter content, students give a brief presentation on deepening papers. Non-presenting students are expected to have prepared by reading these chapters and the two accompanying, deepening papers (see below) before the lecture. The lecture is concluded with debate on the accompanying paper.
2. comparative fieldwork in small groups of 2-4 students: spatial gradients among and within water bodies around Amsterdam (field 2 d, lab processing 2 d), concluded by student seminars on fieldwork (4 hrs); student groups write a report on their fieldwork subject (length 5-10 pp, 11 pt Times New Roman, Introduction, Method, Results, Discussion, References containing ~ 10 papers from the primary literature)
3. literature study for deepening presentations and field work report.

Toetsvorm
Written exam (60%), fieldwork report (30%), oral presentations (both on book and lab work, content and quality, 10%). The written exam is open book.

Literatuur
Book: Dobson M & Frid C., 2009. Ecology of Aquatic Systems, 2nd edition.Oxford University Press, 321 pp; ISBN: 9 780199 297542
Selected deepening papers (liable to change, will be communicated at

start of course):

Rivers
Poole GC, 2002. Fluvial landscape ecology: addressing uniqueness within the river discontinuum. Freshwat Biol 47, 641-660.
Lamouroux N, Poff NL, Angermeier PL, 2002. Intercontinental convergence of stream fish community traits along geomorphic and hydraulic gradients. Ecology 83, 1792-1807

Estuaries
Bishop MJ, Kelaher BP, Smith MPL, York PH, Booth DJ, 2006. Ratio-dependent response of a temperate Australian estuarine system to sustained nitrogen loading. Oecologia 149, 701-708.
Soetaert K, Middelburg JJ, Heip C, 2006. Long-term change in dissolved inorganic nutrients in the heterotrophic Scheldt estuary (Belgium, The Netherlands) Limnol Oceanogr 51, 409-423.

Coastal Seas
Bianchi TS, Westman P, Andren T, Rolff C, Elmgren R, 2000. Cyanobacterial blooms in the Baltic Sea: natural or human-induced? Limnol Oceanogr 45, 715-726.
McQuatters-Gollop A, Raitsos DE, Attrill M, Edwards M, Lavender S, Mee L, 2007. A new long-term chlorophyll dataset reveals a regime shift in North Sea phytoplankton biomass unconnected to nutrient levels. Limnol. Oceanogr. 52, 635-648.

Open Ocean
Worm B, and many others, 2006. Impacts of biodiversity loss on ocean ecosystem services. Science 314, 787-790.
Beaugrand G, 2009 Decadal changes in climate and ecosystems in the North Atlantic Ocean and adjacent seas. Deep Sea Res II 56, 656-673.

Aanbevolen voorkennis
Basic statistics, introduction in hydrology

Doelgroep
MSc Earth Sciences (all tracks), MSc Hydrology, MSc Biology, MSc Ecology

Archaeometry III (Analytical Methods)

Vakcode	AM_450289 ()
Periode	Ac. Jaar (september)
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. P.Z. Vroon
Docent(en)	prof. dr. E.B. Guttmann-Bond
Lesmethode(n)	Practicum
Niveau	400

Doel vak
Providing insight in the use of modern inorganic analytical methods in archaeology and archaeometry.

Inhoud vak
The course consists of a series of lectures and laboratory exercises. Lectures will focus on the principles of a number of the most current analytical methods, on the understanding of the significance of numerical results obtained with these methods, and on their workable applications to archaeology and archaeometry. The laboratory exercises will give a hands-on training in different analytical methods (all aspects of sample handling and sample preparation, chemical analysis, electron/ion-beam techniques, mass spectrometry, data acquisition and interpretation).

Onderwijsvorm
Lectures and laboratory work.

Toetsvorm
Essay on laboratory results and interpretation.

Literatuur
Lecture notes and reader with selected papers/chapters

Overige informatie
This course will be offered in 2012 - 2013 as from December.

Assessing the Landscape

Vakcode	AM_450404 ()
Periode	Periode 4
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. E. Koomen
Docent(en)	drs. E. Koomen
Lesmethode(n)	Werkcollege, Computerpracticum, Excursie
Niveau	400

Doel vak
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.

Inhoud vak
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?

Onderwijsvorm
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.

Toetsvorm
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.

Literatuur
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.

Vereiste voorkennis
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.

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

Doelgroep
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.

Overige informatie
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

Vakcode	AM_450226 ()
Periode	Periode 5
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	drs. A.J. Wagtendonk
Docent(en)	dr. R.A.M. de Jeu, drs. A.J. Wagtendonk
Lesmethode(n)	Computerpracticum
Niveau	400

Doel vak
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.

Inhoud vak
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. The student will be trained in the use of GIS and special attention will be paid to the use of mobile GIS systems.

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

Toetsvorm
Written exam (ca. 50%) and practical computer exam (ca. 50%).

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

Aanbevolen voorkennis
Advice regarding previous course taken: AB_!076: GIS and digital geographical data

Capita Selecta Structural Geology and Tectonics

Vakcode	AM_450144 ()
Periode	Periode 4
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. B.P. Zoetemeijer
Docent(en)	dr. B.P. Zoetemeijer, dr. E. Willingshofer

Lesmethode(n)	Hoorcollege

Doel vak
To be able to link geological and geophysical data sets of various scales to viable concepts in Earth Sciences, thereby conveying the understanding of processes which are involved in the deformation of the lithosphere.

Inhoud vak
Students have to choose a topic for their self- study about which they have to hand in a written report and give a concise oral presentation. Topics are provided during the first session and cover certain aspects of a general theme, which may vary on a yearly basis. Themes may cover aspects which are important for the tectonic evolution of particular regions like the Alps or may cope with process-oriented issues like different modes of extension etc. The results of the self studies will be presented and discussed in the group. A period of ~ 4 weeks is given for preparing the presentation and the report. Relevant literature will be partly provided.

Onderwijsvorm
Combined; presentation and discussion meetings (~5 x 3hrs), self study, written and oral presentations.

Toetsvorm
Student paper (50%) and oral presentation (50%)

Overige informatie
This course is not offered in 2013/2014.

Catchment Response Analysis

Vakcode	AM_450003 ()
Periode	Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. M.J. Waterloo
Docent(en)	dr. M.J. Waterloo, dr. H.J. van Meerveld
Lesmethode(n)	Werkcollege, Computerpracticum
Niveau	400

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

The course contributes to the Knowledge and Understanding and

Application of Knowledge and Understanding final attainment levels of the Msc Hydrology Programme. Knowledge and understanding is obtained through the studying of theory as provided in the 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.

Inhoud vak
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.

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

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

Literatuur
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.

Vereiste voorkennis
The student should be familiar with the subjects of the BSc course Introduction to Hydrology and Climatology (AB_1074) as detailed in the Introduction to Hydrology and Climatology (2013) course reader by M.J.

Waterloo, V.E.A. Post and K. Horner.

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

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

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

Climate and Policy

Vakcode	AM_450188 ()
Periode	Periode 3
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. P.H. Pattberg
Docent(en)	prof. dr. ir. P. Vellinga, dr. P.H. Pattberg, E. Papyrakis
Lesmethode(n)	Werkcollege
Niveau	400

Doel vak
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.

Inhoud vak
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 Fourth 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.

Onderwijsvorm
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.

Toetsvorm
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.

Literatuur
Reader

Climate Modelling

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

Inhoud vak
Geological archives show convincingly that the climate system experiences variability on a wide range of time-scales. For Quaternary studies, climate variations at the following time-scales are most important: glacials-interglacials, millennia and centuries-decades. This course focuses at the mechanisms behind these variations, thereby using climate models as a tool, i.e. numerical computer models in which the dynamics of the climate system are calculated. The combination of these models and geological data will be treated extensively. The course consists of lectures giving an overview of climate models and their application (different types for different time-scales) 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?

Onderwijsvorm
Lectures, discussion meetings and computer exercises.

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

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

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

Communication, Organization and Management

Vakcode	AM_470572 ()
Periode	Periode 2
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. J. Maas
Docent(en)	dr. H. Wels, prof. dr. F. Scheele, dr. M.B.M. Zweekhorst
Lesmethode(n)	Hoorcollege, Werkgroep
Niveau	500

Doel vak
To get acquainted with theories on organisational behaviour
To obtain a deeper understanding of communication from the perspective of sharing and influencing results
To acquire knowledge on organisational structures and designs

To get acquainted with important theories on organisational transitions and change management
To acquire insight into different management practices in the health and life sciences sector
To gain insight in leadership and interpersonal behaviour
To obtain insight in methods for motivation and conflict management
To improve communication skills
To practise analytical and advisory skills

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

Onderwijsvorm
Lectures (approximately 22 hours), response lectures (4 hours), self study, training workshops (12 hours), self-study and writing project assignment (approximately 120 hours).

Toetsvorm
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.

Literatuur
To be announced on Blackboard

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

Overige informatie
Attendance to training, workshops, interviews and discussions is indispensable

Decision Making Processes

Vakcode	AM_450402 ()
Periode	Periode 3
Credits	6.0

Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. E. Vasileiadou
Docent(en)	dr. E. Vasileiadou
Lesmethode(n)	Werkcollege
Niveau	400

Doel vak
1. be able to distinguish between different groups of analysis tools for decision-making processes, and understand their underlying assumptions;
2. be able to use some of these tools in practice in different decision contexts;
3. be familiarized with scientific literature in the field; and
4. have fostered skills in oral expression and argumentation in English.

Inhoud vak
Economic rationality and CBA, (Climate) Models in decision-making and scientific rationality, Participatory tools and social rationality, Multi-criteria analysis, Scenarios, Integrated Assessment Frameworks and political rationality.

Onderwijsvorm
Classes 22 hours
Individual homework 106 hours
Exam preparation 40 hours
Total 168 hours

Toetsvorm
Individual assignments (40%), Exam (60%)

Literatuur
de Bruin, K., R. B. Dellink, et al. (2009). "Adapting to climate change in The Netherlands: an inventory of climate adaptation options and ranking of alternatives." Climatic Change 95: 23–45.

Hage, M. and P. Leroy (2008). Stakeholder Participation Guidance for the Netherlands Environmental Assessment Agency. Main Document. the Hague, Netherlands Environmental Assessment Agency.

Hoppe, R. and M. Hisschemöller (2001). Coping with Intractable Controversies: The Case for Problem Structuring in Policy Design and Analysis. Knowledge, Power and Participation in Environmental Policy Analysis. M. Hisschemöller, R. Hoppe, W. Dunn and J. Ravetz. New Brunswick, Transaction Publishers: 47-72.

Hulme, M. (2009). Why we disagree about climate change. Understanding Controversy, Inaction and Opportunity. Cambridge, Cambridge University Press.

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.

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

Nördstrom, E., L. O. Eriksson, et al. (2010). "Integrating multiple criteria decision analysis in participatory forest planning: Experience from a case study in northern Sweden." Forest Policy and Economics 12: 562-574.

Petersen, A. C. (2008). "The practice of climate simulation and its social and political context." Netherlands Journal of Geosciences 87(3): 219-229.

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

Aanbevolen voorkennis
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

Doelgroep
MSc students

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

Diagenesis of Sedimentary Rocks

Vakcode	AM_450169 ()
Periode	Periode 5
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. H.B. Vonhof
Docent(en)	dr. H.B. Vonhof
Lesmethode(n)	Computerpracticum

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

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

Inhoud vak
The course will cover carbonates and their diagenetic products and is concerned primarily with the preservation potential of the main carbonate and detrital phases under marine, meteoric and burial

diagenetic settings. As a consequence, the porosity evolution in sedimentary rocks will be of relevance to this course. This has both fundamental and applied aspects. The course will involve theoretical knowledge as well as case studies.

Onderwijsvorm
Classes and microscope practical

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

Literatuur
Course notes and handout

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

Ecohydrology

Vakcode	AM_450014 ()
Periode	Periode 2
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. M.J. Waterloo
Docent(en)	prof. dr. L.A. Bruijnzeel
Lesmethode(n)	Werkcollege, Computerpracticum
Niveau	400

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

Inhoud vak
This course describes and discusses basic interactions between the vegetated land surface, the atmosphere and the hydrosphere. Basic questions dealt with include: what determines the broad vegetation patterns of the world, and how do these in turn determine the

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

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

Toetsvorm
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%).

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

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

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

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

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

Empirical Methods for Spatial Policy

Vakcode	AM_450401 ()
Periode	Periode 2
Credits	6.0
Voertaal	Engels

Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. T. de Graaff
Docent(en)	dr. T. de Graaff
Lesmethode(n)	Hoorcollege, Werkgroep
Niveau	400

Doel vak
The final attainment levels. The student understands the state of the art of economic research methods in the domain if spatial planning, environmental policy. The student can apply these methods in his/her own research, in particular in the Master thesis.

Inhoud vak
Key issues to be addressed are econometric methods (from OLS to discrete choice modelling), scenario analysis, evaluation techniques (including revealed and stated preference techniques, survey design), spatial interaction models and spatial econometrics.

Onderwijsvorm
Number of contact hours is 36 hours,

Toetsvorm
Written exam (75%); assignments (25%).

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

Vereiste voorkennis
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).

Energy System Transitions

Vakcode	AM_468019 ()
Periode	Periode 3
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. M. Hisschemoller
Docent(en)	dr. M. Hisschemoller
Lesmethode(n)	Werkgroep
Niveau	400

Doel vak
The learning objectives are to gain insight into:
- The way government and the energy sector deals with environmental issues, including the way they steer innovation;
- The concepts of industrial transformation and transition management

and;
- The scientific and political debates with respect to key energy options.

Inhoud vak
Energy policies are increasingly based on the premise that government alone cannot guarantee improvement of environmental conditions and that the technological advances will not suffice given the complexity of the current environmental problems. A change toward sustainability (transition, industrial transformation) involves issues of socio-technical innovation as well as cultural and institutional transformations of the systems.
Such a change, although radical in character, will be gradual in practice as it is believed to last 25 years or more. An important new debate has emerged about the scale at which these socio-technological and institutional changes should take place in order to achieve desired sustainability goals. Theoretical and historical aspects of system innovation and a transition towards sustainability will be addressed. The objective is to give students a critical perspective, and to make the link to questions of social and political shaping of transition processes. In working groups, the students gain experience with exploring options to stimulate long- term transition processes by using a backcasting method.

Onderwijsvorm
Lectures and workshops.

Toetsvorm
A written closed book examination (50%) and a short (1000- 2000 words) paper (50%). Both the paper and the examination must be a 5. 5 or higher. Not only the material in the reader, but also the material presented during the classes will be examined in this course.

