



Module Handbook

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Applied & Environmental Geoscience Master of Science

Faculty of Science
Department of Geosciences



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1. Admission Requirements

Admission requirements are:

- a Bachelor's degree in one of the subjects of geology, geoecology, environmental science, geophysics, mineralogy, physical geography, soil science, mathematics, physics, chemistry, biology, computer science, civil engineering, or in a related subject with environmental relevance in which a grade of 2.5 or better
- English language proficiency equivalent to CEFR level B2
- a minimum number of credit points in the following subjects and/or areas of knowledge, completed in the prior studies:
 - Mathematics (6 CP)
 - Physics (6 CP)
 - Chemistry (6 CP)
 - Geology (6 CP)

An admission is also possible on the condition to obtain lacking competencies of up to 30 CP prior to registration for the Master's thesis process.

2. Qualification Goals

Applied & Environmental Geoscience (AEG) is an international research-oriented study program focusing on the evaluation and solution of environmental problems. Special emphasis is given to environmental problems in the subsurface such as the pollution of drinking water supplies from groundwater resources, the non-sustainable use of natural resources, the impact of short and long-term waste disposal, and the effects of climate and land-use change on soil and water quality.

The program aims for a comprehensive understanding of the physical, chemical, and biological process mechanisms in the geo- and hydrosphere. Students from various science backgrounds learn to qualitatively and quantitatively address complex processes in soils, water and air and to evaluate environmental risks based on multi-disciplinary approaches.

For an individual study focus, students choose one of three specializations:

- Environmental Chemistry and Environmental Microbiology
- Environmental Physics
- Hydrogeology

While the detailed subject specific competences acquired in AEG depend on the individual study focus of a student, three compulsory modules get students familiarize with core areas in environmental chemistry, groundwater modeling and global change processes, essential for understanding the basic paradigms and concepts in environmental geosciences. The focus is laid on a distinct quantitative, process-oriented approach to address the geo- and hydrosphere, along with the acquisition of essential practical skills (both in the lab and in the field) with respect to environmentally relevant problems. This enables students to:

- define and analyze environmental problems,
- plan and undertake appropriate field and laboratory investigations (collecting, recording and analyzing relevant data sets),
- present and interpret data, and
- develop ecologically and economically sound mitigation strategies.

The international mix of students fosters intercultural skills and qualifies graduates of the program to communicate and work in an international context.

For graduates, the AEG program opens up a variety of professional fields depending on the chosen specialization and the respective academic background - some are trained in geosciences, others in environmental sciences, chemistry, biology, physics or engineering. Therefore, AEG alumni are working in a variety of fields, particularly in:

- **environmental consultancies** working in characterization of sites, environmental risk assessment, management of water resources, design and operation of remediation technologies, and modeling of flow and reactive transport in subsurface systems
- **environmental agencies** and **non-governmental organizations** (NGOs)
- **(re-)insurance companies** covering costs of environmental risks and remediation

Furthermore, AEG lays an excellent foundation for **doctoral studies** in programs of earth sciences, environmental sciences, and environmental engineering.

3. Module Overview

"Applied & Environmental Geoscience" (AEG) is a 2-year program consisting of 5 compulsory modules (30 credits), 10 elective modules (60 credits) and a Master's thesis (30 credits).

Compulsory modules for all AEG students

These compulsory modules provide an introduction to the necessary theoretical and quantitative aspects of environmental and applied geosciences:

- **Environmental Chemistry** covers chemical thermodynamics in aqueous systems, sorption and partitioning processes of organic and inorganic compounds in the hydrosphere and practical case studies. The objective is to gain quantitative evaluation and prediction capabilities for important hydrogeochemical parameters based on sound thermodynamic concepts. By this, fate and behavior of chemicals in the environment can be predicted.
- **Global Change** establishes a fundamental quantitative scientific understanding of various global change processes. Different topics are presented and discussed in a combination of lectures and seminar presentations introducing and comparing climatic systems of the past and present, climate change models, possible impacts of global change processes on various environmental systems and compartments (regions, species, pollution, land use) and future effects.
- **Groundwater Modeling 1** has a strong emphasis on physical hydrogeology, covering flow and transport in groundwater systems. Emphasis is given on quantitative description of groundwater flow and solute transport, deriving governing equations and analytical solutions for simple configurations. Computer methods for the solution of groundwater problems are taught in the Groundwater Modeling 2.

The following compulsory modules promote the acquisition of additional interdisciplinary, methodological, conceptual, as well as practical skills in preparation for the Master's thesis project:

- **Scientific Practice** is a research-oriented internship within a work group of the Department of Geosciences. The key objective is to gain insight in ongoing research projects and to plan and design a research agenda for a potential Master's thesis. Students benefit from close interaction with staff and research groups, and the opportunity to begin their Master's thesis as early as the third semester.
- **Scientific Presentation** includes 4 participations on the Master's Day including one attendance with a poster presentation of the results of the Master's thesis project, the presentation of the results of the Master's thesis in the respective research group and the attendance at 8 department seminars. This module serves to acquire communication and presentation skills.

Compulsory for students who have received admission with conditions

Students who have received admission with conditions (such as successful participation in the module "Earth Processes" or a module in introductory mathematics, physics or chemistry) must also fulfill these conditions in order to be able to register for the final module.

Compulsory modules in the chosen specialization

For each specialization, a combination of three relevant core modules is defined. These are compulsory modules for those who choose the respective specialization.

Specialization Environmental Chemistry and Environmental Microbiology

- Biotransformation of Pollutants
- Environmental Analytical Chemistry
- Hydrogeochemical Modeling

Specialization Environmental Physics

- Atmospheric Physics
- Climate Dynamics
- Physics of the Earth's Surface

Specialization Hydrogeology

- Groundwater Modeling 2
- Hydrogeological Field Investigation Techniques
- Remediation of Contaminated Sites

Elective Modules

The remaining necessary 42 credits can be chosen from any of the available modules listed in this module handbook.

Upon request, additional modules related to the content and qualification objectives of the program can be admitted as elective modules by the chairperson of the examination board.

These can be Master modules and/or a maximum of 2 Bachelor modules (only those that were not yet completed in the previous Bachelor's degree). Participation in these modules cannot be guaranteed and requires, in addition to the approval of the examination board, the admission by the respective lecturer.

Medium of Instruction

AEG courses are taught in English. In the elective area, additional modules in German can be chosen.

The following figures show the degree program for the three specializations.

Specialization Environmental Chemistry and Environmental Microbiology

MSc Applied & Environmental Geoscience

Specialization: Environmental Chemistry and Environmental Microbiology

1. Sem.	2. Sem.	3. Sem.	4. Sem.
Groundwater Modeling 1 6 ECTS	Hydrogeochemical Modeling (Modeling of Reactions, Microbial Dynamics and Bioreactive Transport) 6 ECTS	Elective Module 6 ECTS	Elective Module 6 ECTS
Environmental Chemistry 6 ECTS		Elective Module 6 ECTS	Scientific Presentation 6 ECTS
Global Change 6 ECTS	Elective Module 6 ECTS	Scientific Practice 6 ECTS	Master Thesis 30 ECTS
Environmental Analytical Chemistry 6 ECTS	Elective Module 6 ECTS		
Biotransformation of Pollutants 6 ECTS	Elective Module 6 ECTS		

-  Master Thesis (30 ECTS)
-  Mandatory Modules (30 ECTS)
-  Elective Modules Specialization (18 ECTS)
-  Elective Modules (42 ECTS)

Specialization Environmental Physics

MSc Applied & Environmental Geoscience

Specialization: Environmental Physics

1. Sem.	2. Sem.	3. Sem.	4. Sem.	
6 ECTS Groundwater Modeling 1	6 ECTS Atmospheric Physics	6 ECTS Elective Module	6 ECTS Elective Module	
6 ECTS Environmental Chemistry	6 ECTS Climate Dynamics	6 ECTS Elective Module	6 ECTS Scientific Presentation	
6 ECTS Global Change	6 ECTS Elective Module	6 ECTS Scientific Practice	30 ECTS Master Thesis	
6 ECTS Physics of the Earth's Surface	6 ECTS Elective Module			
6 ECTS Elective Module	6 ECTS Elective Module			

- Master Thesis (30 ECTS)
- Mandatory Modules (30 ECTS)
- Elective Modules Specialization (18 ECTS)
- Elective Modules (42 ECTS)

Specialization Hydrogeology

MSc Applied & Environmental Geoscience

Specialization: Hydrogeology

1. Sem.	2. Sem.	3. Sem.	4. Sem.
Groundwater Modeling 1 6 ECTS	Hydrogeological Field Investigation Techniques 6 ECTS	Elective Module 6 ECTS	Elective Module 6 ECTS
Environmental Chemistry 6 ECTS	Remediation of Contaminated Sites 6 ECTS	Elective Module 6 ECTS	Scientific Presentation 6 ECTS
Global Change 6 ECTS	Groundwater Modeling 2 6 ECTS	Scientific Practice 6 ECTS	Master Thesis 30 ECTS
Elective Module 6 ECTS	Elective Module 6 ECTS		
Elective Module 6 ECTS	Elective Module 6 ECTS		

- Master Thesis (30 ECTS)
- Mandatory Modules (30 ECTS)
- Elective Modules Specialization (18 ECTS)
- Elective Modules (42 ECTS)

4. Module Handbook M.Sc. Applied & Environmental Geoscience

The following module descriptions give a comprehensive overview for the Master's degree in Applied & Environmental Geoscience (AEG).

The content of the modules and the lecturers may be subject to change. The respective module coordinator is responsible for further information and questions concerning the individual modules.