Literatuur
Reader composed of scientific papers selected by the lecturers

Environmental Economics

Vakcode	E_STR_EEC (60442040)
Periode	Periode 2
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Economische Wet. en Bedrijfsk.
Coördinator	dr. S. Poelhekke
Docent(en)	dr. G.C. van der Meijden, dr. S. Poelhekke
Lesmethode(n)	Hoorcollege
Niveau	400

Doel vak
The aim of this course is to provide students with key insights regarding the nature of environmental problems and how environmental policy should be designed. This course consists of two parts. The first part comprises lectures by the teacher based on journal articles and on five chapters of an advanced textbook (Perman et al., 2011). The second part is devoted to group discussions based on readings of classical

articles, which are presented by the students. Moreover, there will be two homework assignments, which will be discussed in class.

The lectures offer a treatment of modern economic theories and methods to study the relationship between natural resources, environmental quality, economic structure, and environmental policy. The student is expected to develop 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 is to practice working with economic models to analyze some important mechanisms in the field of environmental economics. The presentation/discussion sessions are intended to improve the participants' economic reasoning and communication skills.

After following this course, you:
- have a profound understanding of the fundamental factors why environmental problems materialize (positive and negative externalities);
- have a profound understanding about the strengths and weaknesses of the various environmental policy instruments (taxes, quotas, voluntary agreements);
- have a good understanding about the linkages between production technology, natural resources, and sustainability;
- are able to work with simple economic models to analyze the dependence between natural resource and the economy, and to study the effects of environmental policy;
- have a good understanding of the economic challenges faced by resource-rich economies;
- have sharpened your economic reasoning and intuition, and have improved your presentation skills.

Inhoud vak
The following topics will be dealt with in the lectures:
- biological and physical aspects of environmental processes and problems;
- the economics of non-renewable and renewable resources;
-advanced topics in the economics of resource-rich economies;
- advanced topics in environmental policy theory (including instrument choice and the so-called 'Green Paradox');
- advanced theory and methods of monetary valuation of environmental change;
- models for the analysis of environmental policy and natural resource use.

The topics for the group discussions and student presentations can be chosen by the participants. A list of key journal articles is available for a broad range of topics, but if students wish to present on a topic that is not on the list, that is possible too.

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

Toetsvorm
Written exam (60%), presentation (20%), two assignments (10%), and class participation (10%) conditional on the exam grade being 5.0 or higher

Literatuur
- Chapters 5-7, 11-12, 14-15 and 17 from Perman, P., Y. Ma, M. Common, D. Maddison, and J. McGilvray (2011), Natural Resource and Environmental

Economics. Addison Wesley, Longman Ltd, 4th edition.
- Additional articles from the economics literature (available via BlackBoard)

Aanbevolen voorkennis
A thorough understanding of microeconomics.

Environmental Remote Sensing

Vakcode	AM_450145 ()
Periode	Periode 3
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. R.A.M. de Jeu
Docent(en)	dr. R.A.M. de Jeu
Lesmethode(n)	Werkcollege, Computerpracticum
Niveau	400

Doel vak
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.

Inhoud vak

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.

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

Toetsvorm
Written Exam

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

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

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

Exploring Earth Processes and Resources

Vakcode	AM_450405 ()
Periode	Periode 4
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. R.A.M. de Jeu
Examinator	dr. R.A.M. de Jeu
Docent(en)	dr. R.A.M. de Jeu, prof. dr. H. Doust, dr. L.C. Matenco
Lesmethode(n)	Werkcollege, Computerpracticum
Niveau	400

Doel vak
Sedimentary basins and mountain belts provide important resources to humanity, including drinking water, hydrocarbons, minerals and geothermal energy. Surface and crustal to lithospheric scale processes determine the living environment and provide benefits, through geo-resources, as well as threats imposed, for instance, by geohazards like

earthquakes and they also contribute to our vulnerability to global change. Understanding of the links between the state of the Earth's surface and the main processes active therein is therefore of great importance. This course aims at
• Arming the students with phenomenological understanding of Earth surface processes at different spatial and time scales, which are needed to further understand locations and potential of economic-relevant reserves (e.g. oil, gas, but also fresh water).
• An enhanced understanding of many facets of petroleum exploration industry and its impact on society including a review of the natural requirements needed for petroleum accumulation and the concept of petroleum systems.
• An enhanced understanding of our global hydrological cycle and the vulnerability of our water resources.
At the end of the course the student should have a basic knowledge of earth system processes at different spatial and temporal scales, with special emphasis on sustainable exploration of our natural resources.

Inhoud vak

The course contains 3 parts plus a series of oral presentations given by the students. The first part deals with fast shallow surface processes and focuses on the hydrological and biogeochemical cycles. The second part deals with sedimentary processes and petroleum systems. The last part consists of practicals where the students will work on case studies to enhance their understanding on the Earth System and how process knowledge could lead to a more sustainable exploration of our natural resources.

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

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

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

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

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

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

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

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

Field Course Netherlands (Measurements Techniques)

Vakcode	AM_450126 ()
Periode	Periode 5
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. J. Groen
Docent(en)	dr. B.M. van Breukelen, dr. J. Groen, drs. M.M.A. Groen, dr. M.J. Waterloo
Lesmethode(n)	Werkcollege, Veldwerk
Niveau	500

Doel vak
The objective of this course is to familiarize students with measurement methods and techniques that are commonly used in hydrology and environmental sciences.

At the end of the course the student should be able:
1. to select the appropriate field measurement methods and techniques for a certain hydrological question
2. to operate the equipment
3. to evaluate and interprete the results
4. to carry out the fieldwork in Portugal, which directly follows this course, and other research projects independently.

Inhoud vak
This course deals with a broad range of field measurement aspects of hydrological studies. The course starts with a one-day excursion to familiarize the participants with the geology and geomorphology of the Dinkel River watershed and practical research experience is subsequently gained through a study of the water balance and hydrochemistry of the area. This part of the course includes instructions in geophysical, geohydrological, meteorological, soil physical, and hydrochemical measurement techniques that are commonly used in surface and groundwater movement studies and in water quality investigations. Spatial data collection and processing methods are practiced through the use of portable geographic information systems. The last few days of the course are used for the analyses of data and the preparation of presentations. At this time, combining the results of different methods for estimating the water balance components solves the water balance for the area and an overview is prepared of the regional hydrochemistry. Key course

subjects are installation of
hydrological equipment, rainfall, water level and discharge measurements, installation of piezometers, geodetic surveys and groundwater gradient assessment, soil and aquifer permeability measurements (pumping test, auger hole method), automatic weather station operation, geo-electrical measurements (Schlumberger, Wenner array methods), soil moisture and tension measurements, water sampling and chemical analysis, datalogger programming, data processing and analyses, and finally, presentation techniques.

Onderwijsvorm
The 10 day course takes place at Camping Meuleman at the De Lutte, Overijssel and the direct surrounding carried out in the field. During 6 days students are in the field, receive instructions and carry out measurements in the direct surroundings of the camping and along the Dinkel River. Students work in groups of 4 to 5. In the evenings and the last two days students attend presentations by staff members on various subjects, interpret the data acquired in the field and prepare a presentation for the final evening according to a prescribed format. During the presentation every individual group member presents a part of the data and interpretations. Students have a total of 77 contact hours (days and evenings).

Toetsvorm
Students are evaluated on the basis of:
1. Individual performance in the field (33 %)
2. Individual presentation (33 %)
3. Group performance (33 %)

Literatuur
Course reader: Breukelen et al., 2009. Handbook for Field Hydrological Measurements. VU University Amsterdam. Reader is available on Blackboard.

Doelgroep
1. Dutch and foreigns students of VU Hydrology Masters program
2. Students from other universities in the Netherlands following an elecive course
3. Studenst from other European countries on Erasmus scholarships following an elective course

Overige informatie
Participants work in groups of three to four persons.

Field Research Project Geosciences of Basins and Lithosphere

Vakcode	AM_450195 (450003)
Periode	Ac. Jaar (september)
Credits	24.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. B.P. Zoetemeijer
Docent(en)	dr. B.P. Zoetemeijer
Lesmethode(n)	Bijeenkomst

Doel vak
Development, planning and carrying out fieldworkor scientific research and reporting the results. The main aim of fieldwork on the methodological side is to bring the students in a state where they are efficient managers of their field time. Because of its limited duration, an efficient use of fieldwork time is of crucial importance. An efficient fieldwork is one where the largest amount of relevant and good quality information is gathered. Both concepts of relevance and good quality cannot be defined in absolute terms and depend on the scientific problem being addressed. Only a thorough understanding of the tackled issues (academic or not) and its continuous update under the light of the new data being collected allows for identification of the relevant information to be obtained and the level of accuracy required.

Inhoud vak
The Field Research Project will allow students to develop their own scientific questions based on field observations into small- scale research projects. These projects will include the usual stages of planning and preliminary literature research (1 or 2 weeks), the fieldwork (2 or 4 weeks), the research itself (2 or 4 weeks) and reporting the results (2 or 4 weeks). The research topic can be in any of the Master's programme's disciplines and include numerical and laboratory analyses.

Onderwijsvorm
Fieldwork, laboratory work

Toetsvorm
Written report

Vereiste voorkennis
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.

Overige informatie
The Field Research Project is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the research project. This agreement should be put forward to the master co-ordinator (dr B. P. Zoetemeijer) before the start of the project.

From Source to Sink: Chemical and Physical Cycles

Vakcode	AM_450146 ()
Periode	Periode 2
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. M. ter Voorde
Docent(en)	dr. M. ter Voorde

Lesmethode(n)	Werkcollege, Computerpracticum
Niveau	400

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

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

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

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

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

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

Papers:
• Noller et al., Introduction to Quaternary geology
• Matenco et al., (2013) Quantifying the mass transfer from mountain ranges to deposition in sedimentary basins: Source to sink studies in the Danube Basin–Black Sea system (Global and Planetary Change)
• More papers, to be used for the exercises, will be made available via Blackboard

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

Geothermal Energy

Vakcode	AM_450409 ()
Periode	Periode 5
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. M.P. Bokhorst
Lesmethode(n)	Hoorcollege, Computerpracticum
Niveau	400

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

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

have to choose an optimal solution for the customer. A business case is build in which different geothermal options have to be considered and compared to a conventional solution for climate control in the buildings concerned.

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

Toetsvorm
The final mark is made up of assignments (10%), a presentation, 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.

Literatuur
All materials will be digitally provided through Blackboard

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

Overige informatie
Students are on a steep learning curve of integrated techno-economic-policy concepts. Mental alertness and the flexibility are therefore essential to gaining maximum benefit from the course!
Update (Sept 10 2013): This course is not offered in 2013/2014. The next opportunity to follow this course will be spring 2015.

Global Biogeochemical Cycles

Vakcode	AM_450332 ()
Periode	Periode 4
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. J. van Huissteden
Docent(en)	dr. J. van Huissteden
Lesmethode(n)	Computerpracticum, Hoorcollege
Niveau	400

Doel vak
To achieve insight in the role of biogeochemical cycles of the Earth system in the past and present.

Inhoud vak
The course commences with an overview of the major global biogeochemical cycles and their natural and anthropogenic disturbances. The main subject is exchange of C, N, P, and S between soil, water, atmosphere, and biota on global and local scales in different climatic zones (tropics, temperate, boreal and arctic zone) and environments, e.g. forests, wetlands and marine environments. We address the relation of biogeochemical cycles with the climate system, and with the hydrological cycle. Examples of quantification of fluxes using different measurement techniques are included. Emphasis will be on evidence of large-scale global past perturbations of the biogeochemical cycles on Earth both in the past and in the present. Next to present-day anthropogenic changes, we also focus on changes in the past: changes occurring along with the Milankovitch driven glacial-interglacial oscillations , the dynamics during the millennial scale Dansgaard-Oeschger events, the Paleocene-Eocene boundary and from the Cretaceous. These illustrate the full natural range of change of the coupled biogeochemical and climate system on Earth.

Onderwijsvorm
Lectures + workshop attendance. If the number of students is too small for a full lecture programme we will work with essay assignments and workshops

Toetsvorm
Written exam, evaluation of assignments handed out during the course

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

Groundwater Hydraulics

Vakcode	AM_450009 ()
Periode	Periode 2
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. H. Kooi
Docent(en)	dr. H. Kooi
Lesmethode(n)	Werkcollege
Niveau	400

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

of the methods used.

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

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

Doelgroep
Students in the Hydrology Master

High Resolution Archives

Vakcode	AM_450331 ()
Periode	Periode 2
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. H.B. Vonhof
Docent(en)	dr. C.J. Beets, dr. H.B. Vonhof
Lesmethode(n)	Werkcollege, Computerpracticum
Niveau	400

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

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

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

low latitudes. Furthermore we will investigate archives that record seasonal variation at high and low latitudes.

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

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

Onderwijsvorm
Classes, Literature discussion, and computer practicals

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

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

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

Historical Geography

Vakcode	AM_450292 ()
Periode	Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. A.M.J. de Kraker
Docent(en)	dr. A.M.J. de Kraker
Lesmethode(n)	Werkgroep, Excursie
Niveau	500

Doel vak
Student will be skilled in analysing the development of at least four different cultural landscapes over a longer time scale and assessing relevance of both the buried and still visible aspects of the cultural landscape today by giving four presentations and delivering one paper.

Inhoud vak
This master course deals with the interaction of man and his physical environment in the Low Countries (Belgium and the Netherlands) and adjacent countries on a time scale of the recent two thousand years. During this period man has had an impact on his environment by

reclamation, various kinds of land use and changing its hydrology. At the same time natural conditions, such as geological, hydrological and paedological conditions, but also climate, continued to have an impact on the social, economic and political organization of local communities. How did societies of the past adapt to these changes and become resilient? As a consequence the natural landscape(s) evolved into several distinctive cultural landscapes.
During classes and two fieldtrips three distinctive landscapes of the Low Countries and adjacent European countries, their main characteristics and how they have evolved during the recent 2,000 years will be highlighted. These landscapes are: sandy soil region, clay soil region and the peat areas. A fourth landscape will be subject of self tuition and may be chosen from the Low Countries or from a wider European context in order to complete the masters.