Legende		Legend	
Benotungs-system:	b = benotet ub = unbenotet (bestanden/nicht bestanden) kP = keine Prüfung	Grading System:	g = graded ng = not graded (pass/fail) nE = no exam
Prüfungsform / Studienleistung:	K = Klausur MP = Mündliche Prüfung H = Hausarbeit/Hausaufgaben, Bericht R = Referat/Präsentation LP = Laborprotokoll ET = erfolgreiche Teilnahme	Assessment / Study Requirement:	WE = written assessment OE = oral assessment A = term paper/assignment, written report R = report, presentation LP = lab protocol / journal SP = successful participation
Prüfungsdauer:	Dauer der Prüfung in <i>min</i>	Duration of Assessment:	Duration of the assessment in <i>min</i>
Gewichtung:	Gewichtung der Prüfungsnote für die Modulnote	Weighting:	Weighting of grade for the module
SWS:	Semesterwochenstunden	CH:	Credit Hours
Status:	o = obligatorisch f = fakultativ	Status:	c = compulsory op = optional
Art der Lehrform:	V = Vorlesung S = Seminar Ü = Übung/Tutorium GÜ = Geländeübung LP = Laborpraktikum PR = Projekt	Type of Lecture:	L = lecture S = seminar E = exercise/tutorial FC = field course LC = laboratory course PR = project
CP:	Leistungspunkte (ECTS-Punkte)	CP:	Credits (ECTS)

Compulsory Modules

Module Number	Module Title	Module Coordinator	CP	Semester
M 101	Scientific Practice	Merkel	6	W / S
M 103	Scientific Presentation	Bocherens	6	W / S
M 104	Master Thesis (Abschlussmodul)	-	30	W / S
M 201	Groundwater Modeling 1	Cirpka	6	W
M 207	Environmental Chemistry	Zarfl	6	W
M 229	Global Change	Rehfeld	6	W

Elective Modules

Module Number	Module Title	Module Coordinator	CP	Semester
Accepted B.Sc. Modules				
B 408	Geophysik / Geophysics	Drews	6	S
B 504	Hydrologie	Schwientek	6	W
B 506	Water Treatment	Angenent	3	W
B 514	Introduction Earth Surface Processes	Beer	6	W
M.Sc. Modules Applied Geosciences				
M 202	Hydrogeological Field Investigation Techniques	Leven	6	S
M 203	Groundwater Modeling 2	Yuan	6	S
M 205	Remediation of Contaminated Sites	Finkel	6	S
M 206	Case Studies in Environmental Geosciences	Cirpka	6	W
M 208	Environmental Isotope Chemistry	Mason-Jones	6	S
M 209	Environmental Chemistry Lab	Haderlein	6	W
M 210	Environmental Microbiology and Geomicrobiology	Kappler	6	S
M 211	Geomicrobiology Lab	Kappler	6	S
M 212	Advanced Geophysics	Drews	6	W
M 213	GIS and Remote Sensing	Schäuble, Lörcher	6	W
M 214	Geotechnical Engineering	Leven	6	W
M 216	Atmospheric Physics	Platis	6	S
M 218	Environmental Analytical Chemistry	Zwiener	6	W
M 219	Earth Processes	Süß	6	W
M 220	Field Seminars in Applied Geosciences	Merkel	6	W / S
M 221	Environmental and Human Health Risk Assessment of Chemicals	Escher	6	W

M 222	Hydrogeochemical Modeling → substituted by module M 242		6	S
M 225	Field Seminars in Applied Geosciences 2	Merkel	3	W / S
M 227	Sustainable Environmental Biotechnology Systems 1	Angenent	6	S
M 228	Sustainable Environmental Biotechnology Systems 2	Angenent	6	W
M 230	Geosphere-Biosphere Interactions	Dippold	6	S
M 232	Internship	Glotzbach	6	W / S
M 233	Biotransformation of Pollutants	Fabregat	6	W
M 236	Modelling for Sustainable River Management	Zarfl	6	S
M 238	Rhizosphere Processes in a Changing World	Muehe	6	W
M 239	Geo-Bio-Interactions in Tropical Landscapes of Kenya	Otieno, Dippold	6	W
M 240	Isotopes in Ecosystem Sciences	Dippold, Stock	6	W
M 242	Modeling of Reactions, Microbial Dynamics and Bioreactive Transport	Cirpka	6	S
M 243	Tropical Ecology of South America	Ebner	6	W, every other year
M 244	Geothermal Reservoirs	Süß	6	S
M 245	Physical Processes in Surface Waters	Calamita, Zarfl	6	S
M 246	Scientific Writing of a Thesis	Muehe	3	W
M 322	Climate Dynamics	Rehfeld	6	S
M.Sc. Modules Mineralogy and Geology, Biogeology				
M 301	Physics of the Earth's Surface	Glotzbach	6	W
M 305	Advanced Field Methods in Geoscience	Norton	6	W / S
M 308	Isotope Geochemistry	Schönberg	6	W
M 312	Advanced Sedimentology	NN	6	W
M 315	Glaciology	Weikusat	6	W
M 317	Data Analysis and Modeling Methods in Geoscience and Environmental Science	Drews	6	W / S
M 321	Experimental and Analytical Methods in Geoscience and Environmental Science	Schulz	6	W
M 324	Economic Geology	Walter	6	S, every other year
M 325	Data Analysis and Modeling Methods in Geoscience and Environmental Science 2	Drews	6	W / S
M 326	Experimental and Analytical Methods in Geoscience and Environmental Science 2	Schulz	6	S
M 409	Marine Geology and Geochemistry	Schulz	6	W
Additional Elective Modules				
Single Events / Teach@Tübingen Lectures / M.Sc. Modules from other Departments on demand after approval of the examination board				

Module Number: M 101	Module Title: Scientific Practice				Type of Module: M.Sc. Compulsory				
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: Approx. 20 h			Private Study: 160 h			
Duration Module Coordinator	1 semester				Merkel				
Regular Cycle	every semester (recommended in the 3 rd semester)								
Language	English								
Learning- / Teaching Forms	Individual guidance by supervisor, scientific papers								
Module Content	• Compilation of an example research proposal of an individually selected topic in agreement and under supervision of a responsible supervisor • Independent studies in the selected topic including literature research • Formulation of an appropriate problem set, analysis of relevant processes, presentation of the research outline, the required methodologies and the research goals • Set-up of a research schedule including the individual milestones • Writing of the research proposal								
Qualification Goals	• In addition to well-founded professional competence, successful scientific work also requires conceptual and planning competences before and during a research project. In setting up an exemplary research proposal, students will collect experiences in all important steps of planning a research project. • Preparing a research proposal in a written report helps students to acquire important methodological expertise to become acquainted with new fields of research, to identify and discuss relevant problem scenarios, to develop feasible methodological approaches and to present them in an appropriate written form.								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting
	Scientific Practice	PR	c	1	6	A	-	ng	-
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience								
Prerequisites	-								

Module Number: M 103	Module Title: Scientific Presentation				Type of Module: M.Sc. Compulsory				
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h			Contact Time: 60 h / 4 SWS			Private Study: 120 h		
Duration Module Coordinator	1 semester				Bocherens				
Regular Cycle	every semester								
Language	English								
Learning- / Teaching Forms	Oral seminar presentations and poster								
Module Content	• Four participations at the Master's Day event, including one attendance with a poster presentation of the results of the Master's Thesis project • A presentation of the results of the Master Thesis in the respective research group • Attendance at 8 institute seminars								
Qualification Goals	A professional presentation of scientific research projects and their results is a fundamental prerequisite of a successful career both in scientific as well as in the economic world. Students are able to present their research projects in various forms (oral presentation and poster) and acquire in communication skills and presentation competence through oral presentation and discussion with a competent audience.								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting
	Attendance of 8 Institute Seminars and 4 participations on the Master Day	S	c	2	6	R	-	-	-
	Poster Project	PR	c	1		A	-	-	-
	Presentation of the M.Sc. thesis in the Research Group	PR	c	-		R	-	-	-
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience								
Prerequisites	Scientific Practice								

Module Number: M 104	Module Title: Master Thesis (Abschlussmodul)				Type of Module: M.Sc. Compulsory				
Credits (ECTS)	30								
Workload - Contact Time - Private Study	Workload: 900 h		Contact Time: variable depending on the activity			Private Study: variable depending on the activity			
Duration Module Coordinator	1 semester				Respective supervisors				
Regular Cycle	every semester								
Language	German or English (for AEG only in English)								
Learning- / Teaching Forms	Independent research project under supervision (100%)								
Module Content	Literature research, field and/or laboratory tasks preparation of a scientific essay								
Qualification Goals	• Students independently prepare a research outline and perform a scientific study • Preparation of a scientific essay								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting
	Master Thesis	PR	c	-	30	A	6 months	g	1
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience								
Prerequisites	Completion of all required courses								

Module Number: M 201	Module Title: Groundwater Modeling 1			Type of Module: M.Sc. Compulsory / Elective						
Credits (ECTS)	6									
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 90 h / 6 SWS			Private Study: 90 h				
Duration Module Coordinator	1 semester			Cirpka						
Regular Cycle	every winter semester (1 st semester)									
Language	English									
Learning- / Teaching Forms	Ex-cathedra lecture sessions and computer exercises									
Module Content	The module gives an introduction into the processes and mathematical description of flow and transport and aquifers and soils (physical hydrogeology and groundwater hydraulics). The emphasis is on closed-form solutions of the groundwater-flow and transport equations. Topics include: • Characterization of aquifers • Concept of the porous medium • Derivation of the groundwater-flow and Richards equation • Analytical solutions (steady-state and transient 1-D solutions, well hydraulics) • Regional groundwater flow • Multi-phase partitioning of solutes • Derivation of the advection-dispersion equation • Analytical solutions for solute transport									
Qualification Goals	Students know the basic concepts of quantitative subsurface hydrology in different geological environments and acquire general competences in the basic physical principles of groundwater flow and transport. They can calculate groundwater flow and solute transport for simple geometries and are aware of the underlying assumptions. They acquire the key competences needed to tackle standard hydrogeological problems by analytical solutions.									
Requirements for Obtaining Credit, Grading, Weight if appl.	<i>Courses</i>	<i>Type of Lecture</i>	<i>Status</i>	<i>CH</i>	<i>CP</i>	<i>Type of Exam / Study Requirement</i>	<i>Duration of Exam</i>	<i>Grading System</i>	<i>Weighting</i>	
		<i>Groundwater Modeling 1</i>	<i>L</i>	<i>c</i>	<i>4</i>	<i>3</i>	<i>WE</i>	<i>90</i>	<i>g</i>	<i>1</i>
			<i>E</i>	<i>c</i>	<i>2</i>	<i>3</i>				
Applicability	M.Sc. Applied & Environmental Geoscience; M.Sc. Geo-wissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology									
Prerequisites	Students have a firm background in mathematics and physics corresponding to the competences acquired in the BSc modules Mathematik für Naturwissenschaftler and Physik. They have basic programing skills in Matlab.									