Onderwijsvorm
Study group (8-10 h), working class (4 h), preparing four presentations (4x15 h), two whole day fieldtrips (16 h), writing paper (20 h) reading literature (40-50 h)

Toetsvorm
presentations (25%) and final paper (75%)

Literatuur
Reader’s content: nrs. A-J are not compulsory

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2. Bieleman, J. (1985) Rural change in the Dutch province of Drenthe in the seventeenth and eighteenth centuries. Agricultural History Review vol. 33, part II, 105-117.
3. Roessingh, H.K. (1979) Tobacco growing in Holland in the seventeenth and eighteenth centuries: a case study of the innovative spirit of Dutch peasants. Acta Historiae Neerlandica XI, 18-54.
4. Bieleman, Jan (1993) Dutch agriculture in the Golden Age, 1570-1660. In: Karel Davids & Leo Noordegraaf (eds) The Dutch economy in the Golden Age. Nine studies. Nederlandsch Economisch-Historisch Archief, Amsterdam, 159-183.
5. Dejongh, Guy and Erik Thoen (1999), Arable productivity and the former territory of Belgium in a long-term perspective (from the Middle Ages to the end of the Ancien Régime). In: Bavel, Bas J.P. van, & Erik Thoen (eds) Land productivity and agro-systems in the North Sea area (Middle Ages - 20th century). Elements for comparison. Comparative rural history of the North Sea area, vol. 2. Turnhout, 30-64.
6. Comet, Georges (1997), Technology and agricultural expansion in the middle ages, the example of France north of the Loire. In: Grenville Astill & John Langdon (eds) Medieval farming and technology. The impact of agricultural change in Northwest Europe, Leiden, 11-40.
7. Raepsaet, Georges (1997) The development of farming implements between the Seine and the Rhine from the second to the twelfth centuries. In: Grenville Astill & John Langdon (eds) Medieval farming and technology. The impact of agricultural change in Northwest Europe, Leiden , 41-68.
8. Thoen, Erik (1997) The birth of "the Flemish husbandry": agricultural technology in medieval Flanders. In: Grenville Astill & John Langdon (eds) Medieval farming and technology. The impact of agricultural change in Northwest Europe, Leiden, 69-88.
9. Hoppenbrouwers, Peter (1997), Agricultural production and technology

in the Netherlands, c. 1000-1500. In: Grenville Astill & John Langdon (eds) Medieval farming and technology. The impact of agricultural change in Northwest Europe, Leiden, 89-115.
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11. Uhlig, Harald (1971) Field and field systems. In: R.H. Buchanan et all (eds) Man and his habitat. Essays presented to Emyr Estyn Evans. London, 93-125.
12. Thoen, Erik (2001), A Commercial survival economy in evolution. The Flemish countryside and the transition to capitalism (Middle Ages – 19th century)
13. Hoppenbrouwers, Peter and Jan Luiten van Zanden (2001), Peasants into farmers? The transformation of rural economy and society in the Low Countries (Middle Ages -19th century) in the light of the Brenner debate. Corn Publication Series 4. Brepols Turnhout.
14. Brenner, Robert P. (2001) The Low Countries in the transition to capitalism....
A) Ven, G.P. van de (ed)(1993) Man-made lowlands. History of water management and land reclamation in the Netherlands. Matrijs, Utrecht. (available in O-442)
B) Lambert, Audry M. (1985) The making of the Dutch landscape. An historical geography of the Netherlands. Academic Press. London etc. 2nd ed. (available in some photocopies in O-442)
15. Roessingh, H.K. (1970) Village and hamlet in a sandy region of the Netherlands in the middle of the 18th century. An application of the Guttman scalogram technique to socio-historical research. Acta Historiae Neerlandica IV, 105-129.
16. Smeerdijk, Dirk G. van, Theo Spek & Marja J. Kooistra (1995) Anthropogenic soil formation and agricultural history of the open fields of Valthe (Drenthe, the Netherlands) in mediaeval and early modern times. Mededelingen Rijks Geologische Dienst 52, 451-479.
17. Spek, Theo (1992) The age of plaggen soils. An evaluation of dating methods for plaggen soils in the Netherlands an Northern Germany. In: A. Verhoeve & J.A.J. Vervloet (eds) The transformation of the European rural landscape. Brussel, 72-91. Also published as Wageningen Studies in Historical Geography 1, Report 66, 72-130. Wageningen.
17a. Spek, Theo (2004) Het Drentse esdorpenlandschap. Een historisch-geografische studie. Stichting Matrijs-Utrecht, 3 vols, only the summary.
18. Spek, Theo Interactions between Humans and Woodland in Prehistoric and Medieval Drenthe (The Netherlands): an Interdisciplinary Approach. In: Kirby K.J. and C. Atkins (eds), The Ecological History of European Forests, 81- 95.
19. Heidinga, H.A. (1987): Kootwijk and his neighbours: settlement territories on the Veluwe since the Early Middle Ages. In: Medieval Settlement and Economy North of the Lower Rhine. Archeology and history of Kootwijk and the Veluwe (the Netherlands). Cingula 9. Van Gorcum, Assen/Maastricht, 153-174.
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library)
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F) Hesselink, Annika.W (2002), History makes a river. Morphological changes and human interference in the river Rhine. The Netherlands. Netherlands Geographical Studies no. 292. Dissertation Utrecht. (available in O-442)
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H) Henderikx, Peter A. (1988) The lower delta of the Rhine and the Maas: landscape and habitation from the Roman period to c. 1000. In: Berichten van de Rijksdienst voor het Oudheidkundig Bodemonderzoek 36, 1986, 447-599. (available in O-442)

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J) Tooley, R.V. (1978) Maps and map-makers. London.

Aanbevolen voorkennis
Bachelor Earth and Life Sciences / Bachelor Aarde & Economie, Bachelor Archeaology

Hydrochemistry

Vakcode	AM_450052 ()
Periode	Periode 4
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. B.M. van Breukelen
Docent(en)	dr. B.M. van Breukelen
Lesmethode(n)	Werkcollege, Computerpracticum, Practicum
Niveau	400

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

Inhoud vak
Hydro(geo)chemistry is essential for solving problems related with (ground)water quality and ecohydrology. The following topics are included: sampling and analysis of (ground)water; thermodynamics and kinetics of hydrogeochemical processes; reactive properties of hydrogeological systems; dissolution and precipitation of minerals; carbonate chemistry; weathering of silicates; cation exchange; surface complexation; redox-processes; effects of evaporation and mixing of

different water types; introduction to geochemical modelling; lab and field analysis of inorganic solutes in water.

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

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

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

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

Doelgroep
Hydrology Master students

Hydrological Systems and Water Management

Vakcode	AM_1012 ()
Periode	Periode 1
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. P.J. Stuijfzand
Docent(en)	prof. dr. P.J. Stuijfzand
Lesmethode(n)	Werkgroep, Hoorcollege
Niveau	400

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

Inhoud vak
After introducing the concepts of porosity and permeability the hydrogeological characteristics of various regions in the world are explored, in connection with their geomorphology, lithology / sedimentology and structural geology.
Groundwater mapping techniques based on both a hydrological and hydrochemical systems analysis are presented. The dynamics in flow and chemistry of groundwater are elucidated and explained in terms of natural and man-made variations in groundwater recharge and discharge, fresh and salt water intrusion / inundation, pollution and leaching of aquifers, and climate change.

The occurrences of and how to recognize palaeogroundwater are explained. Environmental effects of groundwater pumping, like wetland degradation, land subsidence, salinization and acidification pass in review.
Methods are presented, to monitor groundwater pressure and quality, to determine the origin and age of groundwater, and to image groundwater flow using physical, chemical and isotope tracers. Various techniques are presented to manage groundwater in stressed environments. The focus is here on MARS (Managed Aquifer Recharge Systems, like artificial recharge and river bank filtration). Special attention is given to define suitable hydro(geo)logical settings for MARS and to optimize water quality improvements during aquifer passage.

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

Toetsvorm
Written examination (100%)

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

Vereiste voorkennis
450024 (Inleiding Hydrologie)

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

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

Imaging the Earth Surface

Vakcode	AM_450403 ()
Periode	Periode 4
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	V. Pinto Nunes Nogueira Diogo MSc

Docent(en)	prof. dr. H.J. Scholten, V. Pinto Nunes Nogueira Diogo MSc
Lesmethode(n)	Werkcollege, Computerpracticum
Niveau	400

Doel vak
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.

Inhoud vak
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.

Onderwijsvorm
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.

Toetsvorm
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.

Literatuur
The relevant literature consists of scientific papers and book chapters in English that will be listed in Blackboard at the start of the course. These papers are provided through (links) on Blackboard.

Vereiste voorkennis
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.

Aanbevolen voorkennis
This subject 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.

Doelgroep
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.

Overige informatie
The practical GIS-skills obtained in this course are essential to the subsequent Assessing the Landscape course (450404).

The second coordinator of this course is Vasco Diogo.

International Masterclass Geoarchaeology

Vakcode	AM_450191 ()
Periode	Ac. Jaar (september)
Credits	10.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. H. Kars
Docent(en)	prof. dr. H. Kars
Lesmethode(n)	Werkcollege
Niveau	500

Doel vak
To gain a thorough insight into two or three geoarchaeological subjects on an international level.

Inhoud vak
In the first part of the class two or three geoarchaeological subjects in the fields of biomolecular archaeology and heritage management will be presented by an international team of lecturers from Amsterdam, York and Stockholm. In the second part all master students in geoarchaeology and archaeological science will meet in one of these three cities and will present their Research Project during a two- or three-day symposium, which is followed by a one-day excursion.

Onderwijsvorm
lectures, presentations, literature study, excursion

Toetsvorm
essays (50 %), presentation of research project (50 %)

Introduction Field Excursion

Vakcode	AM_450229 ()
Periode	Periode 1
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. J.J.G. Reijmer
Docent(en)	dr. G.V. Bertotti, dr. F.M. Brouwer, prof. dr. J.J.G. Reijmer
Lesmethode(n)	Veldwerk

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

Inhoud vak
The excursion follows a transect through the Eastern 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 Eastern Alps and train critical thinking and communication skills in group discussions and individual presentations.

Onderwijsvorm
7-day field programme and evening sessions

Toetsvorm
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.

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

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

Overige informatie
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.

Low Temperature Deformations of Rocks and Regions

Vakcode	AM_450180 ()
Periode	Periode 5
Credits	3.0

Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. G.V. Bertotti
Docent(en)	dr. G.V. Bertotti
Lesmethode(n)	Werkcollege

Doel vak
The course focuses on the deformation of rocks and regions in the Earth's upper crust, that is, in the brittle domain.

The main goal of the course is to provide students the skills to interpret relevant data and use them to predict deformation patterns at various scales and establish relations with causative stress fields.

Students are expected to acquire the following skills
- Predict stress fields of regions and specific structures such as folds and faults given specific boundary conditions and data points;
- Predict patterns of deformations in various domains at different spatial scales;
- Interpret the geological record to derive stress- strain conditions during deformation;
- Use observation to derive predictions for the deformation and general physical properties of larger regions.

Inhoud vak
The course is organized in four blocks dedicated to four different topics, together covering the most important issues of low temperature deformation of rocks and regions. The blocks focuses on:
- The structural geology, architecture and mechanics of faults
- Folding and fracturing
- Geometry, kinematics and mechanics of large scale contractional structures
- An issue with societal relevance such as, for instance, the earthquakes associated with the extraction of hydrocarbons or other.
In a further session, the results of the practical works are presented and discussed.
In all these components, a special attention will be dedicated to connections between small scale observations and large scale tectonics

Contact hours:
Lectures: 3 hours
Practicals: 12 hours

Onderwijsvorm
The course will have a "hands-on" approach typically starting with the analysis of real world data and then deriving general knowledge. Following a short introduction, the students will split in small groups and work through the practicals following a road-map prepared by the lecturer. At the end, they are required to prepare a schematic report of the results they have reached.

During these activities, students are accompanied by the lecturer who will also take the opportunity of presenting specific theoretical issues.

Toetsvorm

Students will work in small groups to tackle specific topics and/or case studies. Reports on the practical works are compulsory. Results will be presented and subjected to general discussion. Reports will be graded. The final grade results from these reports. The possibility of a final exam (oral or written) is kept open and will be decided at the beginning of the course.

Literatuur
Structural Geology by H. Fossen – Cambridge University Press

Material in the form of a comprehensive hand-outs and selected publications will be provided on Blackboard.

Magmatic Processes

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

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

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

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

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

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

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

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

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

Doelgroep
First year MSc students in Earth Sciences

Man and Climate: From Hominids to Modern Civilisation

Vakcode	AM_450187 ()
Periode	Periode 4
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. A.M.J. de Kraker
Docent(en)	prof. dr. H. Renssen, dr. A.M.J. de Kraker
Lesmethode(n)	Werkcollege
Niveau	500

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

Inhoud vak

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

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

Toetsvorm
Written exam

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

Mantle Properties in Lithosphere Development

Vakcode	AM_450225 ()
Periode	Periode 1
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. W. van Westrenen
Docent(en)	prof. dr. G.R. Davies
Lesmethode(n)	Werkcollege

Doel vak
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.

Inhoud vak
In this course we will (1) Provide you with an up-to-date overview of what seismology, petrology, and mineral physics tell us about the properties of and processes in the Earth's interior. (2) Clarify the links between heat, pressure, mineral properties, density variations, and 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).

Onderwijsvorm
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

Toetsvorm
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%)

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

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

Doelgroep
First year MSc students Earth Sciences, tracks Solid Earth, and First year MSc students GBL

Master Thesis Applied Environmental Geosciences

Vakcode	AM_450268 ()
Periode	Ac. Jaar (september)
Credits	27.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. S.J.P. Bohncke
Niveau	500

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

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

Onderwijsvorm
Research project or work placement/traineeship.

Toetsvorm
Written report/thesis.

Vereiste voorkennis
Bachelor exam Earth Sciences, and at least 36 EC of the programme of the master specialisation concerned should be registered by the student administration. Otherwise, admission only when granted by the examining board.

Overige informatie
The Master thesis is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the Master thesis work placement or research project. This agreement should be put forward to secretary of the Examination Board before the start of the work placement or research project.
The master thesis work placement or research project may be extended by a volume of 12 EC using the optional subject 'Extension of master thesis in Earth Sciences' (450149).
Information on Master thesis projects is provided by departmental lecturers and is made available on the departmental pages of the Faculty website.

Master Thesis Archaeometry (M-variant)

Vakcode	AM_450299 ()
Periode	Ac. Jaar (september)
Credits	27.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. H. Kars
Niveau	600

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

Inhoud vak
As in the Research Project, the student will be enabled to independently perform scientific research, either at the Institute or at another university. Alternatively, the Master Thesis can be used as an apprenticeship with a company in the field of geoarchaeology as an introduction into commercial archaeology.

Onderwijsvorm
fieldwork, laboratory work, apprenticeship.

Toetsvorm
written report

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

Master Thesis Archaeometry (O-variant)

Vakcode	AM_450300 ()
Periode	Ac. Jaar (september)
Credits	27.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. H. Kars
Niveau	600

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

Inhoud vak

As in the Research Project, the student will be enabled to independently perform scientific research, either at the Institute or at another university. Alternatively, the Master Thesis can be used as an apprenticeship with a company in the field of geoarchaeology as an introduction into commercial archaeology.

Onderwijsvorm
Fieldwork, laboratory work, apprenticeship.

Toetsvorm
Written report.

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

Master Thesis Earth Sciences and Economics

Vakcode	AM_450407 ()
Periode	Ac. Jaar (september)
Credits	27.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. M.P. Bokhorst

Doel vak
Learning to prepare and conduct a research project, or to successfully fulfil a work placement/traineeship in trade, industry, government or otherwise and to write a scientific report thereof at the academic Master's level. In practical conduct, working methods, attitude, collaboration, writing and other communication the student should demonstrate his or her:
- advanced knowledge and understanding of both fields and their clear integration, 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 andrationale underpinning these, to specialist and non-specialist audiences.

Inhoud vak
Research project or work placement (traineeship) in the master's programme Earth Sciences and Economics with a volume of 27 EC and related master thesis report.

Onderwijsvorm
Research project or work placement/traineeship.

Toetsvorm
written report or thesis

Vereiste voorkennis
Bachelor exam Earth Sciences, and at least 36 EC of the programme of the master specialisation concerned should be registered by the student administration. Otherwise, admission only when granted by the examination board.

Overige informatie
The Master thesis is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the Master thesis work placement or research project. This agreement should be put forward to the master co-ordinator before the start of the work placement or research project. Information on Master thesis projects is provided by departmental lecturers and is made available on the different involved departmental pages of the Faculty website (e.g. IVM, Paleoclimatology, Hydrology, Spatial Economics (FEWEB), Sedimentology).

Master Thesis Landscape Archaeology (M-variant)

Vakcode	AM_450297 ()
Credits	27.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. S.J. Kluiving
Niveau	600

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

Inhoud vak
As in the Research Project, the student will be enabled to independently perform scientific research, either at the Institute or

at another university. Alternatively, the Master Thesis can be used as an apprenticeship with a company in the field of geoarchaeology as an introduction into commercial archaeology.

Onderwijsvorm
Fieldwork, laboratory work, apprenticeship

Toetsvorm
Written report

Overige informatie
The Master thesis is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the Master thesis work placement (M-variant) or research project (O-variant). This agreement should be put forward to the secretary of the; examination board before the start of the work placement or research project.
The master thesis work placement or research project may be extended by a volume of 12 EC using the optional subject 'Extension Master Thesis Lanscape Archaeology' (450301).
Admission to the Master Thesis is only granted to master students (students without a bachelor degree are therefore excluded). Admission requirements are checked by the examining board. Participants should register in time (preferably 2- 3 months in advance) with the staff member/department in question.

Master Thesis Landscape Archaeology (O-variant)

Vakcode	AM_450298 ()
Periode	Ac. Jaar (september)
Credits	27.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. S.J. Kluiving
Niveau	600

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

Inhoud vak
As in the Research Project, the student will be enabled to independently perform scientific research, either at the Institute or at another university. Alternatively, the Master Thesis can be used as an apprenticeship with a company in the field of geoarchaeology as an introduction into commercial archaeology.

Onderwijsvorm
Fieldwork, laboratory work, apprenticeship

Toetsvorm
Written report

Overige informatie
The Master thesis is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the Master thesis work placement (M-variant) or research project (O-variant). This agreement should be put forward to the secretary of the examination board before the start of the work placement or research project.
The master thesis work placement or research project may be extended by a volume of 12 EC using the optional subject 'Extension Master Thesis Landscape Archaeology' (450301).
Admission to the Master Thesis is only granted to master students (students without a bachelor degree are therefore excluded). Admission requirements are checked by the examining board. Participants should register in time (preferably 2-3 months in advance) with the staff member/department in question.

Master Thesis Paleoclimatology and Geo-ecosystems

Vakcode	AM_450201 ()
Periode	Ac. Jaar (september)
Credits	24.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. S.J.P. Bohncke
Niveau	500

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

Inhoud vak
Research project or work placement (traineeship) in the master's; programme; Palaeoclimatology and Geo- ecosystems; with a volume of 24 EC (17 weeks) and related master thesis report.

Onderwijsvorm
Research project or work placement/ traineeship.

Toetsvorm
Written report/ thesis.

Vereiste voorkennis
Bachelor exam Earth Sciences, and at least 36 EC of the programme of the master specialisation concerned should be registered by the student administration. Otherwise, admission only when granted by the examination board.

Overige informatie
The Master thesis is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the Master thesis work placement or research project. This agreement should be put forward to the examination board (mrs. M. Wolters) before the start of the work placement or research project.
The master thesis work placement or research project may be extended by a volume of 12 EC using the optional subject 'Extension Master Thesis Paleoclimate and Geo- Ecosystems' (450270).
Information on Master thesis projects is provided by departmental lecturers and is made available on the departmental pages of the Faculty website.

Master Thesis Solid Earth

Vakcode	AM_450199 ()
Periode	Ac. Jaar (september)
Credits	27.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. B.P. Zoetemeijer

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

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

Onderwijsvorm
Research project or work placement/traineeship. Depending on the subject chosen a course on analytical techniques taught by the departments of Petrology and Isotope Geochemistrymay be integrated in this subject. The course consists of eight mornings, or afternoons, and will cover all aspects of sample handling from sampling techniques in the field, preparation of thin sections, preparation of samples required for analysis, to the basic theory of analytical techniques available in the faculty, data acquisition and interpretation. For practicals that are part of this course students will make use of materials sampled for their own projects.

Toetsvorm
Written report

Vereiste voorkennis
This course is only accessible to students who:
have earned their bachelor's degree
have earned at least 36 EC in the master specialisation programme concerned, as registered by the student administration on March 1st. Otherwise, admission is possible only when granted by the Examination Board.

Overige informatie
The Master thesis is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisor and student that specify the conditions for the Master thesis work placement or research project. This agreement should be put forward to the master co-ordinator (dr B.P. Zoetemeijer) 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

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

Doel vak
Gain a sufficient understanding of the theoretical basis of metamorphism (i.e. chemical thermodynamics) for the calculation of phase equilibria in open and closed systems for common non-metamorphic protoliths. This approach will be the basis for critically assessing PTt paths and; hence deriving the implications for geodynamic processes preserved in metamorphic rocks. Learning the basics of phase equilibrium modelling

using Thermocalc, TheriakDomino and/or Perple_X. Expand skills in optical microscopy as applied to metamorphic rocks.

Inhoud vak
Metamorphic phase equilibria, their variance and calculation; theoretical (chemographic) analysis of assemblages and reactions; element distribution between minerals; recognition of stable assemblages and of reactions in rocks. Role of fluid phases. Metamorphism of pelitic sediments, carbonate rocks and mafic (igneous) rocks. Geothermobarometry and PT- paths. Diffusion mechanisms and the concept of closure temperature as pertaining to geochronology of metamorphic processes. Critical assessment of PTt- data. Relation between PTt- paths and geodynamic processes.

Onderwijsvorm
Lectures with associated class- and homework and tutorial seminars. Three 15- to 30-minute written tests to help keep track of your progress. Practicals: microscopy, chemographic analysis, calculation of phase equilibria, geothermobarometric calculations, online assignment closure temperature. 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).

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

Literatuur
Textbook: Winter (2010) An introduction to igneous and metamorphic petrology, 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.

Doelgroep
First year MSc Earth Sciences students in the Solid Earth track.

Overige informatie
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

Vakcode	AM_450400 ()
Periode	Periode 1

Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. M.G. Lijesen
Docent(en)	dr. C.L. Behrens, dr. M.G. Lijesen, prof. dr. H.L.F. de Groot
Lesmethode(n)	Hoorcollege, Werkgroep
Niveau	400

Doel vak
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.

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

Onderwijsvorm
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

Toetsvorm
Written exam (75 %) and assignments (25 %)

Literatuur
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

Dixit, A. and J.E. Stiglitz, 1977, Monopolistic Competition and optimum product diversity, American Economic Review, 67, 297-308.

Hazledine, T., 2010, Oligopoly price discrimination with many prices, Economics Letters, 109, 150-3

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

Pearce, D.W., Atkinson, G. and S. Mourato, 2006, Cost-benefit analysis and the environment: recent developments, Organization for Economic Cooperation and Development, Paris

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

Aanbevolen voorkennis
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.

Microstructures in Tectonites

Vakcode	AM_450158 ()
Periode	Periode 4
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. H. Stel
Docent(en)	dr. H. Stel
Lesmethode(n)	Practicum

Doel vak
To provide the students a guide to microstructures in rocks induced by deformation

Inhoud vak

During the course, the main mechanism of deformation of minerals and rocks will be discussed and it will be shown by practical work how these mechanisms left their imprint on mesoscopic and microscopic scale. Topics of interest are a.o.: pressure solution, dislocation glide and climb; recovery recrystallization and the formation of mylonites. Information that is derived from microscopic observations will be compared with general models of rock deformation such as derived from experimental work. Special attention will be given to microstructures that yield information between deformation-induced foliations and the growth of metamorphic minerals.

Onderwijsvorm
During the course, the main mechanism of deformation of minerals and rocks will be discussed and it will be shown by practical work how these mechanisms left their imprint on mesoscopic and microscopic scale. Topics of interest are a.o.: pressure solution, dislocation glide and climb; recovery recrystallization and the formation of mylonites. Information that is derived from microscopic observations will be compared with general models of rock deformation such as derived from experimental work. Special attention will be given to microstructures that yield information between deformation-induced foliations and the growth of metamorphic minerals.

Toetsvorm
Written exam

Literatuur
Reader: a guide to the practicals

Doelgroep
Master students Solid earth

Modern Climate Systems

Vakcode	AM_450185 ()
Periode	Periode 1
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. G.M. Ganssen
Docent(en)	dr. G.M. Ganssen
Lesmethode(n)	Werkcollege
Niveau	400

Doel vak
To understand the physical and chemical processes that control atmosphere and ocean.

Inhoud vak
This introductory course gives a (short) overview into the physical and chemical processes driving the atmosphere and the ocean. Knowledge of the modern climate processes forms the basis for understanding Climate Change today and in the past.

Knowledge to gain about:

- the basic parameters and properties of atmospheric and ocean examples
- 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

Onderwijsvorm
Lectures and workshops, literature reading.

Toetsvorm
Written exam

Literatuur
Lecture notes, selected papers and Ruddiman, W.F., 2008. Earth's Climate: past and future.W.H. Freeman and Company New York.

Modern Geo-ecosystems

Vakcode	AM_450313 ()
Periode	Periode 1
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. G.M. Ganssen
Docent(en)	dr. G.M. Ganssen
Lesmethode(n)	Werkcollege, Excursie
Niveau	400

Doel vak
To understand the interactions between the geo-, bio-, hydro- and atmosphere in a selected number of modern terrestrial and marine geo-ecosystems. Special focus is given on both the natural processes and the human impact during the Anthropocene.

Inhoud vak
Anthropogenic changes to the Earth’s climate, land, oceans and biosphere are now so huge and rapid that the concept of a new geological epoch defined by the action of humans, the Anthropocene, is widely and seriously debated.

Knowledge to gain about:
- scale, magnitude and significance of modern environmental change especially in relation to Earth’s geological history.

Onderwijsvorm
Lectures, literature study, student presentations (45 minutes, teaching eachother by lecturing) and essay writing.

Toetsvorm
Oral presentation, written essay

Literatuur

Lecture notes, selected papers.

Orogenesis

Vakcode	AM_450190 ()
Periode	Periode 3
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. J.R. Wijbrans
Docent(en)	prof. dr. J.R. Wijbrans
Lesmethode(n)	Werkcollege, Computerpracticum

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

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

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

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

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

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

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

Vereiste voorkennis
BSc Geology

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

Doelgroep
1st year MSc Earth Science Solid Earths

Overige informatie
Guest teachers include B. Petri (MSc) University of Strasbourg and VU University.

Palaeo-ecology/Palynology

Vakcode	AM_450054 ()
Periode	Periode 3
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. S.J.P. Bohncke
Docent(en)	dr. S.J.P. Bohncke
Lesmethode(n)	Werkcollege
Niveau	500

Doel vak
The student can independently read and interpret and apply palynological literature. The student must be able to integrate palynological evidence in his or her research or thesis. He or she is able to handle the specific terminology that is needed to start his or her own palynological analyses.

Inhoud vak
The basal principles of palynology and applications in Quaternary geology such as climate reconstructions and paleoenvironmental reconstructions and human impact on vegetation.

Onderwijsvorm
Lectures: on pollen dispersion, deposition and preservation. How to construct a pollen diagram. How to interpret a pollen diagram, the local and regional signal. The relation between pollen assemblage and paleovegetation. Quaternary vegetation- and climate history of NW Europe.

Palynological characteristics of glacial, interglacial and interstadial pollen records, biostrigraphy. Anthropogenic impact as recorded in pollen diagrams. Landscape reconstructions applying pollen en macrobotanical data. Raised bogs as paleoclimatic archieves in the Holocene.
Literature study: on specific articles concerning the application of palynology in Quaternary studies.
Practical: the study of pollen morphological features using a microscope, the practical collection and the digital photo database. Different fossil pollen assemblages will be studied ranging from glacial to interglacial. Together the students work on pollen slides from one specific core and will make and interpret a pollen diagram.

Toetsvorm
Written examination on theory; essay on the practical part.

Aanbevolen voorkennis
Geobotanie AB_1062

Perspectives on Ancient Landscapes

Vakcode	L_BAMAARC009 ()
Periode	Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Letteren
Coördinator	dr. S.J. Kluiving
Docent(en)	dr. S.J. Kluiving, dr. A. Prent
Lesmethode(n)	Werkcollege
Niveau	400

Doel vak
• Understanding of theoretical concepts and approaches in current landscape research: processual, interpretative, phenomenological
• Competence in applying these concepts and approaches to specific case studies in European and Near Eastern Archaeology

Inhoud vak
The course focuses on the following key issues and research questions:
• How do we look at past landscapes within an archaeological framework?
• What characterizes the different methodological -like new processual, phenomenological, hermeneutic and Annaliste- approaches in landscape archaeology?
• What are the underlying concepts?
• How do weapply these approaches in our own research?
These issues and questions are discussed with the help of cases taken from Northwest-European, Scandinavian and Mediterranean archaeology.

Onderwijsvorm
Lectures, class room discussions

Toetsvorm
Written essay (70%), participation in class room discussions (30%).

Literatuur
Will be made available during the course

Vereiste voorkennis
Students admitted to one of the following Master's programmes can take this course : Archaeology (all three programmes) or Classics and Ancient Civilizations (all three programmes)

Doelgroep
Core Course for Master students Specialisation Landscape Archaeology. Also accessible to Master students Ancient History and Ancient Cultures, as well as Geo-archaeology.