Module Number: M 207	Module Title: Environmental Chemistry				Type of Module: M.Sc. Compulsory / Elective				
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 90 h / 6 SWS			Private Study: 90 h			
Duration Module coordinator	1 semester				Zarfl				
Regular Cycle	every winter semester (recommended for 1 st semester)								
Language	English								
Learning- / Teaching Forms	Lectures, Exercises, Tutorial, Team work								
Module Content	• Chemical thermodynamics in aqueous systems • Sorption and partitioning processes of organic and inorganic compounds • Sorption kinetics • Practical applications and case studies								
Qualification Goals	• Role of particles as sorbents, vectors and reactants for contaminants • Quantitative understanding of partitioning and sorption mechanisms of organic and inorganic compounds in the hydrosphere • Knowledge of sorption QSARs for various classes of contaminants • Sorption kinetics and retarded diffusion in porous media • Assessment of contaminant release and cleanup strategies at contaminated sites								
Requirements for Obtaining Credit, Grading, Weight if appl.	<i>Courses</i>	<i>Type of Lecture</i>	<i>Status</i>	<i>CH</i>	<i>CP</i>	<i>Type of Exam / Study Requirement</i>	<i>Duration of Exam</i>	<i>Grading System</i>	<i>Weighting</i>
	<i>Environmental Chemistry Lecture</i>	<i>L</i>	<i>c</i>	<i>2</i>	<i>6</i>	<i>WE</i>	<i>120</i>	<i>g</i>	<i>1</i>
	<i>Environmental Chemistry Exercises</i>	<i>E</i>	<i>c</i>	<i>2</i>					
	<i>Environmental Chemistry Tutorials</i>	<i>E</i>	<i>op</i>	<i>2</i>					
Applicability	M.Sc. Applied & Environmental Geoscience, M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology								
Prerequisites	Basic knowledge in chemistry, physics, hydrogeology								

Module Number: M 229	Module Title: Global Change				Type of Module: M.Sc. Compulsory / Elective				
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 65 h / 5 SWS			Private Study: 115 h			
Duration Module Coordinator	1 semester				Rehfeld				
Regular Cycle	every winter semester								
Language	English								
Learning- / Teaching Forms	Per week: 3 h lecture (2 h + 1 h), 2 h seminar (2 student talks of 15 minutes plus discussion with two opposing hypotheses and groups, 2 students per talk)								
Module Content	• Analytical Climate System • Climate of Today (modern climate change including observation and models) • Climate System of the Past • Future Global Change including climate and resources • Impacted Systems (regions, species, pollution, land use) • Counter Measures								
Qualification Goals	Quantitative scientific understanding of global change (especially climate, resources, pollution), how to measure and model global-change variables in time and in sub-systems, technological options for countermeasures The students know the current state of research and are able to present and communicate the underlying concepts in presentations and discussions.								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting
	Global Change	L	C	39	4	WE	2	g	66, 6
		S	C	26	2	R	1	g	33, 3
Applicability	M.Sc. Applied & Environmental Geoscience; M.Sc. Geoökologie/Geoecology								
Prerequisites	-								

Module Number: B 408	Module Title: Geophysik / Geophysics				Type of Module: B.Sc. Compulsory / Elective					
Credits (ECTS)	6									
Workload - Contact Time - Private Study	Workload: 180 h			Contact Time: 75 h / 5 SWS			Private Study: 105 h			
Duration Module Coordinator	1 semester				Drews					
Regular Cycle	every summer semester									
Language	English									
Learning- / Teaching Forms	The module uses a combination of in-class lectures, in-class exercises, applied field exercises and online videos.									
Module Content	This module offers a broad introduction into the principles of applied geophysics with a focus on sub-surface imaging techniques using gravimetry, magnetics, seismics, geoelectrics and electromagnetics. Field based exercises are conducted in small groups offering 'hands on' experiences in collecting, processing and interpretation of geophysical data. In-class exercises include theoretical problem-solving, self-designed practical setup (e.g., using minicomputers and smart phones), and computational methods.									
Qualification Goals	(1) Obtain a basic understanding of geophysical sub-surface imaging techniques in theory & practice, and understand relevant earth-system processes and parameters where these techniques can be applied. (2) Develop transferable skills in quantitative data analysis and rigorous problem solving strategies using physics and mathematics.									
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting	
		Geophysik / Geophysics	L	c	4	4	WE +A	90	g	1
			FE	c	1	2	A	-	-	-
Applicability	B.Sc. Geowissenschaften (recommended in the 4 th semester), B.Sc. Umweltnaturwissenschaften (recommended in the 2 nd semester), M.Sc. Applied & Environmental Geoscience									
Prerequisites	A firm background in mathematics and physics is expected.									

Modulnummer: B 504	Modultitel: Hydrologie			Art des Moduls: B.Sc. Wahlpflicht					
ECTS-Punkte	6								
Arbeitsaufwand - Kontaktzeit - Selbststudium	Arbeitsaufwand: 180 h		Kontaktzeit: 45 h / 3 SWS			Selbststudium: 135 h			
Moduldauer Modulkoordination	1 Semester			Schwientek					
Häufigkeit des Angebots	jedes Wintersemester								
Unterrichtssprache	Deutsch								
Lehr- / Lernformen	3 SWS kombiniert Vorlesung & Übung								
Modulinhalt	Das Modul gliedert sich in thematische Blöcke, die aufeinander aufbauen und zunehmend spezifischer werden. Beginnend mit der globalen Wassermenge und die Verteilung auf wesentliche Kompartimente, sowie die Zirkulation im Wasserkreislauf folgt die Beschreibung des hydrologischen Einzugsgebiets als Basiseinheit für hydrologische Betrachtungen aller Art und umreißt die wesentlichen quantitativen Einzugsgebietsprozesse bis hin zum Abfluss am Gebietsauslass. Das Thema Stoffhaushalt und Flussfracht behandelt qualitative Aspekte der hydrologischen Transportsysteme, auch in Abhängigkeit der betrachteten Zeitskala. Ein eigener Abschnitt beschäftigt sich mit Seen und deren Rolle im hydrologischen Geschehen. Weitere, zunehmend angewandte Abschnitte widmen sich u.a. der Wasserbewirtschaftung und dem Einfluss des Menschen vor dem Hintergrund ökologischer Zusammenhänge.								
Qualifikationsziele	Die Studierenden • verstehen die Dynamik des Wassers und wie es zwischen Kompartimenten zirkuliert und können problembezogen die Wasserhaushaltsgleichung aufstellen • kennen gängige praktische und rechnerische Methoden der Hydrometrie • begreifen hydrologische Einzugsgebiete als Systemeinheiten und sind in der Lage wesentliche Einzugsgebietsprozesse, wie z.B. Hochwasserentstehung, nachvollziehen und die Ursachen zu analysieren • erkennen die Vielschichtigkeit von Wasser- und Gewässerqualitätsaspekten und sind in der Lage qualitative Informationen in Bezug zu setzen und zu evaluieren • können Frachtberechnungen durchführen und Stoffbilanzen erstellen • verstehen die Wechselbeziehungen zwischen Geologie, Klima, Hydrologie und Landschaftsentwicklung • kennen wichtige Aspekte der Wasserwirtschaft und daraus entstehender Konflikte, z.B. Wasserkraftnutzung - Gewässerschutz • erlangen an zahlreichen praktischen Beispielen Einblicke und Verständnis für Fragestellungen der hydrologischen Forschung								
Voraussetzung für die Vergabe von Leistungspunkten / Benotung (ggf. Gewichtung)	Lehrveranstaltungen	Art der Lehrform	Status	SWS	LP	Prüfungsform / Studienleistung	Prüfungsdauer	Benotungssystem	Gewichtung
	Hydrologie	V	o	2	3	K	90	b	1
		Ü	o	1	3				
Verwendbarkeit	B.Sc. Geowissenschaften, B.Sc. Geoökologie, B.Sc. Umweltnaturwissenschaften								
Teilnahmevoraussetzungen	Neben der regelmäßigen Teilnahme wird eine solide naturwissenschaftliche und geologische/geomorphologische Grundausbildung vorausgesetzt. Kenntnisse entsprechend der im Modul Grundwasserhydrologie vermittelten Kompetenzen sollten vorhanden sein.								

Module Number: B 506	Module Title: Water Treatment			Type of Module: B.Sc. Compulsory / Elective						
Credits (ECTS)	3									
Workload - Contact Time - Private Study	Workload: 90 h		Contact Time: 45 h / 3 SWS			Private Study: 45 h				
Duration Module Coordinator	1 semester			Angenent						
Regular Cycle	every winter semester									
Language	English									
Learning- / Teaching Forms	The module includes lectures and accompanying exercises									
Module Content	The module includes - Basics of Water and Wastewater Treatment - Coagulation, filtration, sedimentation - Adsorption - Membrane Filtration - Oxidation - Disinfection - Activated Sludge Plants - Sludge Treatment - Anaerobic Digestion - Alternative and modern processing - Combination of individual processes - Up-to-date examples of drinking water treatment plants and wastewater treatment plants									
Qualification Goals	Students understand the basics of physical, chemical, and biological processes of drinking water treatment and wastewater treatment. They know the approaches of different treatment technologies and are able to apply suitable processes to remove selected pollutants. They are able to combine suitable process steps to treatment trains which are able to solve given problems.									
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting	
		Water Treatment	L	c	2	3	WE	120	g	1
			E	c	1					
Applicability	B.Sc. Geowissenschaften, B.Sc. Geoökologie, B.Sc. Umweltnaturwissenschaften, M.Sc. Applied & Environmental Geoscience									
Prerequisites	Basic background in Chemistry and Physics comparable to contents that can be acquired in the modules of the B.Sc. program									

Module Number: B 514	Module Title: Introduction to Earth Surface Processes			Type of Module: B.Sc. Elective					
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Times: 60 h / 4 SWS		Private Study: 120 h				
Duration Module Coordinator	1 Semester			Beer					
Regular Cycle	every winter semester								
Language	English								
Learning- / Teaching Forms	Lectures and Exercises								
Module Content	• This course presents the physical basis for mass transport at the Earth's surface. Mechanisms for the production of topography and erosion/sedimentation processes are discussed. • An introduction to the physics of the following processes will be covered: rock weathering; glacier flow, fluvial and eolian erosion, transport, and deposition; and hillslope mechanics. • Field examples and application of geomorphic methods for quantifying the rates of fluvial and hillslope processes, and landscape modelling.								
Qualification Goals	At the end of the course the students will have: • A good understanding of the theoretical underpinnings of the physics and chemistry of Earth's surface processes; • Interpreting landscape evolution using observations and theory for applications such as risk assessment (e.g. hillslope failure, outburst floods) and geo-engineering. • Practical experience using field instrumentation, basic computer modelling of landscape evolution (Matlab) and remote sensing								
Requirements for Obtaining Credit, Grading, Weight if appl.	<i>Courses</i>	<i>Type of Lecture</i>	<i>Status</i>	<i>CH</i>	<i>CP</i>	<i>Type of Exam / Study Requirement</i>	<i>Duration of Exam</i>	<i>Grading System</i>	<i>Weighting</i>
	<i>Introduction to Earth Surface Processes</i>	<i>L</i>	<i>c</i>	<i>2</i>	<i>6</i>	<i>A</i>		<i>g</i>	
		<i>E</i>	<i>c</i>	<i>2</i>					
Applicability	B.Sc. Geowissenschaften, B.Sc. Geoökologie, B.Sc. Umweltnaturwissenschaften, M.Sc. Applied & Environmental Geoscience								
Prerequisites	"Introduction to Geosciences", "Mathematik 1 für Naturwissenschaftler", "Mathematik 2 für Naturwissenschaftler" (recommended)								