Petroleum Geology of the North Sea

Vakcode	AM_450317 ()
Periode	Periode 2
Credits	7.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. B.P. Zoetemeijer
Docent(en)	prof. dr. J. de Jager
Lesmethode(n)	Hoorcollege

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

Inhoud vak
Different lecturers from 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.

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

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

Literatuur
The lecturers will make extensive literature lists available.

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

Petroleum Systems and Regional Geology

Vakcode	AM_450179 ()
Periode	Periode 1
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. J. de Jager
Docent(en)	prof. dr. H. Doust
Lesmethode(n)	Werkcollege

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

Inhoud vak
This course reviews a number of issues, technical and otherwise, that impact on exploration for hydrocarbons worldwide. Emphasis is placed on the need to be able to study subsurface issues from the most regional to the most local and to integrate data and concepts from all sorts of different disciplines. The main objective of the course is to teach students to appreciate the overall application of basin studies to the evaluation of petroleum resources. The strong link between basin tectonics and stratigraphy at all scales, as well as the importance of taking an integrated view through developing regional geologic skills are emphasized.

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

Onderwijsvorm
Lectures, practical examples worked by students.

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

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

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

Petroleum Systems for Earth and Economics

Vakcode	AM_450408 ()
Periode	Periode 1
Credits	6.0

Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. J.D.A.M. van Wees
Lesmethode(n)	Computerpracticum, Hoorcollege
Niveau	400

Doel vak

To provide students with:
A good, all-round idea of what hydrocarbon (oil and gas) exploration and production means to science and society, and to provide an insight into how, why and where accumulations occur
To review some of the world's main petroleum systems and to pick out the main lessons they provide, linking geology to subsurface understanding
To review coupled lithosphere-basin modelling techniques for prospect prediction
To review the concepts of petroleum systems and plays and see how they can be applied to future subsurface analysis and energy supply prediction
To review integrated techno-economic performance assessment techniques for hydrocarbon exploration and production both on asset and portfolio level

Inhoud vak

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

of development.

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

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

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

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

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

Planetary Science

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

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

Inhoud vak
A series of lectures will examine the bodies that make up our solar system, how they 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.

Onderwijsvorm
Lectures plus a day long visit to ESTEC where each student will make a critical review of a recent paper and groups will present a Space mission concept developed during the course. The course counts for 6 ECTS = 160 SBU, which are divided between the different components of this course in the following way (1) 13 * 3 hour lectures = 117 SBU, (2) Background reading and preparation of ESTEC presentations = 33 SBU (3) Excursion to ESTEC = 10 SBU, total 160 ECTS = 6 ECTS

Toetsvorm
The final mark for this course consists of the following components: Active participation and homework (20%), Written exam (40%), Poster preparation and mini-talks at ESTEC (40%).

Literatuur
Peter Bond – Exploring the solar system, augmented with recent scientific papers that will be made available at the start of the course.

Aanbevolen voorkennis
A solid background in geology and geochemistry is recommended but not essential.

Doelgroep
Second year MSc students with a natural science background

Overige informatie
Guest lectures are provided by Dr. Inge Loes ten Kate (Utrecht University), dr. Arie van den Berg (Utrecht University), dr. Bert Vermeersen (TU Delft), dr. Daphne Stam (TU Delft), and Prof. dr. Christoph Keller (Leiden University).

Practical Subsurface Evaluation Workshop

Vakcode	AM_450277 ()
Periode	Periode 3
Credits	2.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. J. de Jager
Docent(en)	prof. dr. H. Doust
Lesmethode(n)	Werkcollege

Doel vak
The course is intended to enable students to acquire and practice subsurface interpretation skills in a realistic, real-world environment. They will have the opportunity to work in teams on the kind of projects they could expect to carry out as practising petroleum geoscientists. The practical exercises use real data. The course represents a summing up of the Petroleum specialisation of Geosciences of basins and

Lithosphere.

Inhoud vak
The course is organised into practical exercises, each taking a few days. Use is made of real data from real situations, and the participants work in small teams to come up with reasonable answers to such questions as: Should we proceed with exploration or appraisal of this prospect? What are the risks versus rewards of continuing? How can this field be best developed?
A very important aspect of the exercises is the opportunity they give to work co-operatively in teams, sharing tasks and integrating each other's skills, in a general competitive atmosphere. Regular reporting of results to the whole group gives the opportunity to polish up participants' presentation skills.
The course is constructed around the so-called "Goonybird" exercise. Data from a hydrocarbon field in the North Sea is used to evaluate a discovery in 3 stages through early appraisal. As more data comes available, teams of participants can see how their interpretations and thoughts have to be modified, whilst becoming more precise. Task to be carried out include: interpretation of a grid of seismic profiles to construct a depth map of the field; geological correlation of wells and construction of a reservoir model; calculation of potential volumes of hydrocarbons with ranges of uncertainty; and prognosis of results of future wells.
If logistically feasible, and desired by participants, an option to view the cores at TNO's core laboratory may be added. Normally an industry representative, who is actively involved in the development and production of the field on which the exercise is based, is present at the final student presentations, and will give the company's latest view of the field and its volumes.

Onderwijsvorm
A full week of practical exercises with real subsurface seismic and well data, which is made available in batches, simulating a real field appraisal programme. Students work in small groups, and give regular presentations.

Toetsvorm
Continuous evaluation of results and presentations by lectures, quality of material delivered.

Overige informatie
This course is only accessible to second year graduate students (with bachelor's degree) who attended MSc courses like Petroleum Systems and Reflection Seismics.

Practical: Palaeoclimate Change and Environmental Impacts

Vakcode	AM_450266 ()
Periode	Periode 4
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. M.A. Prins
Docent(en)	dr. M.A. Prins, dr. S.R. Troelstra, dr. S.J.P. Bohncke, dr. E. Ufkes

Lesmethode(n)	Practicum, Lezing, Werkgroep
Niveau	500

Doel vak
- 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.

Inhoud vak
The practical comprises a series of 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. The research includes core description, defining sampling strategy, basic sample processing, determination of micropaleontological, palynological, geochemical and geophysical 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 laboratory work, oral presentations and discussion meetings are compulsory.

Onderwijsvorm
- An introductory lecture will highlight the most important aspects of the practical course (1 hr).
- Students will be motivated to present and discuss the obtained results during a series of discussion meetings (5 x 2 = 10 hr).
- Laboratory work, data analysis, preparation of presentations (15 x 4 = 60 hr).
- Self-tuition (13 hr).

Toetsvorm
- Laboratory work (20 %)
- Oral presentations and participation in discussion meetings (60 %)
- Written report (20 %)

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

Doelgroep
Master students

Praktijk I

Vakcode	O_MLPRAKI ()
Periode	Semester 1, Semester 2
Credits	15.0
Voertaal	Nederlands
Faculteit	Faculteit der Psychologie en Pedagogiek
Niveau	500

Doel vak
De student maakt kennis met het onderwijs in de praktijk, verzorgt lessen en is betrokken bij andere leerlinggerichte activiteiten. Hij kan

binnen de context van de school theoretische inzichten praktisch vormgeven en weet de praktijkomgeving te benutten om aan eigen ontwikkelpunten te werken.
De student werkt samen met anderen binnen en buiten de school en kan zijn functioneren als teamlid beschrijven en toelichten.

Inhoud vak
Het totale aantal klassencontacturen dat een student moet maken tijdens Praktijk 1 en 2, bedraagt tenminste 250. Tijdens deze uren observeert of verzorgt de student lessen en neemt deel aan andere leerlinggerichte activiteiten. Hij/zij geeft tenminste 120 lessen, waarvan minimaal 40 lesuren in de bovenbouw havo/vwo.
De verdeling en fasering van dit aantal uren over Praktijk 1 en 2 wordt in overleg met de begeleider op school bepaald. In Praktijk 1 ligt de nadruk op het observeren en het onder begeleiding voorbereiden, uitvoeren en evalueren van lessen.

Dit opleidingsonderdeel loopt parallel aan vakdidactiek 1 en algemene didactiek en pedagogiek 1, waardoor een goede wisselwerking mogelijk is tussen theorie en praktijk.

Toetsvorm
Praktijk 1 wordt door de schoolbegeleider beoordeeld aan de hand van een checklist. De schoolbegeleider doet daarbij een voorstel dat door de instituutsbegeleider moet worden onderschreven.

Vereiste voorkennis
Dit vak is alleen te volgen als onderdeel van de universitaire lerarenopleiding

Praktijk II

Vakcode	O_MLPRAKII ()
Periode	Semester 1, Semester 2
Credits	15.0
Voertaal	Nederlands
Faculteit	Faculteit der Psychologie en Pedagogiek
Niveau	500

Doel vak
De student kan, als docent-in-opleiding, verantwoordelijkheid dragen voor het zelfstandig voorbereiden, uitvoeren en evalueren van lessen in de onder- en bovenbouw van het Havo/VWO. Hij kan tevens een bijdrage leveren aan schoolbrede activiteiten. Hij kan binnen de context van de school theoretische inzichten praktisch vormgeven en weet de praktijkomgeving te benutten om aan eigen ontwikkelpunten te werken. Hij kan reflecteren op opgedane ervaringen en verworven inzichten en deze op dusdanige manier beschrijven dat zij inzichtelijk worden voor anderen.
De student toont zich professioneel in de samenwerking met anderen binnen en buiten de school en kan zijn functioneren als teamlid beschrijven en toelichten.

Inhoud vak
Het totale aantal klassencontacturen dat een student moet maken tijdens Praktijk 1 en 2, bedraagt tenminste 250. Tijdens deze uren observeert

of verzorgt de student lessen en neemt deel aan andere leerlinggerichte activiteiten. Hij/zij geeft tenminste 120 lessen, waarvan minimaal 40 lesuren in de bovenbouw havo/vwo.

De verdeling en fasering van dit aantal uren over Praktijk 1 en 2 wordt in overleg met de begeleider op school bepaald. Tijdens Praktijk 2 draagt de student verantwoordelijkheid voor een of meer klassen. Hij bereidt het onderwijs voor, voert het uit en evalueert het. Hij werkt hierbij nadrukkelijk samen met sectiegenoten en andere collega's binnen de school en is zich bewust van de context waarin zijn lessen plaatsvinden. In het portfolio doet hij verslag van zijn functioneren als teamlid en collega in de school.

Dit opleidingsonderdeel loopt parallel aan vakdidactiek 2 en algemene didactiek en pedagogiek 2, waardoor een goede wisselwerking mogelijk is tussen theorie en praktijk.

Toetsvorm
Praktijk 2 wordt door de schoolbegeleider beoordeeld aan de hand van een checklist waarop het eindcijfer voor de praktijk wordt gebaseerd. De schoolbegeleider doet daarbij een voorstel dat door de instituutsbegeleider moet worden onderschreven.

Tevens beoordeelt schoolbegeleider het functioneren van de student als teamlid en collega op basis van de door de student uitgevoerde portfolio-opdrachten.

Vereiste voorkennis
Dit vak is alleen te volgen als onderdeel van de universitaire lerarenopleiding.

Precambrian Geology

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

Doel vak
The Precambrian (Archean and Proterozic) comprises the immensely long time periods between the initial formation of the planet Earth and the earliest Paleozoic radiation of life forms with endo- or extra-skeletons. This course intends to summarize the Precambrian Geology in a general and interdisciplinary manner covering the evolution of the lithosphere, the hydrosphere, the atmosphere and the biosphere.

Inhoud vak

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

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

Toetsvorm
Essay – presentation – poster

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

Vereiste voorkennis
BSc Geology

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

Doelgroep
2nd year MSc Earth Sciences.

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

Professionele ontwikkeling en onderzoek I

Vakcode	O_MLVPOOI ()
Periode	Semester 1, Semester 2
Credits	3.0
Voertaal	Nederlands
Faculteit	Faculteit der Psychologie en Pedagogiek
Coördinator	ir. E.J.F. Scheringa
Docent(en)	drs. Y.G. Meindersma, dr. H.B. Westbroek, drs. H.R. Goudsmit, drs. I. Pauw, drs. S. Attema-Noordewier
Lesmethode(n)	Hoorcollege, Werkcollege
Niveau	500

Doel vak
De student kan systematische reflecteren op het eigen handelen in de onderwijspraktijk en daardoor richting geven aan de eigen professionele ontwikkeling.
De student kan een onderzoeksvraag formuleren voor een onderzoek aan zijn/haar eigen onderwijspraktijk, deze vraag inbedden in een theoretisch kader en een opzet maken voor de uitvoering van het onderzoek.

Inhoud vak
Dit vak bestaat uit twee delen: een reflectiedeel en een onderzoeksdeel. Het reflectiedeel krijgt vorm en inhoud in zogenaamde peergroepbijeenkomsten. Hierin reflecteert de studenten samen met anderen op zijn/haar handelen in de praktijk en leert daaruit ontwikkelpunten af te leiden, acties te formuleren en deze te evalueren. Verschillende instrumenten en methodes worden gebruikt (logboek, reflectiecirkel, intervisie,…) om de student in staat te stellen de complexiteit van de onderwijspraktijk te doorgronden en hiervan te leren.
In het onderzoeksdeel wordt een opzet gemaakt van een praktijkonderzoek. In dit onderzoek diept de student één of meer vraagstukken uit de (eigen) onderwijspraktijk uit, waarbij een onderzoeksvraag ingebed wordt in een theoretisch kader en op één of enkele scholen empirisch materiaal wordt verzameld. In plenaire bijeenkomsten komen onderwerpen aan de orde als het formuleren van de probleemstelling en de onderzoeksvraag, het verkennen van de literatuur en het verzamelen van de data. Daarnaast kan de student beroep doen op individuele begeleiding rondom zijn/haar onderzoek. Dit alles mondt uit in een eerste onderzoeksformat voor het praktijkonderzoek dat vervolgens in het vak Professionele Ontwikkeling en Onderzoek 2 uitgevoerd, gepresenteerd en geëvalueerd wordt.

Onderwijsvorm
colleges, werkgroepbijeenkomsten en individuele begeleiding van het onderzoek door instituutsbegeleiders.

Toetsvorm
Uitvoeren van opdrachten.

Literatuur
Een literatuurlijst wordt verstrekt aan het begin van de opleiding.

Vereiste voorkennis
Dit vak is alleen te volgen als onderdeel van de universitaire lerarenopleiding.

Overige informatie
Voor alle onderdelen geldt een aanwezigheidsplicht.