Module Number: M 202	Module Title: Hydrogeological Field Investigation Techniques				Type of Module: M.Sc. Elective				
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 90 h / 6 SWS			Private Study: 90 h			
Duration Module Coordinator	1 semester				Leven				
Regular Cycle	every summer semester (subsequent to the module Groundwater Modeling 1)								
Language	English								
Learning- / Teaching Forms	Lecture with exercises (during semester) and field course (1 week block course)								
Module Content	The module deals with methods of applied hydrogeology, and focuses in particular on techniques for hydrogeologic site investigation for which the theoretical basis of hydrogeological investigation techniques is taught and consolidated in exercises. As part of a field course, the hydrogeological site investigation techniques are transferred into practice. Methods, which are discussed in the module include among others: drilling methods, well construction, groundwater sampling, pumping tests under various boundary conditions, single well methods, and tracer testing.								
Qualification Goals	Students are able to independently plan, carry out, and evaluate hydrogeological field tests. They develop investigation strategies for a hydrogeological exploration of a site, guide and carry out site investigations and collect and analyze data. They generate a local hydrogeological site characterization of the aquifer resp. the subsurface and provide hydrogeological parameters of the subsurface. They are able to apply their knowledge and understanding as well as their problem solving skills in new and unfamiliar situations.								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting
	Hydrogeological Investigation Techniques	L/E	c	3	3	WE	180	g	0.5
	Hydrogeological Field Course	FC	c	3	3	A	-	g	0.5
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience It is related to other method-oriented modules of applied geosciences (e.g. Geotechnical Engineering, Praktische Hydrogeologie, Hydrogeologie und Wasserchemie, Geophysics).								
Prerequisites	The module requires the competences of the M.Sc. module "Groundwater Modeling 1".								

Module Number: M 203	Module Title: Groundwater Modeling 2			Type of Module: M.Sc. Elective					
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 90 h / 6 SWS		Private Study: 90 h				
Duration Module Coordinator	1 semester			Yuan					
Regular Cycle	every summer semester (recommended 2 nd semester)								
Language	English								
Learning- / Teaching Forms	Theoretical aspects of numerical flow-and-transport modeling are taught in ex-cathedra lecture sessions. Extensive computer exercise tutorials provide students with 'hands on' experiences in modeling groundwater-flow and transport problems.								
Module Content	The module gives an introduction into the numerical modeling of groundwater flow and conservative transport. Topics include: • Discretization methods for groundwater flow (Finite Volume Method) and solute transport (particle tracking, Finite Volume Method) • Finite Volumes "by hand" • Modeling of steady-state and transient groundwater flow with MODFLOW • Calibration of numerical groundwater-flow models • Modeling of solute transport with MT3DMS								
Qualification Goals	Students understand the principles of computer models for groundwater flow and solute transport. They can set up simple numerical models themselves. They can use standard computer codes for groundwater flow-and-transport problems. They are proficient in the workflow of practical groundwater-flow modeling studies (design of a site-specific conceptual model, discretization of the problem, use of professional simulation software, calibration of the model to data, reporting).								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting
		L	c	4	4	WE	180	g	1
	Groundwater Modeling 2		E	c	2				
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience								
Prerequisites	Students have competences corresponding to those of the MSc Module Groundwater Modeling 1. They have basic programing skills in Matlab.								

Module Number: M 205	Module Title: Remediation of Contaminated Sites			Type of Module: M.Sc. Elective						
Credits (ECTS)	6									
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 60 h / 4 SWS			Private Study: 120 h				
Duration Module Coordinator	1 semester				Finkel					
Regular Cycle	every summer semester (recommended in the 3 rd semester)									
Language	English									
Learning- / Teaching Forms	Flipped classroom: Students work individually on lectures, which are followed by discussion sessions including tutorials; additionally, students work on case study projects to address practical problems quantitatively.									
Module Content	• Subsurface contaminant distribution • Non aqueous phase liquids in porous media (NAPLs): Behavior and dissolution kinetics • Dissolved compounds: Transport in groundwater • Site investigation and sampling strategies • Integral pumping tests • In situ and ex situ source zone remediation technologies • Plume remediation: Natural attenuation, permeable reactive barriers, pump-and-treat • Remediation technology selection: Technical, economical and environmental aspects • Integrated contaminated land management									
Qualification Goals	Students learn to address real case scenarios of contaminated sites and to interpret the inherent contamination characteristics due to subsurface conditions and the compounds under consideration. The comprehensive overview on practical aspects of contaminant hydrogeology involves building of conceptual models of a contaminated site, assessing potential risks and developing solution strategies for subsurface contaminations, a key competence of environmental geoscientists.									
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting	
		Remediation of Contaminated Sites	L,E	c	2	3	A	2h	g	0,5
			PR	c	2	3	R	-	g	0,5
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience									
Prerequisites	M.Sc. modules "Groundwater Modeling 1", "Environmental Chemistry" or equivalent competences									

Module Number: M 206	Module Title: Case Studies in Environmental Geosciences				Type of Module: M.Sc. Elective				
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h			Contact Time: 30 h / 2 SWS		Private Study: 150 h			
Duration Module coordinator	1 semester				Cirpka				
Regular Cycle	every winter semester (recommended 3 rd semester)								
Language	English								
Learning- / Teaching Forms	The module uses several seminar sessions at the beginning of the semester to introduce problems sets which are to be solved in teams. Several project meetings with the lecturer give the individual groups feedback on their work on a regular basis. Project presentations and discussion complete the module.								
Module Content	This course is aimed to apply methods and techniques acquired in previous modules on typical environmental problems. • Several case studies will be presented along with all relevant data • Students will work in small groups addressing specific problem scenarios • Starting from initial data sets students will analyze the problem, develop solution strategies and present their solution								
Qualification Goals	Highly specific subject oriented projects enable students to analyze a problem, set up fundamental assumptions, collect and evaluate available data. Solving complex problems in environmental geosciences generally includes multidisciplinary approaches from various fields of expertise such as hydrogeology and hydrogeochemistry. Dealing with such scenarios, students gain experience in designing conceptual site models, define the relevant physical and chemical processes involved and develop a solution strategy. The integrative module fosters a variety of competences including the capacity for analysis and teamwork, quantitative problem solving skills and presentation and reporting skills.								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting
	Case Studies in Environmental Geosciences	PR	c	2	6	R	30	g	1
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geocology, M.Sc. Applied & Environmental Geoscience								
Prerequisites	Competences corresponding to the M.Sc. modules "Grondwater Modeling 1" and "Groundwater Modeling 2"								

Module Number: M 208	Module Title: Environmental Isotope Chemistry (Environmental Chemistry 2)				Type of Module: M.Sc. Elective				
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h			Contact Time: 90 h / 6 SWS			Private Study: 90 h		
Duration Module coordinator	1 semester				Mason-Jones				
Regular Cycle	every summer semester								
Language	English								
Learning- / Teaching Forms	Lectures, exercises, team work, presentations								
Module Content	• Basic principles of isotope geochemistry (definitions, fractionation mechanisms, etc.) • Relevant isotope systems for the hydrosphere (esp. C, H, O, N, S) • Organic and Compound-specific organic isotope chemistry • Application of isotope systems for forensic and process identification purposes • Principles of isotope analysis • Applications and case studies								
Qualification Goals	• Knowledge of prospects, limitations and applications of isotope methods in environmental chemistry • Knowledge of theory and interpretation of isotope fractionation processes • Knowledge of basic principles and applications of core methods for isotope analysis • Application of isotope methods in the context of contaminant hydrology (natural attenuation and tracer studies)								
Requirements for Obtaining Credit, Grading, Weight if appl.	<i>Courses</i>	<i>Type of Lecture</i>	<i>Status</i>	<i>CH</i>	<i>CP</i>	<i>Type of Exam / Study Requirement</i>	<i>Duration of Exam</i>	<i>Grading System</i>	<i>Weighting</i>
	<i>Inorganic Environmental Isotope Chemistry</i>	<i>L</i>	<i>c</i>	<i>2</i>	<i>3</i>	<i>WE</i>	<i>120</i>	<i>g</i>	<i>0,5</i>
	<i>Inorganic Environmental Isotope Chemistry Exercises</i>	<i>E</i>	<i>c</i>	<i>1</i>					
	<i>Organic Environmental Isotope Chemistry</i>	<i>L</i>	<i>c</i>	<i>2</i>	<i>3</i>	<i>A</i>	<i>120</i>	<i>g</i>	<i>0,5</i>
	<i>Organic Environmental Isotope Chemistry Exercises</i>	<i>E</i>	<i>c</i>	<i>1</i>					
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience								
Prerequisites	Basic knowledge in chemistry and physics for geoscientists								

Module Number: M 209	Module Title: Environmental Chemistry Lab (Environmental Chemistry 3)				Type of Module: M.Sc. Elective				
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 90 h / 6 SWS		Private Study: 90 h				
Duration Module coordinator	1 semester			Haderlein					
Regular Cycle	every winter semester								
Language	English								
Learning- / Teaching Forms	Lab experiments in small teams; project, seminar								
Module Content	- Analytical methods for organic & inorganic contaminants in environmental samples - Concepts and methods for the quantification of contaminants and degradation processes - Insights in current research projects in the fields of environmental chemistry & environmental microbiology								
Qualification Goals	- Knowledge and application of key lab techniques in environmental chemistry (Sampling, extraction- & enrichment techniques, chromatography (IC, GC, HPLC); mass spectrometry; stable isotope analyses) - Experimental design; practical laboratory skills; evaluation and interpretation of experimental data and their uncertainty. - Knowledge of current research topics in environmental chemistry & microbiology.								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting
	Environmental Chemistry Lab	LC	c	5	6	SP	-	g	0,4
		PR	c	1		LP	-	g	0,6
			Grading is based on the lab performance, lab protocols and final report; no final exam.						
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geocology, M.Sc. Applied & Environmental Geoscience								
Prerequisites	General chemistry; aquatic chemistry; microbiology on B.Sc. level M.Sc. module "Environmental Chemistry 1"								