Professionele ontwikkeling en onderzoek II

Vakcode	O_MLVPOOII ()
Periode	Semester 1, Semester 2
Credits	6.0
Voertaal	Nederlands
Faculteit	Faculteit der Psychologie en Pedagogiek
Coördinator	dr. H.B. Westbroek
Docent(en)	dr. C.P. van Velzen, prof. dr. J.J. Beishuizen, drs. W. Jongejan, dr. H.B. Westbroek, dr. E. van den Berg, dr. J.J.M. van Eersel, W. Maas, drs. Y.G. Meindersma, drs. S. Attema-Noordewier, dr. T. Bosma, dr. A.A. Kaal
Lesmethode(n)	Hoorcollege, Werkcollege
Niveau	500

Doel vak
De student kan een praktijkonderzoek opzetten, uitvoeren en hierover rapporteren.

Inhoud vak
In het praktijkonderzoek diept de student één of meer vraagstukken uit de (eigen) onderwijspraktijk uit. Hij of zij doet dat door het opzetten, uitvoeren en evalueren van een op de eigen onderwijspraktijk gericht onderzoek waarbij op één of enkele scholen empirisch materiaal wordt verzameld. Aan de hand van de opzet die gemaakt is tijdens de module Professionele Ontwikkeling en Onderzoek 1 ontwerpt de student onderzoeksinstrumenten om empirisch gegevens te verzamelen voor het beantwoorden van de onderzoeksvraag en voert hij/zij het onderzoek uit. In een artikel voor een vaktijdschrift voor leraren rapporteert hij/zij over het onderzoek waarin aan de orde komen vraagstelling, relevantie, verankering in bestaande theorie, gebruikte instrumenten, data, conclusie en discussie. De student presenteert ook zijn/haar onderzoek tijdens de Onderwijsresearchdag.

Onderwijsvorm
Onderzoek, verplichte deelname aan colleges praktijkonderzoek, werkgroepbijeenkomsten, individuele begeleiding door instituutsbegeleiders.

Toetsvorm
De rapportage van het praktijkonderzoek vindt plaats in de vorm van een posterpresentatie en een artikel voor een vaktijdschrift voor leraren.

Het artikel wordt gezamenlijk beoordeeld door de eerste begeleider en tweede lezer, die wordt aangezocht door de eerste begeleider. De presentatie van het onderzoek op de Onderwijsresearchdag wordt meegenomen in de eindbeoordeling. Ook de mate van zelfstandigheid in het opzetten, uitvoeren en rapporteren van het onderzoek wordt beoordeeld

Literatuur
Een literatuurlijst wordt verstrekt aan het begin van de opleiding.

Vereiste voorkennis
Dit vak is alleen te volgen als onderdeel van de universitaire lerarenopleiding.
Om dit vak te volgen moet het vak Professionele Ontwikkeling en Onderzoek 1 met goed gevolg zijn afgelegd.

Overige informatie
Voor alle onderdelen geldt een aanwezigheidsplicht.

Project Environmental Impact Assessment

Vakcode	AM_450406 ()
Periode	Periode 5
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. R. Janssen
Docent(en)	dr. R. Janssen, dr. M.A. van Drunen
Lesmethode(n)	Werkcollege, Computerpracticum

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

Inhoud vak
In this course students will experience how commercial consultancy firms operate. They organize their work in projects. During the course the students have to deal with all relevant aspects of working in projects: writing a tender (including cost estimation, time schedules), managing a project (task divisions, communication, time writing, sending bills), data management, analysis, reporting, presenting. There will be introducing lectures, workshops, an excursion to the Vondelpark and opportunities to get advice.

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

Toetsvorm
Students will be assessed on specific assignments: writing a tender (in couples; 15%), process management (in groups of 5-7 students, 15%), the environmental impact assessment report (60%) and presentation (10%). Details about the assignment are in the study manual.The students will be assessd.

Literatuur
Links to reading material are provided in the study manual

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

Qualitative and Quantitative Research Methods

Vakcode	AM_470582 ()
Periode	Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. J.F.H. Kupper

Docent(en)	dr. H. Wels, dr. B.J. Regeer, dr. J.F.H. Kupper, dr. ir. R. Hoopman
Lesmethode(n)	Hoorcollege, Werkgroep, Computerpracticum
Niveau	400

Doel vak
Understanding the differences between beta- and gamma research
To acquire insight and understanding of a transdisciplinary research process. This includes knowledge of the character of and need for transdisciplinary approaches, and their advantages and disadvantages
To acquire insight into various quantitative and qualitative research methods and their underlying theoretical concepts
To understand the relative strengths and weaknesses of the various research methods
To know how to interpret quantitative and qualitative findings
To acquire insight and understanding of the possibilities to integrate quantitative and qualitative research information
To be able to make an adequate transdisciplinary research design for the investigation of a specific problem.

Inhoud vak
Contemporary societies increasingly face complex social problems, like climate change, HIV/ AIDS or ethnic and religious diversity . These complex problems involve a variety of social actors: policy-makers, professionals, NGOs, industry, science and of course the public at large. Addressing such complex issues demands a transdisciplinary approach that investigates, analyzes and integrates the positions and knowledge of different actors. This course offers an (advanced) introduction to various research methods used in transdisciplinary research: questionnaires, systematic observations using all the senses, surveys and statistics, semi-structured in-depth interviews, as well as several interactive and participatory methods. These methods are commonly used in transdisciplinary research into complex problem contexts, communication, and opportunities for intervention. Strengths and weaknesses of each research method and technique will be discussed, as well as its possibility to be applied in different societal contexts. Throughout the course, you will apply theoretical knowledge about the various research methodologies in the training of different qualitative and quantitative methods, and in making a research design. In small groups, students are trained in: (1) qualitative research methods such as semi structured interviews and observation techniques, (2) quantitative research methods such as questionnaires, 3) analysis of the data, and (4) writing a transdisciplinary research design.

Onderwijsvorm
Lecture (20h), Training workshops (30h), Self-study (107h), Examiniation (3h).

Toetsvorm
Group assignment (50%) and exam (50%). Both parts need to be passed (6).

Literatuur
Announced on blackboard one month before course starts

Doelgroep
Compulsory course in the Master programme Management, Policy Analysis and Entrepreneurship for the Health and Life Sciences (MPA) and

compulsory course within the Science communication- and Societal differentiations of Health, Life and Natural Sciences Masters programmes.

Overige informatie
Attendance of training workshops is compulsory. For further information please contact harry.wels@falw.vu.nl.

Reflection Seismic for Geologists

Vakcode	AM_450170 ()
Periode	Periode 4
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. B.P. Zoetemeijer
Examinator	dr. B.P. Zoetemeijer
Docent(en)	dr. B.P. Zoetemeijer
Lesmethode(n)	Werkcollege, Computerpracticum

Doel vak
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.

Inhoud vak
Assuming a basic knowledge of the principles of reflection seismology, this course provides a modular programme with hands-on experience on interpreting seismic 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.

Onderwijsvorm
The course uses two different methods:
Oral lessons, where the lecturer presents various topics. Students must be aware that the content of this course is difficult to find in 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.

Toetsvorm
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.

Literatuur
All materials will be digitally provided through Blackboard.

Overige informatie
Teaching staff: John Verbeek

Regional and Urban Economics

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

Faculteit	Fac. der Economische Wet. en Bedrijfsk.
Coördinator	prof. dr. H.L.F. de Groot
Examinator	prof. dr. H.L.F. de Groot
Docent(en)	prof. dr. H.L.F. de Groot, prof. dr. J. Rouwendal
Lesmethode(n)	Hoorcollege
Niveau	400

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

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

Onderwijsvorm
lecture
tutorial

Literatuur
Steven Brakman, Harry Garretsen and Charles van Marrewijk (2009): The New Introduction to Geographical Economics, Cambridge University Press, Cambridge, MA (second edition)

Research Project Applied Environmental Geosciences

Vakcode	AM_450267 ()
Periode	Ac. Jaar (september)
Credits	24.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. S.J.P. Bohncke
Niveau	500

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

Inhoud vak
Research project in the master's specialisation Applied Environmental Geosciences: 2 weeks preparation, 7 weeks research, 7 weeks report.

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

Toetsvorm
Written report. Grading is based on report.

Overige informatie
The Research Project is subject to the school's Work placement and thesis regulations (stage- en scriptieregeling). These regulations require detailed written agreements between supervisors and student that specify the conditions for the Master thesis work placement or research project. This agreement should be put forward to the secretary of the examination board before the start of the work placement or research project.
Admission to this Research project is only granted to students with a BSc degree Earth Sciences and other students who have been admitted to the MSc degree programme by the Examination Board. Admission requirements are checked by the Examination Board on April 15th. Participants should register in time (preferably before March 1st) with the staff member/department in question and via the regular way.

Research Project Archaeometry

Vakcode	AM_450296 ()
Periode	Ac. Jaar (september)
Credits	27.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. H. Kars
Niveau	500

Doel vak
Learning to prepare and conduct a research project and to write a scientific report thereof at the academic Master's level. In both practical conduct and writing the student should demonstrate his or her:
- advanced knowledge and understanding of the field, thus providing a

basis or opportunity for originality in developing and applying ideas;
- problem solving abilities in new or unfamiliar environments within broader contexts;
- ability to integrate knowledge and to handle complexity;
- ability to clearly communicate conclusions, and the knowledge and rationale underpinning these, to specialist and non-specialist audiences.

Inhoud vak
The geoarchaeological research projects will allow students to develop their own scientific questions into small-scale research projects within the framework of larger existing research projects. These projects will include the usual stages of planning and preliminary literature research (2 weeks), the research itself (8 weeks) and reporting the results (8 weeks). The research topic can be in any of the geoarchaeological disciplines and include fieldwork and laboratory analyses.

Onderwijsvorm
Fieldwork, laboratory work

Toetsvorm
Written report

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

Research Project Earth Sciences and Economics

Vakcode	AM_1103 ()
Periode	Ac. Jaar (september)
Credits	18.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen

Research Project Landscape Archaeology

Vakcode	AM_450295 ()
Periode	Ac. Jaar (september)
Credits	27.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. S.J. Kluiving

Niveau	500

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

Inhoud vak
The geoarchaeological research projects will allow students to develop their own scientific questions into small-scale research projects within the framework of larger existing research projects. These projects will include the usual stages of planning and preliminary literature research (2 weeks), the research itself (8 weeks) and reporting the results (8 weeks). The research topic can be in any of the geoarchaeological disciplines and include fieldwork and laboratory analyses.

Onderwijsvorm
Fieldwork, laboratory work.

Toetsvorm
Written report.

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

Research Project Paleoclimatology and Geo-ecosystems

Vakcode	AM_450202 ()
Periode	Ac. Jaar (september)
Credits	27.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. S.J.P. Bohncke
Niveau	500

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

Inhoud vak
Research project in the master's; programme Palaeoclimatology and Geo-ecosystems: 2 weeks preparation, 8 weeks research, 8 weeks report.

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

Toetsvorm
Written report

Overige informatie
Admission to this Research project is only granted to students with a BSc degree Earth Sciences and other students who have been admitted to the MSc degree programme by the Examination Board. Admission requirements are checked by the Examination Board on April 15th. Participants should register in time (preferably before March 1st) with the staff member/department in question as well as via the regular way.

Research Project Solid Earth

Vakcode	AM_450200 ()
Periode	Ac. Jaar (september)
Credits	27.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. B.P. Zoetemeijer
Lesmethode(n)	Werkcollege

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

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

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

Toetsvorm
Written report

Vereiste voorkennis
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.

Overige informatie
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 (dr B. P. Zoetemeijer) before the start of the work placement or research project.

Science and Communication

Vakcode	AM_470587 ()
Periode	Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. B.J. Regeer
Docent(en)	dr. B.J. Regeer, dr. J.F.H. Kupper, T. de Lange MSc, B.M. Tielemans
Lesmethode(n)	Hoorcollege, Werkgroep
Niveau	500

Doel vak
- 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).

Inhoud vak
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.

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

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

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

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

Overige informatie
Guest lecturers amongst others:
A. van der Plas (TNO)
F. van Dam (CSG, Centre for Society and the Life Sciences)

Science in Dialogue

Vakcode	AM_1002 ()
Periode	Periode 2
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. J.F.H. Kupper
Docent(en)	dr. J.F.H. Kupper

Lesmethode(n)	Werkgroep, Hoorcollege
Niveau	500

Doel vak
To gain knowledge and insight into:
- the basic concepts and issues in the understanding of science-society interactions, both from a philosophical 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 mutual understanding and learning
To acquire or improve:
- the individual student's skills for effective interpersonal communication
- the individual student's skills for the design and facilitation of the science-society dialogue

Inhoud vak
This course examines the public character of scientific controversy and focuses on the communicative aspects of a fruitful science-society dialogue. At the dawn of the 21st century, science, and particularly fields that combine science and engineering such as nanotechnology and synthetic biology, holds a great promise for the progress of our societies. At the same time, these developments are controversial. They lead to a variety of concerns related to risks, benefits and wider moral issues. Nanotechnology creates materials with novel characteristics that help us, but may also contain risks for health and environment. Synthetic biology develops new biological systems that may be very useful, but radically change the nature and meaning of life. Clearly, advances in science do not always match the needs, desires and expectations of society. On the other hand, parts of society might not always appreciate the nature and scope of scientific findings. For a fruitful relationship between science and society, a constructive science-society dialogue is necessary.
This course offers advanced lectures on the basic concepts and issues of dialogical science communication: communication, learning, dialogue, understanding, controversy, democracy. A series of workshops and small group assignments presents communicative tools and spaces such as discussion games, science theatre and multimedia platforms that can be used to design and facilitate science-society interactions. Training workshops will focus on improving the students' individual communication and facilitation skills. The students' individual learning curve as a science communicator and facilitator is monitored by means of a personal development plan. The course is completed with an individual essay assignment about the sense and nonsense of the science-society dialogue.

Onderwijsvorm
Lectures (14h), Workgroups (28h), Training workshops (24h), Selfstudy, (82h), Dialogue presentations (12h)

Toetsvorm
Group assignment (50%), Take home exam (30%), Mini portfolio (20%)

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

Doelgroep
Optional course in the MSc specialization Science Communication

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

Science Journalism

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

Doel vak
To acquire knowledge and insight into:
- the popularization of natural scientific knowledge and the use of different media
- the criteria for effective science journalism with respect to diverse media
- the role of science journalists in the debate about knowledge in society
To acquire skills in:
- writing popular scientific texts for different genres such as news, background and interview
- designing science communication for different media such as newspaper, radio and internet
Orientation to the professional practice of science journalism

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

Onderwijsvorm
Lectures and seminars on theory and practice of science journalism and writing skill training (36h). Considerable time is set aside for

performing science journalism in assignments (108h). The assignments are assessed by lecturers and fellow students (peer-review process). Self study (16h).

Toetsvorm
Individual exam (20%), Individual Assignments (50%, Small Group Assignments (30%)

Literatuur
Announced on Blackboard one month before start of the course

Doelgroep
All Master students with a Beta-Bachelor degree. Students taking this course as part of their C-differentiation 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 co-ordinator (Frank Kupper) before enrolment.

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

Science Museology

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

Doel vak
• Gain insight in the role of museum exhibits in the field of science communication.
• Apply theoretical notions of science communication and science education, to conduct science communication research in museum settings.
• Apply qualitative and quantitative research methods to design, conduct, and report on a research project in museum settings.
• Apply theoretical notions of science communication, science education and exhibit design to advise on adjustments and/or development of exhibitions.

Inhoud vak
This course is about the role of science museums/centers, zoos and natural history museums in science communication. You will get familiar with theories of science communication and informal science education in museum setting, and will be introduced to different educational methods as well as styles of communication, different approaches to exhibit design & development, and different methods of research and evaluation of exhibitions.
Guest speakers 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 developing informal science & technology learning programs.
Through several assignments you are encouraged to combine theory and practice, working step-by-step towards (part of) an exhibition (re-) design. The assignments come from museums and science centers, such as NEMO, Museon, Naturalis, Delft Science Centre, and Artis.

Onderwijsvorm
Lectures (14 h)
Workgroups (40 h)
Home-study for group assignments (64 h)
Home-study for individual assignments (32 h)

Toetsvorm
Group assignment (40%), presentations (poster and oral) (10%), and exams (take-home and written) (50%). For all the assignment, presentations and all exams a pass-grade must be obtained.

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

Vereiste voorkennis
Bachelor in any of the Beta Sciences

Doelgroep
Optional course in the C-differentiations (Science Communication) 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.

Overige informatie
Guest lecturers:
E. Hamstra (Northernlight)
C. Vermeulen (Artis)
M. van der Meer (Delft Science Centre)
I. van Zeeland (Naturalis)
And possibly additional guest lecturers from NEMO, Boijmans van Beuningen, Museon, Van Gogh Museum, etc.

Scotland Excursion

Vakcode	AM_450354 ()
Periode	Periode 6
Credits	3.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. S.J.P. Bohncke
Docent(en)	dr. S.J.P. Bohncke, dr. M.A. Prins, dr. S.R. Troelstra
Lesmethode(n)	Veldwerk
Niveau	400

Doel vak
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.

Inhoud vak
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 illuminate the most important aspects of the paleoclimatic (marine and terrestrial) evolution in Scotland. Traces of early life forms and the evolution thereof will be discussed in the context of a changing environment through time.

Toetsvorm
Oral presentations during the excursion on topics visited the previous day.

Overige informatie
This course takes place every other year. Next excursion will be in June 2014.

Sediment Petrography of Heavy Minerals

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

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

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

Onderwijsvorm
Lectures and practical courses

Toetsvorm
Oral examination and determination of a heavy mineral sample by the student

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

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

Overige informatie
This optional course is offered every two years. The next course takes place in 2013 - 2014.

Sedimentary Basins

Vakcode	AM_450154 ()
Periode	Periode 2
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. G.V. Bertotti
Docent(en)	dr. G.V. Bertotti, dr. B.P. Zoetemeijer, prof. dr. J.J.G. Reijmer
Lesmethode(n)	Computerpracticum, Hoorcollege

Doel vak
The main goal of the course is to provide students the skills to analyze and interpret data on sedimentary basins and derive quantitative reconstruction of their tectono-sedimentary evolution. In order to do so, the student should be able to:
• Combine different data sets to understand tecto-sedimentary processes controlling the evolution of sedimentary basins.
• Combine class material with significant, compiled literature material.
• To 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.

Inhoud vak
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.

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

Toetsvorm
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.

Literatuur
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

Vakcode	AM_450330 ()
Periode	Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. F.J.C. Peeters
Docent(en)	dr. F.J.C. Peeters, dr. C. Kasse, dr. S.J.P. Bohncke, dr. M.A. Prins
Lesmethode(n)	Excursie, Werkcollege
Niveau	400

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

Inhoud vak
The course deals with the sedimentology, geochemistry and stratigraphy of marine, coastal, fluvial, lacustrine, eolian, and periglacial palaeoclimate records. The focus is on those processes relevant for understanding how climate/environmental change is recorded in the

different palaeoclimate archives. In addition, the susceptibility of key aspects of those environments to climate- change impacts will be addressed. Marine and terrestrial palaeoclimate records receive equally attention.

Onderwijsvorm
Lectures, literature study, group discussions .

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

Literatuur
Lecture notes, selected papers.

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

Doelgroep
Master students Earth and Environmental Geosciences
Master students in Paleoclimatology

Sociale geografie II

Vakcode	AM_1051 ()
Periode	Ac. Jaar (september)
Credits	12.0
Voertaal	Nederlands
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	J.A. van der Schee
Lesmethode(n)	Werkcollege
Niveau	400

Soil and Environment

Vakcode	AM_1030 ()
Periode	Periode 2
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. B.M. van Breukelen
Docent(en)	dr. B.M. van Breukelen, dr. J. van Huissteden, dr. H.J. van Meerveld
Lesmethode(n)	Practicum, Hoorcollege, Excursie
Niveau	400

Doel vak
To acquire a basic understanding of physical and chemical processes operating in soils and their relationship with the biosphere and the atmosphere; as well as human impacts (erosion, pollution) on these

processes and management strategies. To acquire experience with basic measurement and analytical techniques used in soil science.

Inhoud vak
The theoretical knowledge dealt with in this course consists mostly of basic concepts relating to:
Soil physics: basic physical concepts like bulk density, hydraulic conductivity, water retention; basic descriptions of transport of heat and water, gas exchange, soil water measuring techniques.
Soil chemistry: weathering, pH buffering, nutrients, adsorption, decomposition and transformation of organic matter.
Soil erosion: processes and measuring techniques.
Biota and organic matter: uptake of nutrients by plants, origin and uptake of (greenhouse) gases in the soil.
Soil contamination: types, sources, behaviour, remediation techniques.
Practical skills include acquiring of experience with various basic field and lab techniques.
Field activity: taking undisturbed soil samples, measure soil pH, soil water content using Time Domain Reflectometry (demonstration)
Laboratory: determination of soil texture (grain sizes), organic matter content, soil pH, porosity, permeability.

Onderwijsvorm
Lectures (10x2 hours), Field work excursion (8 hours), Lab practicals (2x4 hours): total 36 hours.

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

Literatuur
Books:
Principles and Practice of Soil Science: the soil as a natural resource, R.E. White, 4th edition, 2010
Introduction to Physical Hydrology, M. Hendriks, 2010

Scientific papers:
Larssen et al. Acid Rain in China, Environmental Science and Technology: 418-425, 2006.

Digital content distributed via blackboard:
Lecture slides, course manual, field and lab practical manuals

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

Aanbevolen voorkennis
Inleiding hydrologie (AB_450024), Bodemkunde (AB_450091).

Doelgroep
Master students Earth Sciences and Earth and Economy. This course is not intended for Master Hydrology students.

Spatial Processes in Ecology and Evolution

Vakcode	AM_1039-UvA ()

Periode	Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Niveau	500

Inhoud vak
This course is offered by the UvA. See for the course description:
http://studiegids.uva.nl/web/uva/sgs/nl/c/8773.html

Overige informatie
Coordinator: M. Boerlijst (UvA).
The course description can be found on the UvA website:
http://studiegids.uva.nl/sgs/WebSite_nl.
Course registration via UvA, not VU.

Sustainability and Growth

Vakcode	AM_468011 ()
Periode	Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. A.J. Gilbert
Docent(en)	dr. A.J. Gilbert, prof. dr. J.J. Boersema
Lesmethode(n)	Hoorcollege, Werkgroep
Niveau	400

Doel vak
Sustainability & Growth uses the DPSIR analytical framework to present the breadth of environmental problems, and the different disciplines employed in the analysis of their causes, effects and possible solutions. It is the first course in the Environmental and Resource Management (ERM) programme and is followed by all students from all specialisations. It serves to develop a common base of knowledge that subsequent courses will develop further.
By the end of this course, students should be able to:
• classify and illustrate the diversity of environmental problems;
• explain the concepts of sustainability and growth, as well as other key concepts from the natural and the social sciences;
• explain causality for a selection of environmental problems;
• evaluate frameworks and indicators used in analysing environmental trends;
• explain the roles of stakeholders and policy in dealing with environmental problems;
• analyse an environmental problem using the DPSIR framework;
• demonstrate skills, notably writing, framing, presenting, and reviewing.

Inhoud vak
Without economic growth, we would not enjoy our current lifestyles. Economic growth is also needed to repair the environmental damage we have already done. Consequently sustainability cannot be achieved

without growth. Identification of a path to sustainability is fraught with difficulties because many environmental problems have become 'wicked'. Wicked problems are typically associated with strong moral, political and professional issues, such that there may be little consensus about what the problem is, let alone how to resolve it. Sustainable development is seen as having three main components: the environment, the economy, and the society. These three components provide the basic disciplines addressed in this course – natural, economic and social sciences. The course draws on an analytical tool, the 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 taming of 'wicked' problems, even if this is limited to identifying where 'wickedness' lies such as inadequate scientific knowledge or uncertainty with regards to the benefits of environmental remediation.
DPSIR may be seen to comprise two 'arms': causality of environmental problems (=DPS); and consequences of environmental problems (=IR). Because I and R are covered in other ERM courses, Sustainability and Growth emphasises causality. Topics range from fisheries, to poverty, to the setting of environmental standards, to the inclusion of stakeholders, to climate change.

Onderwijsvorm
The course involves lectures, student presentations, student reviews, workshops, debates, seminars and a documentary

Toetsvorm
The final grade for Sustainability & Growth is derived from:
1) group activities worth 30% of the final grade
2) an assignment and peer review worth 30% of the final grade
3) an exam worth 40% of the final grade.
To pass the course, students must receive a grade exceeding 5.0 (out of 10) for the exam and their overall grade must exceed 5.5. There is one re-sit of the exam. Students who are graded 5.5 or lower for the assignment have one opportunity to revise it.

Literatuur
Available via the online reader on Blackboard:
Boersema, J. & L. Reijnders (eds.) 2009. Principles of Environmental Sciences. Springer, Berlin. Chapters 1, 2, 4, 5, 6, 7, 8, 10, 11, 12 (pp 207-211), 13, 14, 23, 26.
Required text for Environmental Economics.
Tietenberg, T.H. & L. Lewis. 2010. Environmental economics and policy. Addison-Wesley, Boston. Chapters 6 (pp 104-118), 14 (pp 301-322), and 20 (pp 458-466).

Vereiste voorkennis
Admittance to ERM

Doelgroep
Students interested in a broad understanding of the environmental sciences.

Sustainable Energy Analysis

Vakcode	AM_468018 ()
Periode	Periode 1

Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	E. Papyrakis
Docent(en)	prof. dr. J.J.C. Bruggink, E. Papyrakis
Lesmethode(n)	Werkcollege, Hoorcollege
Niveau	400

Doel vak
After following this course the students are able to:
- Make use of scientific information about major energy resources and conversion processes to assess the economic and environmental impacts of existing and new technologies in the energy sector;
- Apply this scientific information in the widely different contexts of industrialised, emerging and least developed nations;
- Assess the potential; and implications of using wind, solar and biomass; technologies in both rich and poor nations;
- Evaluate the sustainability implications of different; fossil fuel; technology choices in a comprehensive and balanced way;
- Explain the environmental risks and supply potential of nuclear energy.

Inhoud vak
The role of conventional and renewable energy on the road towards sustainability forms the main topic of this module. Energy use drives economic development while at the same time 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. Moreover, the potential role of energy technologies is strongly dependent on the stage of economic development of the region and sector where it will be applied. The following subjects will be dealt with in more detail:
- Introduction to energy technology assessment and global energy use patterns;
- Biomass technology applications in developed and developing nations
- Wind and solar technology applications in developed and developing nations
- Fossil fuel resources and sustainability;
- Nuclear energy resources and sustainability.

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

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

Literatuur
Reader with open source literature

Sustainable Land Management

Vakcode	AM_1015 ()

Periode	Periode 3
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	drs. W.A.M. Tuijp
Docent(en)	dr. W.R.S. Critchley
Lesmethode(n)	Werkcollege
Niveau	400

Doel vak
What are the enabling and limiting factors to sustainable land management? How can smallholder farmers in the developing world adapt to climate change? What can farmers in developing countries – and especially Africa – do to improve their food security? Can organic agriculture help feeding the world? Are biofuels the solution for our energy needs of tomorrow?
These and many other questions will be discussed during this interdisciplinary course. Its main focus is on what can be done about the problems of soil erosion and land degradation, and their relevance to climate change and poverty reduction. "Sustainable Land Management" is a new approach that involves both people and technical issues. The course spans a wide range of topics, including environmental problems, history of approaches, conservation technologies in the field, indigenous knowledge, working with local people, and skills in research and development in the tropics. There is a combination of theory and practice, with a strong emphasis on illustrated case studies from over 20 countries.

Inhoud vak
Environmental degradation and rural poverty: processes and impact. History of conservation: from failed approaches to new concepts in rural development; principles and practices of Sustainable Land Management (SLM). Agriculture in Development. SLM technologies: humid areas/dry areas. International environmental protocols and their impact on rural development programs. Socio-economic factors including population/land tenure/gender/incentives/marketing and labeling. Energy and biofuels; biodiversity, genetic modification and organic production. ICTs in rural development. Indigenous knowledge and local innovation, Participatory learning and action, including research methodology).

Onderwijsvorm
Interactive lectures (about 38 hours in total) with illustrated case studies supplemented by group work activities; conducted and examined in English.

Toetsvorm
One topic will be chosen by each student for a paper of 3.000 words based on further reading (50% mark). There will also be a final examination (50% mark).

Literatuur
"Where the land is greener" WOCAT, Eds Liniger and Critchley, plus additional supporting literature.
https://www.wocat.net/en/knowledge-base/documentation-analysis/global-overview-book.html

Doelgroep
Aimed at Master's students with environmental and developmental interests: especially those with some geography/earth science/hydrological/biological/ecological/environmental background, but social scientists can also benefit from this course.