Module Number: M 210	Module Title: Environmental Microbiology and Geomicrobiology				Type of Module: M.Sc. Elective						
Credits (ECTS)	6										
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 60 h / 4 SWS			Private Study: 120 h					
Duration Module coordinator	1 semester				Kappler						
Regular Cycle	every summer semester										
Language	English										
Learning- / Teaching Forms	Lecture and seminar (student presentations)										
Module Content	• General environmental microbiology and geomicrobiology • Microbial degradation of pollutants • Redox zonation, thermodynamics • Microbe-mineral interactions • Bioremediation • Biogeochemical cycles										
Qualification Goals	The students • can read and evaluate current literature about various topics in Environmental Microbiology and Geomicrobiology and can present these topics to an interdisciplinary audience of students • obtain an advanced and detailed understanding of current topics Geomicrobiology and Environmental Microbiology • understand the kinetics and energetics of microbially catalyzed processes and the consequences of these processes for the environment • know about the contribution role of microbial processes for biogeochemical cycling (C, N, S, Fe, Si, P) • know about environmental behavior and microbial transformation of selected organic and inorganic pollutants • understand the interactions of microorganisms with solid substrates (minerals and surfaces)										
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses			Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting
	Environmental Microbiology and Geomicrobiology			L,S	c	4	6	R	45	g	1
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience										
Prerequisites	Geomicrobiology; basic knowledge in microbial physiology and in microbial ecology										

Module Number: M 211	Module Title: Geomicrobiology Lab Course				Type of Module: M.Sc. Elective				
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 90 h		Private Study: 90 h				
Duration Module coordinator	2 weeks lab course; report writing afterwards			Kappler					
Regular Cycle	every summer semester								
Language	English								
Learning- / Teaching Forms	Lab exercises								
Module Content	• Cultivation and microscopic characterization of microorganisms • Quantification of microbial activities • Analysis of nucleic acids (DNA, qPCR) • Active participation in a current research project of the Geomicrobiology research group								
Qualification Goals	The students • can apply various microbial lab techniques (sterile working techniques) • are able to follow and interpret microbial activities quantitatively • know about different microbial metabolic pathways, in particular microbial formation and transformation of minerals • know about current topics in geomicrobiology • understand and are able to present research questions, hypotheses, experimental approaches and methods, results from their experiments and the data evaluation and interpretation								
Requirements for Obtaining Credit, Grading, Weight if appl.	<i>Courses</i>	<i>Type of Lecture</i>	<i>Status</i>	<i>CH</i>	<i>CP</i>	<i>Type of Exam / Study Requirement</i>	<i>Duration of Exam</i>	<i>Grading System</i>	<i>Weighting</i>
	<i>Geomicrobiology Lab</i>	<i>LC</i>	<i>c</i>	<i>6</i>	<i>6</i>	<i>SP</i>	-	-	-
						<i>R</i>	-	<i>g</i>	<i>1</i>
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience								
Prerequisites	Geomicrobiology; basic knowledge in microbial physiology and in microbial ecology								

Module Number: M 212	Module Title: Advanced Geophysics				Type of Module: M.Sc. Elective					
Credits (ECTS)	6									
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 90 h / 6 SWS			Private Study: 90 h				
Duration Module coordinator	1 semester				Drews					
Regular Cycle	Every winter semester									
Language	English									
Learning- / Teaching Forms	The module uses a combination of in-class lectures, in-class & applied exercises, and online videos.									
Module Content	This module teaches advanced methods in geophysics including data acquisition, processing and modelling. In each semester we will typically explore one or two methods in-depth (e.g., refraction seismics, electrical resistivity tomography, ground-penetrating radar, magnetics) and develop a full processing chain from first principals, e.g., including survey planning, data acquisition, forward modeling and data integration using computational inverse techniques.									
Qualification Goals	(1) Gain an advanced understanding for specific geophysical methods. (2) Understand the principals of forward and inverse modelling and apply it with computational methods. (3) Build-up transferable skills (e.g., signal analysis and numerical modeling) also applicable in many other geo- and environmental disciplines.									
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting	
		Advanced Geophysics	L	o	4	4	WE/ OE	90	g	1
			FC	o	2	2				
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Applied & Environmental Geoscience									
Prerequisites	Solid understanding of basic geophysical sub-surface imaging taught at the BSc levels. Programming skills are helpful but not strictly essential and can also be acquired in class.									

Module Number: M 213	Module Title: GIS and Remote Sensing			Type of Module: M.Sc. Elective						
Credits (ECTS)	6									
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 75 h / 5 SWS			Private Study: 105 h				
Duration Module Coordinator	1 semester			Schäuble, Lörcher						
Regular Cycle	every winter semester									
Language	English									
Learning- / Teaching Forms	Lectures and accompanying guided computer exercises, project assignment.									
Module Content	• General introduction to GIS (definition, components, applications and samples) • Acquisition of geo-datasets: getting field data with personal GPS-smartphones (Android, iOS) and public datasets using web sources • Application of GIS by considering the most important aspects in practice, e.g. map projections, georeferencing of scanned images, GPS-data, digitizing of maps, analysis of vector and raster datasets, presentation and visualization of spatial datasets. • Usage of free software: QGIS (with plugins) for scientific analysis and Google Earth Pro for data preparation and distribution to the public • Introduction to remote sensing and advanced raster analysis, e.g. surface analysis and hydrological simulations. • Students have to complete a small GIS project at the end of the course									
Qualification Goals	Students will get the knowledge to use Geographical Information Systems (GIS) in general and for their own scientific projects. They will learn how get the geodata to do that as well. This course combines lectures, computer exercises and GPS field work. Special emphasis is set on practical applications, usability and simplicity. Only GIS software will be used that is freely available (QGIS). Thus, knowledge and workflows can be applied at any time with private notebooks, tablets and smartphones. After completion, the students will have a basic but complete understanding of all relevant aspects of GIS from A-Z. They can start with their own projects from the scratch. QGIS has implemented additional and high-rated GIS software as well (GRASS, SAGA), so every scientific examination can be done.									
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting	
		Geographical information systems and Remote Sensing	L	c	2	6	A	-	g	1
			E	c	2					
Applicability	M.Sc. Applied & Environmental Geoscience, (M.Sc. Geowissenschaften/Geosciences and M.Sc. Geoökologie/Geoecology if capacity allows)									
Prerequisites	Smartphone (Android, iOS or other brand)									

Module Number: M 214	Module Title Geotechnical Engineering				Type of Module: M.Sc. Elective				
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 90 h / 6 SWS			Private Study: 90 h			
Duration Module Coordinator	1 semester				Leven				
Regular Cycle	every winter semester								
Language	English								
Learning- / Teaching Forms	Lecture with exercises (during semester) and lab course (1 week block course)								
Module Content	The module deals with methods of soil mechanics and geotechnical engineering. In a lecture the basic principles of geotechnical classification of soils and rocks, geotechnical investigation methods, and procedures for determining mediated soil and geomechanical parameters are taught and will be consolidated in exercises. During the soil mechanics laboratory course, various geotechnical laboratory methods for determining basic geotechnical soil and rock parameters are practically applied, analyzed, and evaluated.								
Qualification Goals	Students are able to independently develop an investigation plan for a geo-technical and soil mechanical investigation at a site, to carry out and guide a sampling campaign. Evaluating the soil mechanical data, they determine relevant geotechnical parameters, analyze them and present them in a report. The students are able to apply their knowledge and understanding as well as their problem solving skills in new and unfamiliar situations.								
Requirements for Obtaining Credit, Grading, Weight if appl.	Course	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting
	Geotechnical Engineering	L	c	2	3	WE	120	g	0.5
	Soil Mechanics Lab	LC	c	3	3	A	-	g	0.5
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Applied & Environmental Geosciences, (M.Sc. Geoökologie/Geoecology if capacity allows) It is related to other method-oriented modules of applied geosciences (e.g. Hydrogeological Field Investigations Techniques, Hydrogeologie und Wasserchemie, Geophysics).								
Prerequisites	Basic physical, mathematical, and geological knowledge								

Module Number: M 216	Module Title: Atmospheric Physics			Type of Module: M.Sc. Elective					
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 60 h / 4 SWS		Private Study: 120 h				
Duration Module Coordinator	1 semester			Platis					
Regular Cycle	every summer semester								
Language	English								
Learning- / Teaching Forms	Theoretical aspects of atmospheric physics that are taught in lectures are accompanied by exercises and tutorials in small groups. Field exercises provide 'hands-on' experience and insights in handling atmospheric research.								
Module Content	This course presents the main features of atmospheric physics with a focus on the boundary layer and airborne research. Aircraft have been applied very effectively in many aspects of environmental research and are a powerful instrument for studying the Earth's surface and atmosphere. Instrumented aircraft in situ measurements with minimum disturbances to the atmosphere between sensor and object. Since the recent development of small unmanned aerial vehicles (UAV) research aircraft have opened new possibilities in boundary layer research.								
	This module gives an introduction to these exciting research topics and covers the following topics in lecture, tutorials and hands-on practice: • Introduction to atmospheric physics and the boundary layer • history of research flight • the physics of flight: aerodynamics, avionics and inertial navigation systems, coordinate systems, aircraft icing • measurement and calibration of basic thermodynamic quantities: temperature, pressure, altitude, water vapour, wind vector • turbulent fluxes and small-scale turbulence • flight strategies and field exercise (with UAV) • software strategies for atmospheric data analysis (using RAMA)								
Qualification Goals	Students are familiar with the potential and limits of research aircraft in general, especially regarding UAV, airborne measurement instruments and flight strategies. They will be able to decide what instruments (in terms of suitable aircraft and sensors) are suited for certain environmental studies, particularly regarding costs and experimental effort. They plan, carry out and analyze flight experiments for environmental studies in the lower troposphere.								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting
		L	c	2	3	WE	120	g	0,66
		E	c	1	2	-	-	-	-
		S	c	1	1	R	-	-	0,33
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Applied & Environmental Geosciences								
Prerequisites	Lectures on mathematics and physics of a B.Sc. study, completed by lectures on thermodynamics, atmospheric physics and basics in flow mechanics (UWP1 and UWP2 of the B.Sc. Umweltnaturwissenschaften)								