Overige informatie
Comments from former students:
"I think this course gives a good overview and helps students with a non environmental background to understand essential issues."
"Good job, keep on going! Continue to be part of the ERM programme."
"Whereas other courses focus on scientific dimension of environmental problems SLM is also about the human dimension of environmental solutions. It is one of the few courses that gives a positive perspective for practical solutions. Whereas other courses try to inject "knowledge" theoretical problems and solutions."
"The course was a great launch pad for my thesis research. "
"This should be a specialization track! Sustainable Land Management 2 would be very interesting and give students more time to learn about the topics."

For more information please contact Wendelien Tuyp (w.a.m.tuijp@vu.nl)

Transport Economics

Vakcode	E_STR_TREC (60432050)
Periode	Periode 4
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Economische Wet. en Bedrijfsk.
Coördinator	dr. A.J.H. Pels
Docent(en)	dr. A.J.H. Pels
Lesmethode(n)	Hoorcollege
Niveau	400

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

- learn theoretical and empirical methods applied in the field of transport economics and in related fields, such as transport planning.
- get a good understanding of the fundamental policy questions that are addressed in the field, and the methods with which these are addressed.
- learn the current state of affairs in the literature.
are trained to critically read and properly understand contributions in the leading journals in the field.

Inhoud vak
This course covers advanced topics in theoretical and empirical research on urban transport economics. Key issues are 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.

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

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

Aanbevolen voorkennis
Microeconomics for spatial policy or a similar course

Unsaturated Zone and Near Surface Hydrological Processes

Vakcode	AM_450021 ()
Periode	Periode 4
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. H.J. van Meerveld
Docent(en)	dr. H.J. van Meerveld
Lesmethode(n)	Computerpracticum, Werkcollege
Niveau	400

Doel vak
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.

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
• Present the results of a small hydrological modelling study in a

clear and concise way
• Have obtained an awareness of how vegetation and land management affect soil erosion and water quality

The Unsaturated Zone and Near-Surface Hydrological Processes course contributes to the final attainment levels defined for the hydrology master's:
• Knowledge and understanding – knowledge and insight into the subject is obtained through studying the theory as provided during the lectures, in the text books, and through self-study of scientific papers
• Application of knowledge and understanding – analysis of data during lectures and workshops provides the skills and understanding required to process and analyse hydrological data
• Critical judgment – the student is encouraged to critically judge his/her work during the modelling workshops and the preparation of the report
• Communication – the presentation of the modelling results (structure, readability, etc.), as well as oral communication and discussion skills during the lectures

Inhoud vak
The course focuses on the following topics: hydraulic potential theory; soil water retention aspects; measurement techniques for soil water content and matric potential; stationary and non- stationary unsaturated flow (hydraulics); infiltration during conditions of ponding; determining saturated and unsaturated soil hydraulic conductivities; macropore vs. matrix flow; surface erosion processes (splash, wash and rill erosion) and governing factors.

Onderwijsvorm
The course consists of ten lectures and three computer practicals. The number of contact hours is in the order of 40.

Toetsvorm
Written examination.

Literatuur
Books:
• Koorevaar et al. (1983) Elements of Soil Physics. Elsevier, ISBN 0-444-42242-0 (selected chapters)
• Hillel D (1998) Environmental Soil Physics. Academic Press, ISBN 0-12-348525-8 (selected chapters)
• Morgan, R.P.C. (2005) Soil Erosion and Conservation, 3rd edition. Blackwell Publishing, Oxford, ISBN 978-1405117814 (selected chapters)

Articles:
• Anderson, A., Weiler, M., Alila, Y., and Hudson, R. O., 2009 Dye staining and excavation of a lateral preferential flow network, Hydrology and Earth Systems Science 13, 935-944.
• Bengtsson, L., R.K. Saxena, and Z. Dressie (1987) Soil water movement estimated from isotope tracers, Hydrological Sciences Journal 32:497-520.
• Horton, J.H. and R.H. Hawkins (1965) Flow Path of Rain From the Soil Surface to the Water Table, Soil Science. 100(6):377-383.
• Hoogmoed, W. B., and J. Bouma, (1980) A Simulation Model for Predicting Infiltration into Cracked Clay Soil, Soil Sci. Soc. Am. J. 44: 458–461
• Tricker, A.S. (1981), Spatial and temporal patterns of infiltration, Journal of Hydrology 49: 261-277.

• Western and Grayson. 2000. Soil Moisture and Runoff Processes at Tarrawarra, in: Grayson and Bloschl, Spatial Patterns in Catchment Hydrology: Observations and Modelling, Cambridge University Press.

Vereiste voorkennis
Participants are advised to follow the course on Groundwater Hydraulics (450009) first.

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

Vakdidactiek Aardrijkskunde fase I

Vakcode	O_MLVDAKI ()
Periode	Semester 1, Semester 2
Credits	3.0
Voertaal	Nederlands
Faculteit	Faculteit der Psychologie en Pedagogiek
Coördinator	drs. I. Pauw
Docent(en)	drs. I. Pauw
Niveau	500

Doel vak
De student kan vakinhoudelijke en vakdidactische kennis, vaardigheden en inzichten vertalen naar de eigen vaklessen

Inhoud vak
Tijdens de vakdidactiekcolleges maakt de student kennis met de inhoud en didactiek van het schoolvak en leert deze inzichten in de praktijk vorm te geven. Er is aandacht voor vakspecifieke kennis en vaardigheden en de voor het schoolvak relevante ICT-toepassingen. In het vakdidactiekprogramma vindt eveneens een vertaling plaats van algemeen didactische thema's naar het vak. De leservaringen op school spelen hierbij een belangrijke rol.

Onderwijsvorm
Werkcolleges

Toetsvorm
Beoordeling van het portfolio

Literatuur
Een literatuurlijst wordt verstrekt aan het begin van de opleiding

Vereiste voorkennis
Dit vak is alleen te volgen als onderdeel van de universitaire lerarenopleiding

Overige informatie
Er geldt een aanwezigheidsplicht

Vakdidactiek Aardrijkskunde fase II

Vakcode	O_MLVDAKII ()

Periode	Semester 1, Semester 2
Credits	6.0
Voertaal	Nederlands
Faculteit	Faculteit der Psychologie en Pedagogiek
Coördinator	drs. I. Pauw
Docent(en)	drs. I. Pauw
Lesmethode(n)	Werkcollege
Niveau	500

Doel vak
De student kan vakinhoudelijke en vakdidactische kennis, vaardigheden en inzichten vertalen naar de eigen vaklessen en zijn aanpak verantwoorden.

Inhoud vak
De tijdens Vakdidactiek 1 opgedane kennis en vaardigheden worden in Vakdidactiek 2 verder uitgebreid en verdiept. In dit semester ligt het accent op het zelfstandig vormgeven van een samenhangende lessenserie gericht op de bovenbouw van het Voortgezet Onderwijs, die inhoudelijk en vakdidactisch verantwoord moet worden.

Onderwijsvorm
Werkcolleges

Toetsvorm
Beoordeling van het portfolio en een afsluitend open boek tentamen

Literatuur
Een literatuurlijst wordt verstrekt aan het begin van de opleiding

Vereiste voorkennis
Dit vak is alleen te volgen als onderdeel van de universitaire lerarenopleiding

Reguliere studenten dienen eerst Vakdidactiek 1 afgerond te hebben alvorens aan Vakdidactiek 2 kan worden deelgenomen. Voor instromers (studenten met een tweedegraads bevoegdheid en een master in het Schoolvak) geldt deze verplichting niet.

Overige informatie
Er geldt een aanwezigheidsplicht

Verdieping

Vakcode	O_MLVERD ()
Periode	Semester 1, Semester 2
Credits	3.0
Voertaal	Nederlands
Faculteit	Faculteit der Psychologie en Pedagogiek
Coördinator	dr. J.J.M. van Eersel
Docent(en)	drs. H.R. Goudsmit, dr. J.J.M. van Eersel
Lesmethode(n)	Hoorcollege, Werkcollege
Niveau	500

Doel vak
De student verdiept zich op een onderdeel binnen zijn schoolvak of cluster.
De student is zich bewust van zijn rol als docent in een multiculturele samenleving.
De student kan de verschillende aspecten van diversiteit en multiculturaliteit in het onderwijs benoemen en aangeven hoeverre deze aspecten in zijn of haar eigen schoolpraktijk een rol spelen.

Inhoud vak
Binnen de clusters en vakken worden (verplichte) verdiepingsmodulen aangeboden. Daarnaast volgt elke student het onderdeel multiculturaliteit, waarin een aantal aspecten van onderwijs voor een multiculturele samenleving aan de orde komen:
1. Wat betekent identiteitontwikkeling in het kader van een multiculturele samenleving?
2. Wat is de zin en onzin van intercultureel onderwijs?
3. Wat zijn de verschillende thematieken van diversiteit en multiculturaliteit in de klas?
4. Wat is er bekend uit onderzoek over diversiteit, cultuur, etniciteit in de onderwijspraktijk?

Onderwijsvorm
Hoorcollege, werkcollege.

Toetsvorm
Bespreking van een casus.

Literatuur
Syllabus met artikelen wordt verstrekt.

Volcanism

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

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

An additional practical aim of this course is to improve your computer skills with Microsoft Excel. To this end I have designed some exercises

which will show you how to use Microsoft Excel in it's most powerful form: visual basic for applications (VBA). This will be a practical during the third lecture.

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

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

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

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

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

Water and Policy

Vakcode	AM_468023 ()
Periode	Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	prof. dr. J.C.J.H. Aerts
Docent(en)	dr. H. de Moel, prof. dr. J. Gupta
Lesmethode(n)	Hoorcollege, Computerpracticum
Niveau	400

Doel vak
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 problem, 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) with its interaction of natural and socio-economic dynamics.
• 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.

Inhoud vak
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.

Onderwijsvorm
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; some 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

Toetsvorm
Written exam (50%), essay (40%) and peer-review (10%)

Literatuur
The literature for this course consists of various academic papers and chapters. This list is subject to possible changes.

• Bengtsson, L. (2010). The global atmospheric water cycle. Environmental Research Letters, 5 025202. http://iopscience.iop.org/1748-9326/5/2/025202
• USGS hydrological cycle education website (PDF on blackboard)

• Water balance components (PDF on blackboard)
• Pechlivanidis, I.G., Jackson, B.M., McIntyre, N.R., Wheater, H.S. (2011). Catchment scale hydrological modelling: a review of model types, calibration approaches and uncertainty analysis methods in the context of recent development in technology and application. Global NEST Journal, Vol 13(3), pp 193-214. https://doc-00-5s-docsviewer.googleusercontent.com/viewer/securedownload/tflg28lh78hf3eco9i5gvj1f7b1v3v1k/dcarmkfl5nbvp813s3ql5bbpu2simltj/1359630900000/Ymw=/AGZ5hq_6v1h8eHm5fZ0ge1R0Az4h/QURHRUVTaDd6M0ZXRFZ0UWpyNVJuX0tVc1dQWDBMMl9RaWhDeloyYWtLOTdFMmh3QjZLZC1UNTFUcTBLS0dTOUdDZVZXdUkzck85UFNaTTFpcUtXVEZBUHU1RmJiQmxnN01DdVoyTjJkWmlsaG4xWkg5dmljbENkMlFncWVBckRmQ0NObmQwNmhkZ1k=?docid=fdba3f0f3f41752a195e3c521b3d1ea4&chan=EgAAALA82VBJ%2B8CQRI1OM4zPMTpZbm7VQuf0gR2T77AXafcB&sec=AHSqidbSk5iHEP2IBE3P-fSXZEomCg_dcbQL1gpXtejby1dKoqOj8gaKoIjylnQRodr5R53hMBSm&a=gp&filename=193-214_778_Pechlivanidis_13-3.pdf&nonce=nd6mu04m24p8g&user=AGZ5hq_6v1h8eHm5fZ0ge1R0Az4h&hash=fanf4gbjr0mmj2aabfvgkuohlt8e001u •••
Droogers, P., Immerzeel, W.W., Terink, W., Hoogeveen, J., Bierkens, M.F.P., Van Beek, L.P.H. and Debele, B., 2012. Water resources trends in Middle East and North Africa towards 2050. Hydrology and Earth System Sciences, 16, 1-14. doi:10.5194/hess-16-1-2012. http://www.hydrol-earth-syst-sci.net/16/3101/2012/hess-16-3101-2012.pdf
• Daniel P. Loucke and Eelco van Beek, 2005. Water Resources Systems Planning and Management – an introduction to Methods, Models and applications. UNESCO, France and WL|Delft Hydraulics, Netherlands: Appendix C: p. 581-590 (sections 1,2,3,4) http://ecommons.library.cornell.edu/handle/1813/2804 • Funke, N., Oelofse, S.H.H., Hattingh, J., Ashton, P.J. and Turton, A.R., 2007. IWRM in developing countries: lessons from the Mhlatuze catchment in South Africa. Physics and Chemistry of the Earth 32(15-18), pp. 1237-1245. doi:10.1016/j.pce.2007.07.018. http://www.sciencedirect.com/science/article/pii/S1474706507001039 • Taikan Oki and Shinjiro Kanae: Global Hydrologic Cycle and World Water Resources, Science, Vol. 313. no. 5790, pp. 1068-1072, 2006. DOI: 10.1126/science http://www.sciencemag.org/content/313/5790/1068.full.pdf?sid=8b7e546f-0ac7-4c38-9599-779ec23efb9b
• Hoff, H, Falkenmark, M., Gerten, D., Gordon, L., Karlberg, L. and Rockstrom, J.: Greening the global water system, Journal of Hydrology, Vol. 384, pp. 177-186, 2010. DOI:10.1016/j.jhydrol.2009.06.026 http://www.sciencedirect.com/science/article/pii/S0022169409003576# • UNISDR (2004). Chapter 2 Risk Awareness and Living with Risk. A global review of disaster reduction initiatives 2004 version Inter-Agency Secretariat of the International Strategy for Disaster Reduction (UN/ISDR). Subchapter 2.1 and 2.2 (partly): p. 35-52. http://www.unisdr.org/files/657_lwr1.pdf
• Merz,B., Hall,J., Disse,M. & Schumann,A. (2010). Fluvial flood risk management in a changing world. Natural Hazards and Earth System Sciences, 10: 509-527. http://www.nat-hazards-earth-syst-sci.net/10/509/2010/nhess-10-509-2010.pdf • Olmstead, S.M. (2010). The economics of managing scarce water resources. Review of Environmental Economics and Policy, Volume 4(2), summer 2010, pp. 179-198. doi:10.1093/reep/req004. http://reep.oxfordjournals.org/content/4/2/179.full.pdf+html
• Olmstead, S.M. (2010). The economics of water quality. Review of Environmental Economics and Policy, Volume 4(1), winter 2010, pp. 44-62. doi:10.1093/reep/rep016. http://reep.oxfordjournals.org/content/4/1/44.full.pdf+html

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