Module Number: M 218	Module Title: Environmental Analytical Chemistry				Type of Module: M.Sc. Elective					
Credits (ECTS)	6									
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 90 h / 6 SWS			Private Study: 90 h				
Duration Module Coordinator	1 semester				Zwiener					
Regular Cycle	every winter semester (recommended for the 1 st semester)									
Language	English									
Learning- / Teaching Forms	The module combines classroom lectures and exercises with a one-week laboratory practical course, which allows students to apply their theoretical classroom knowledge and gain practical laboratory skills. Regular homework and lab presentations give feedback on individual study progress.									
Module Content	The module focuses on: • Analysis of new emerging and polar compounds in environmental media • Basic principles of atmospheric pressure ionization techniques and mass spectrometry • Advanced applications of instrumental analytical techniques with liquid chromatography-mass spectrometry • Special approaches for ultratrace analysis									
Qualification Goals	Students understand the properties of polar compounds. They acquire the theoretical competence to select appropriate problem-oriented analytical methods for environmental pollutants. At the same time the acquired practical skills allow them to handle sophisticated analytical instruments and to develop suitable analytical methods for variable contamination scenarios on demand. Both, the theoretical knowledge and the practical laboratory skills are key competences for environmental scientists.									
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting	
		Environmental Analytical Chemistry	L	c	3	3	WE	120	g	0,5
			LC	c	3	3	LP	-	g	0,5
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience									
Prerequisites	Basic knowledge in chemistry, environmental analytics and statistics									

Module Number: M 219	Module Title: Earth Processes				Type of Module: M.Sc. Elective				
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 45 h / 3 SWS			Private Study: 135 h			
Duration Module Coordinator	1 semester				Süß				
Regular Cycle	every winter semester								
Language	English								
Learning- / Teaching Forms	Lectures are accompanied by exercises and computer tutorials.								
Module Content	• General introduction to geology for non-geologists • Understanding the System Earth (e.g. rocks and minerals) • Surface Processes acting on depositional environments (e.g. rivers, wind, oceans) • Landscape Evolution • Internal Processes (e.g. earthquakes, plate tectonics)								
Qualification Goals	Students with no or little geological background will get a first comprehensive introduction to geology. They understand relevant geological processes and principles acting on earth's surface and subsurface and improve their understanding of interaction of geological processes with various aspects of environmental geosciences.								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting
	Earth Processes	L, E	c	3	6	WE	90	g	1
Applicability	M.Sc. Applied & Environmental Geoscience for students with little or no background in geology								
Prerequisites	none								

Module Number: M 220	Module Title: Field Seminars in Applied Geosciences				Type of Module: M.Sc. Elective				
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: variable			Private Study: variable			
Duration Module Coordinator	1-4 semester				Merkel				
Regular Cycle	variable offers mainly in the summer semester								
Language	English								
Learning- / Teaching Forms	In research field seminars and excursions students identify, outline, describe and discuss selected geological situations in the field with lecturers, fellow students and researchers.								
Module Content	The module focuses on the practical field experiences in applied geosciences. Possible activities include field seminars and excursions, project field campaigns on topics of the applied geosciences e.g. hydrogeology, engineering geology, contaminant hydrogeology.								
Qualification Goals	The capacity to apply knowledge in the field is a key competence of geoscientists. Field seminars and excursions allow students to complement lecture-based knowledge with observational and practical skills. They learn to merge different aspects of applied geosciences in a holistic manner and to apply it to different geological situations. Thematically focused excursions in e.g. contaminant hydrogeology or water resources management deepen the knowledge of regional geology and various specialized topics. Discussing complex problems in the field in groups develops communication and problem solving skills.								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting
	Various Field Seminars in Applied Geosciences	FC	op	-	1-6	A	-	ng	-
	Depending on the type and workload of field seminars variable numbers of credits points can be awarded to individual field seminars. The module is complete when the activities add up to 18 days of field work. The applied nature of field seminars needs to be approved prior to participation.								
Applicability	M.Sc. Applied & Environmental Geoscience								
Prerequisites	Fundamentals in hydrogeology, environmental chemistry and applied geosciences								

Module Number: M 221	Module Title: Environmental and Human Health Risk Assessment of Chemicals			Type of Module: M.Sc. Elective					
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 60 h / 2 SWS + 1 week block course			Private Study: 120 h			
Duration Module Coordinator	1 semester + 1 week in March (block course)				Escher				
Regular Cycle	every winter semester								
Language	English								
Learning- / Teaching Forms	Lecture and exercises Groups of three students conduct a comprehensive environmental and human health risk assessment for one selected chemical each according to the European regulation for industrial chemicals. The risk assessment is performed stepwise in the exercises in groups and then compiled by each student into a written technical report (chemical risk assessment dossiers) Seminar In March, there is a 5-day block with seminar-style applications and special topics and presentations of the chemical risk assessment dossiers. At the end of the week the chemical risk assessment dossiers are completed and will be graded.								
Module Content	• Regulatory methods for environmental risk assessment of chemicals (industrial chemicals, pesticides, pharmaceuticals), European regulation REACH, human vs. ecological risk assessment • PBT assessment (persistence, bioaccumulation, toxicity), classification and labelling of chemicals • Environmental exposure analysis: emission patterns, multimedia fate and transport models for quantifying environmental exposure, predicted and measured exposure concentration • Environmental effect analysis: estimation of hazard potential, tests for ecotoxicity, dose-effect relationships, extrapolation methods, classification of chemicals according to modes of toxic action • Human health risk assessment of chemicals. Exposure estimations and human health effects, cancer risk, risk quotient • Integrated testing strategy for toxicity and ecotoxicity including prediction methods • Risk assessment methods (deterministic vs. probabilistic), risk assessment vs. hazard assessment, uncertainty and sensitivity analyses, precautionary principle • Specific topics: risk assessment of mixtures, risk assessment of transformation products, dynamic risk assessment, water quality assessment								
Qualification Goals	The students are familiar with regulatory approaches to environmental risk assessment of chemicals and can perform a regulatory risk assessment for an industrial chemical. They are aware of pitfalls and challenges and know about new approaches to risk assessment that are still in the research stage.								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting
	Environmental Risk Assessment	L	c	2	6	A	-	g	1
		S	c	2		R	-	-	-
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geocology, M.Sc. Applied & Environmental Geoscience								
Prerequisites									

Module M 222 "Hydrogeochemical Modeling" is substituted by module M 242 "Modeling of Reactions, Microbial Dynamics and Bioreactive Transport".

Module Number: M 225	Module Title: Field Seminars in Applied Geosciences 2				Type of Module: M.Sc. Elective				
Credits (ECTS)	3								
Workload - Contact Time - Private Study	Workload: 90 h		Contact Time: variable			Private Study: variable			
Duration Module Coordinator	1-4 semester				Merkel				
Regular Cycle	variable offers mainly in the summer semester								
Language	English								
Learning- / Teaching Forms	In research field seminars and excursions students identify, outline, describe and discuss selected geological situations in the field with lecturers, fellow students and researchers.								
Module Content	The module focuses on the practical field experiences in applied geosciences. Possible activities include field seminars and excursions, project field campaigns on topics of the applied geosciences e.g. hydrogeology, engineering geology, contaminant hydrogeology.								
Qualification Goals	The capacity to apply knowledge in the field is a key competence of geoscientists. Field seminars and excursions allow students to complement lecture-based knowledge with observational and practical skills. They learn to merge different aspects of applied geosciences in a holistic manner and to apply it to different geological situations. Thematically focused excursions in e.g. contaminant hydrogeology or water resources management deepen the knowledge of regional geology and various specialized topics. Discussing complex problems in the field in groups develops communication and problem solving skills.								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting
	Various Field Seminars in Applied Geosciences	FC	op	-	3	A	-	ng	-
	Depending on the type and workload of field seminars variable numbers of credits points can be awarded to individual field seminars. The module is complete when the activities add up to 9 days of field work. The applied nature of field seminars needs to be approved prior to participation.								
Applicability	M.Sc. Applied & Environmental Geoscience								
Prerequisites	Fundamentals in hydrogeology, environmental chemistry and applied geosciences								

Module Number: M 227	Module Title: Sustainable Environmental Biotechnology Systems 1				Type of Module: M.Sc. Elective				
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 90 h (6 SWS)			Private Studies: 90 h			
Duration Module Coordinator	1 semester				Angenent				
Regular Cycle	every summer semester								
Language	English								
Learning- / Teaching Forms	The module combines class room lectures and field trips.								
Module Content	This course will offer a systems approach to understand energy systems that include a bioprocessing step, such as anaerobic digestion, anaerobic fermentation, microbial fuel cells, and photobioreactors with algae. In general, this course focuses on biomass-to-bioenergy conversion, including introduction to major treatment steps, such as pretreatment steps, fermentation steps, and product separation steps. The course integrates physics, engineering, environmental impacts, economics, and sustainable development. Different energy generation technologies will be compared to gain an understanding of the advantages and limitations of these technologies. Students are expected to be interested in and appreciate the need for quantitative aspects of energy systems. An emphasis of this course is technical and economic analysis of large-scale energy systems and their conceptual design.								
Qualification Goals	This course is intended to students to gain the capabilities to: 1. Use a systems approach to design renewable bioenergy systems. 2. Explain the energy conversion processes for biomass systems. 3. Evaluate the advantages and limitations of renewable bioenergy systems. 4. Assess a system by using nontechnical factors (environmental impacts, economics, and sustainable development) during the design phase. 5. Identify which information is missing during the design phase.								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirements	Duration of Exam	Grading System	Weighting
	Sustainable Environmental Biotechnology Systems 1	L	c	3	6	A	-	g	0,5
		E	c	3		A	-	g	0,5
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience, M.Sc. Biologie								
Prerequisites	Basic knowledge in microbiology or chemistry or physics or geosciences or engineering								

Module Number: M 228	Module Title: Sustainable Environmental Biotechnology Systems 2				Type of Module: M.Sc. Elective				
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 90 h (6 SWS)			Private Studies: 90 h			
Duration Module Coordinator	1 semester				Angenent				
Regular Cycle	every winter semester								
Language	English								
Learning- / Teaching Forms	The module combines class room lectures and a group design project.								
Module Content	This course will offer a systems approach to understand energy systems that include a bioprocessing step, such as anaerobic digestion, anaerobic fermentation, microbial fuel cells, and photobioreactors with algae. In general, this course focuses on biomass-to-bioenergy conversion, including introduction to major treatment steps, such as pretreatment steps, fermentation steps, and product separation steps. The course integrates physics, engineering, environmental impacts, economics, and sustainable development. Different energy generation technologies will be compared to gain an understanding of the advantages and limitations of these technologies. Students are expected to be interested in and appreciate the need for quantitative aspects of energy systems. An emphasis of this course is technical and economic analysis of large-scale energy systems and their conceptual design.								
Qualification Goals	This course is intended to students to use the capabilities from Sustainable Environmental Biotechnology Systems 1 to: 1. Excel in a team-oriented design experience, focused on the application of renewable bioenergy technologies. 2. Design a "real life" renewable bioenergy system.								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirements	Duration of Exam	Grading System	Weighting
	Sustainable Environmental Biotechnology Systems 2	L	c	2	6	A	-	g	1
		E	c	4					
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geocology, M.Sc. Applied & Environmental Geoscience, M.Sc. Biologie								
Prerequisites	Basic knowledge in microbiology or chemistry or physics or geosciences or engineering "Sustainable Environmental Biotechnology Systems 1"								

Module Number: M 230	Module Title: Geosphere-Biosphere Interactions			Type of Module: M.Sc. Compulsory / Elective						
Credits (ECTS)	6									
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 90 h / 6 SWS			Private Study: 90 h				
Duration Module Coordinator	1 semester			Dippold						
Regular Cycle	every summer semester									
Language	English									
Learning- / Teaching Forms	A wide spectrum of teaching methods is to be used comprising lectures with interactive self-preparation sessions, exercises, and presentations. The practical course will cover a complete experimental setup including field experiment, laboratory analysis, data analysis and result presentation and thus will teach practical, multi-step scientific project work.									
Module Content	The course will focus on biogeochemical interactions between the Geosphere and the Biosphere and will start with an introduction into the biogeochemical cycles (C, N, P, S, Fe, water). Thereafter, key interactions at bio-geochemical interfaces will be analyzed process-based regarding their impact on and feedbacks between bio- and geosphere. These processes include weathering and multidirectional fluxes by plant roots (rhizosphere processes), lichens and biofilms, bioturbation by animals, erosion (and its prevention by living organisms), and many more.									
Qualification Goals	Students are familiar with the processes at biogeochemical interfaces including an understanding on feedback mechanisms of bio-geosphere interactions. They have the ability to identify such interfaces, describe them and design experimental approaches to quantitatively describe the magnitude of interaction e.g. of biogeochemical fluxes from bio- to geosphere and vice versa.									
Requirements for Obtaining Credit, Grading, Weight if appl.	<i>Courses</i>	<i>Type of Lecture</i>	<i>Status</i>	<i>CH</i>	<i>CP</i>	<i>Type of Exam / Study Requirement</i>	<i>Duration of Exam</i>	<i>Grading System</i>	<i>Weighting</i>	
		<i>Geosphere-Biosphere Interactions</i>	V	c						2
			Ü	c						4
Applicability	M.Sc. Geoökologie/Geoecology; M.Sc. Applied & Environmental Geoscience									
Prerequisites										

Module Number: M 232	Module Title: Internship				Type of Module: M.Sc. Elective				
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: -			Private Study: 180 h			
Duration Module coordinator	4 weeks				Glotzbach				
Regular Cycle	every semester								
Language	English								
Learning- / Teaching Forms	Work experience								
Module Content	The module consists of a 4-week internship in a company or consultancy active in the field of geoscience, geoecology and /or environmental consulting.								
Qualification Goals	Students get practical training and contact potential employers. They acquire work experience in the occupational fields dealing with geoscientific and environmental topics. They bring their theoretical knowledge into practice and improve presentation and discussion skills.								
Requirements for Obtaining Credit, Grading, Weight if appl.		Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting
	Internship	PR	c	-	-	R	-	ng	
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience								
Prerequisites	-								

Module Number: M 233	Module Title: Biotransformation of Pollutants			Type of Module: M.Sc. Elective						
Credits (ECTS)	6									
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 45 h / 3 SWS		Private Study: 135 h					
Duration Module Coordinator	1 semester			Fabregat						
Regular Cycle	every winter semester									
Language	English									
Learning- / Teaching Forms	Lectures, presentation by students, group projects									
Module Content	• Environmental significance of different pollutant classes • Geochemical principles controlling the abiotic transformation of pollutants • Physiological and biochemical basis for biotransformation of pollutants • Differences between environmental systems and compartments within systems determining pollutant turnover • Transformation reactions and pathways for various organic (e.g. BTEX, chlorinated hydrocarbons) and inorganic pollutants (e.g. radionuclides, nitrate) • Advances in applied remediation techniques and methods to assess pollutant turnover									
Qualification Goals	• Gain knowledge about prominent pollutant compound classes present in the environment as well as their abiotic and biotic transformation reactions • Learn how environmental conditions affect abiotic and biotic pollutant turnover • Apply knowledge gained over the semester to design remediation schemes at contaminated sites and monitor remediation progress									
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting	
		Biotransformation of pollutants	L	c	1	2	R	-	g	1
			S	c	2	4				
Applicability	M.Sc. Geoökologie/Geocology, M.Sc. Applied & Environmental Geoscience									
Prerequisites	Content from M.Sc. module "Environmental Chemistry" Basic knowledge about environmental microbiology (recommended)									

Module Number: M 236	Module Title: Modelling for Sustainable River Management			Type of Module: M.Sc. Elective					
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 60 h / 4 SWS			Private Study: 120 h			
Duration Module Coordinator	1 semester				Zarfl				
Regular Cycle	every summer semester								
Language	English								
Learning- / Teaching Forms	Lecture and accompanying seminar (exercises, presentations, discussions)								
Module Content	• Introduction into different mathematical modelling approaches to describe environmental processes with a specific focus on freshwater ecosystems (including differential systems but beyond), parameter estimation techniques and uncertainty analysis • Understanding interdependent environmental system dynamics within the (socio-)hydrological cycle across scales and system boundaries • Application of models to environmental challenges • Models as tools for decision/discussion support/ sustainable water management								
Qualification Goals	The students are familiar with a variety of modelling approaches and their suitability for specific research questions related to environmental processes. They can deal with uncertainty in parameter values and model structure; evaluate model results and simulated system dynamics. They are aware of current developments in environmental systems analysis and can discuss strengths and weaknesses of applied model approaches. Drawing from a solid understanding of mathematical modeling and socio-hydrological interdependencies, they can critically analyse the role of conceptual and mathematical models in decision support and sustainable water management across spatial and temporal scales.								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting
	Modelling and Simulation for Environmental Process Understanding	L	c	2	6	A	-	g	0.5
		S	c	2		R	-	g	0.5
Applicability	M.Sc. Geoökologie/Geoecologie, M.Sc. Applied & Environmental Geoscience								
Prerequisites	recommended: B.Sc. course "Modellierung in den Geo- und Umweltwissenschaften"								

Module Number: M 238	Module Title: Rhizosphere Processes in a Changing World			Type of Module: M.Sc. Elective					
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 80 h / 5 SWS			Private Study: 100 h			
Duration Module Coordinator	1 semester			Muehe					
Regular Cycle	block course, every winter semester								
Language	English								
Learning- / Teaching Forms	Lecture, Seminar (student presentation) and Practical (two-week lab project)								
Module Content	Soils are globally being degraded by human activity. Abundant and clean water resources are becoming scares. Food production is pushed to new limits to ensure feeding a growing population. Rhizosphere processes play a crucial role in all of these systems, and thus, can contribute to dealing with these global challenges. This course covers the different aspects of rhizosphere processes, namely root activity and growth, soil geochemistry and mineralogy, and soil microbial ecology. It evaluates their contribution in different environmental scenarios including food production, soil and water remediation, water filtration, and contamination.								
Qualification Goals	The learning goals are: 1. To develop the learner's ability to analyze multidisciplinary research literature (agriculture, biogeochemistry, microbial ecology, root-soil processes) and to professionally present it to an interdisciplinary audience. 2. To comprehend and analyze how root-microbe-mineral interactions link to plant productivity, food quality, water and soil health. 3. To envision ways of improving plant-microbe and/or soil traits to ultimately improve soil health, water quality, plant output, and food quality. 4. To evaluate differences in rhizosphere processes during a two-week long laboratory project. 5. To obtain an appreciation for sustainable agriculture in feeding a growing global population.								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CR	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting
	Rhizosphere Processes	L/S	c	2	6	R LP		g	1
	Laboratory Practical Project	PR	c	3					
Applicability	M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience, open to students from other departments if capacity allows								
Prerequisites	Basic competences in microbiology, (bio)geochemistry, soil science and/or plant science are required.								

Module Number: M 239	Module Title: Geo-Bio-Interactions in Tropical Landscapes of Kenya				Type of Module: M.Sc. Elective				
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 120 h / 8 SWS			Private Study: 60 h			
Duration Module Coordinator	1 Semester			Otieno, Dippold					
Regular Cycle	Wintersemester/Summersemester (March/April)								
Language	English								
Learning-/Teaching Forms	Besides transferring basic knowledge via lectures, the field course will include practical excercises in various landscape and ecological zones of Kenya (monitoring data will be collected, evaluated and scientifically discussed). Pre- and post-field trip presentations will deepen the understanding of relevant processes in the respective landscapes and ecosystems.								
Module Content	The module contains basic lectures on geology, geomorphology, hydrology, pedology and ecology of the visited landscapes with specific focus on Biosphere-Geosphere Interactions. The following landscapes and ecosystems will be covered: • Marine and costal ecosystems • Dry and humid savannah (several national parks and mzima springs) • Highland landscapes (rift valley formation, volcanism (Mt. Elgon) and inland lakes systems) • Tropical rainforests (national park) • Lake Victoria basin landscapes Anthropogenically affected areas will be characterized in parallel to their natural systems (mostly national parks) to understand human impact on African ecosystems. Collected knowledge and data will be summarized in scientific presentations at the end of the course.								
Qualification Goals	Students will gain a fundamental understanding of the processes shaping Geo- and Biosphere in tropical landscapes and be able to describe the ecosystems in detail. They will be able to characterize interactions between parent material, geomorphology, water availability and movement, soil development (WRB classification) and the living organisms and their ecological interactions of a broad set of tropical ecosystems and landscape units. Students will be able to describe and quantify human impact on tropical ecosystems.								
Requirements for obtaining Credit, Grading, Weight, etc.)	<i>Courses</i>	<i>Type of Lecture</i>	<i>Status</i>	<i>CH</i>	<i>CP</i>	<i>Type of Exam / Study Requirement</i>	<i>Duration of Exam</i>	<i>Grading System</i>	<i>Weighting</i>
	Field Course on Geo-Bio-Interactions in tropical landscapes of Kenya	<i>L,S</i>	<i>c</i>	<i>2</i>	<i>6</i>	<i>R</i>	<i>2 x 15 min</i>	<i>g</i>	<i>1</i>
		<i>FC</i>	<i>c</i>	<i>6</i>					
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology (can be used for Field Ecology 2), M.Sc. Applied and Environmental Geoscience								
Prerequisites	It is recommended but not obligatory to have participated in the module Geosphere-Biosphere Interactions (M 230).								

Module Number: M 240	Module Title: Isotopes in Ecosystem Sciences			Type of Module: M.Sc. Elective						
Credits (ECTS)	6									
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 90 h / 6 SWS			Private Study: 90 h				
Duration Module Coordinator	1 semester			Dippold, Stock						
Regular Cycle	every winter semester									
Language	English									
Learning- / Teaching Forms	A diverse spectrum of teaching methods is to be used comprising lectures with interactive video section on practical steps in the work with isotopes and individual exercises. Besides introducing into a wide field of possible isotope applications, the course aims to teach the skills in defending project concepts of isotope-based study designs. For this, an interactive seminar simulating a reviewer panel project defense situation will be organized.									
Module Content	The module starts with an introduction into isotope biogeochemistry and tracer-based approaches, the understanding of stabile and radioactive isotopes + methods to analyze them (incl. radiation protection). Thereafter, the focus will be on the isotope application in process based research, i.e. identifying processes and rates in C cycle and organic matter transformation in the terrestrial environment. What specifics occur at the interface plant-soil/biosphere-geosphere? How can incubation studies with isotopes contribute to our understanding on mineralization, soil-atmosphere interactions, contaminant degradation and microbial ecology? Comparable topics will be targeted in the nitrogen and phosphorus cycle always considering bulk or compound-specific isotope analysis. Additionally, water isotopes and their application in ecohydrology but also microbial growth dynamics will be targeted. Radiocarbon dating, erosion quantification, radionuclide-based imaging, and further methods, their advantages and shortcomings will be discussed.									
Qualification Goals	The course addresses M.Sc. students, who intend to use a set of isotope-based natural abundance or tracer methods. Students will learn to apply complex and potentially coupled isotope methods in scientific studies. They will learn to conceptualize an isotope-based study and to present its design and outcome in front of a theoretical reviewer panel simulating a proposal defense.									
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting	
		Isotopes in Ecosystem Sciences	L	c	3	6	R & A	15	g	1:1
			S/E	c	3					
Applicability	M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience									
Prerequisites										

Module Number: M 242	Module Title: Modeling of Reactions, Microbial Dynamics and Bioreactive Transport			Type of Module: M.Sc. Elective					
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h	Contact Time: 60 h / 4 SWS		Private Study: 120 h					
Duration Module Coordinator	1 semester		Cirpka						
Regular Cycle	every summer semester								
Language	English								
Learning- / Teaching Forms	Theoretical aspects of reaction and microbial dynamics and bioreactive transport are taught in ex-cathedra lecture sessions. Extensive computer exercise provide students with 'hands on' experiences in modeling (bio)reactive systems in mixed reactors and coupled to solute transport.								
Module Content	The module gives an introduction into mathematical and numerical modeling of reactions, inter-phase mass transfer, microbial dynamics, and reactive transport relevant for the fate of compounds and microorganisms in porous media. Topics include: • Modeling of mixed systems: ○ Mass balance considerations in mixed systems ○ Speciation calculation ○ Competitive sorption in equilibrium ○ Mass-transfer kinetics ○ Stoichiometry of bioreactions ○ Rate laws of microbial dynamics ○ Numerical simulation of isotope fractionation • Modeling of bioreactive transport ○ Coupled simulation of 1-D transport, microbial dynamics and turnover of reactants ○ Multi-dimensional, mixing-controlled bioreactive transport ○ Analysis of controlling factors								
Qualification Goals	Students can formulate mathematical models of reactive systems (with and without transport) and solve them numerically. They can critically assess which processes dominate under which conditions. They acquire key competences in the quantitative, process-based analysis of reactive systems influenced by microbial processes.								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting
	Modeling of Reactions, Microbial Dynamics and Bioreactive Transport	L	c	2	3	WE	120	g	0.5
		E	c	2	3	A			0.5
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoeology, M.Sc. Applied & Environmental Geoscience								
Prerequisites	Students have competences corresponding to those of the M.Sc. Modules "Groundwater Modeling 1" and "Environmental Chemistry". They have basic programing skills in Matlab.								

Module Number: M 243	Module Title: Tropical Ecology of South America		Type of Module: M.Sc. Elective
Credits (ECTS)	6		
Workload - Contact Time - Private Study	Workload: 180 h	Contact Time: 10 SWS	Private Studies: 30 h
Duration Module Coordinator	1 Semester	Ebner	
Regular Cycle	winter semester (every other year)		
Language	English		
Learning- / Teaching Forms	Field camp, excursions, seminar		
Module Content	This interdisciplinary course deals with the structure, function and dynamics of neotropical ecosystems under different geological, climatic and land-use-related conditions. To record bio-geo-interactions in South American habitats, methods used in botany, zoology, ecophysiology, paleontology, and anthropogeography as well as from earth and environmental sciences are applied. The following topics will be addressed: geology and geological history of South America, water and carbon balance of tropical forests, flora and fauna of different biomes, food relationships, bionics, bioindicators, characterization of river basins, shallow water ecosystems, water relationships between plants, soils and atmosphere, climate change today and in the past, land and forest management systems. Particular attention is paid to the importance of biological diversity for the stability and functionality of tropical ecosystems. Possibilities of sustainable land use while maintaining important ecosystem functions (such as recycling of water, sequestration of carbon, etc.), e.g. through agroforestry systems, are highlighted. The course is conducted in cooperation with various partner universities. The field trip is accompanied by a seminar on Neotropical ecosystems, focusing on the Atlantic rainforest of Brazil, with its, botanical, zoological, geological and climatic characteristics. Topics are: vegetation and soils of selected regions as a reflection of the climatic and geological boundary conditions, geology and earth history, nutrient and water relationships in tropical rainforests, biodiversity patterns, bioindicators, treetops as a pool of ideas for bionics, ecophysiology of epiphytes, climate change effects and adaptations, soils and agriculture, principles and methods of near-natural reforestation, agroforestry systems. The course ends with a summary of the results and a final exam.		
Qualification Goals	During the field camp, students learn to apply field methods for recording the natural conditions (e.g. vegetation recordings, describing soil profiles, creating geological maps, sediment analyses, measuring the microclimate and soil water balance, recording the animal population, bio-indicators), as well as measuring environmental processes (e.g. runoff quantities and particle load in streams, atmospheric deposition, plant-driven water and carbon fluxes), nutrient relationships (e.g. analysis of stomach contents of frogs) and reconstruction of ecosystem history (e.g. through pollen analysis). It provides a platform to expand species knowledge related to Neotropical fauna and flora. The data collected will be analyzed and discussed in terms of biodiversity patterns, ecosystem functions, response of neotropical ecosystems to climate change and anthropogenic influences. Various forms of land use (in particular agroforestry systems, cacao rubber, yerba mate, araucaria) are examined and evaluated with regard to their impact on biodiversity and ecosystem functions. A comparison of different forms of land use takes place in the context of global requirements and socio-economic conditions of the Global South.		

Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirements	Duration of Exam	Grading System	Weighting
	Preparatory seminar	L	c	2	6	WE	120	g	1
	Geoeological field internship Brazil (3 weeks)	S	c	10					
Applicability	M.Sc. Geoökologie/Geoecology, MSc Geowissenschaften, MSc Applied Environmental Geoscience, applicable in M.Sc. Evolution und Ökologie								
Prerequisites	Language course Portuguese is recommended								

Module Number: M 244	Module Title: Geothermal Reservoirs				Type of Module: M.Sc. Elective				
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 70 h / 5 SWS			Private Studies: 110 h			
Duration Module Coordinator	1 semester				Süß				
Regular Cycle	every summer semester								
Language	English								
Learning- / Teaching Forms	Lectures accompanied by exercises and computer tutorials & block course								
Module Content	• General introduction to principles of deep geothermal energy extraction • Understanding geothermal reservoir geology and reservoir dynamics • Exploration methods for geothermal reservoirs • Reservoir characterization techniques for geothermal reservoirs • Field development and economics of deep geothermal energy production								
Qualification Goals	The students with little or no background in deep subsurface exploration will learn about the key technologies needed to characterize the underground. This will include the mapping of reservoir rocks using seismic method and the quantification of reservoir volumes using well information. The students will learn the integration of the data into static and dynamic models for geothermal energy production, including the analysis of key uncertainties and their impact on the economic viability of a geothermal energy production project.								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirements	Duration of Exam	Grading System	Weighting
	Exploration of deep geothermal reservoirs	L, E	c	3	3	WE	45	g	50%
	Modelling of deep geothermal reservoirs	L, E	c	2	3	WE	45	g	50%
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Applied & Environmental Geoscience								
Prerequisites	Introduction to Geosciences or equivalent								

Module Number: M 245	Module Title: Physical Processes in Surface Waters				Type of Module: M.Sc. Elective				
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 60 h / 4 SWS			Private Studies: 120 h			
Duration Module Coordinator	1 Semester				Calamita, Zarfl				
Regular Cycle	every summer semester								
Language	English								
Learning- / Teaching Forms	Lecture and exercises								
Module Content	This course explores the fundamental physical processes that govern the behaviour of surface waters, including lakes, rivers, and reservoirs. Topics covered include fluid dynamics, thermal stratification, mixing processes, wave dynamics, and sediment transport. The course emphasizes the interaction between physical forces and water chemistry, biological systems, and environmental factors. Students will gain a comprehensive understanding of how physical processes influence water quality, ecosystem dynamics, and hydrological cycles, with practical applications in environmental management, water resource planning, and climate studies.								
Qualification Goals	• Develop a comprehensive understanding of the physical principles governing surface water flow, including hydrodynamics, wave mechanics and stratification. • Explain the interaction between flow processes and natural landscapes, including rivers, lakes and reservoirs, estuaries. • Analyze and quantify physical processes such as sediment transport, erosion, deposition, and pollutant dispersion in surface water systems. • Evaluate the impact of natural and anthropogenic influences, such as climate change, urbanization, and dam construction, on surface water dynamics. • Validate and interpret model results to support decision-making in water resource management.								
Requirements for Obtaining Credit, Grading, Weight if appl.	<i>Courses</i>	<i>Type of Lecture</i>	<i>Status</i>	<i>CH</i>	<i>CP</i>	<i>Type of Exam / Study Requirements</i>	<i>Duration of Exam</i>	<i>Grading System</i>	<i>Weighting</i>
	<i>Lecture</i>	<i>L</i>	<i>c</i>	<i>2</i>	6	A		g	100%
	<i>Seminar</i>	<i>S</i>	<i>c</i>	<i>2</i>					
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience								
Prerequisites	A firm background in mathematics, physics and chemistry is expected.								

Module Number: M 246	Module Title: Scientific Writing of a Thesis			Type of Module: M.Sc. Elective					
Credits (ECTS)	3								
Workload - Contact Time - Private Study	Workload: 90 h		Contact Time: 45 h / 3 SWS			Private Study: 45 h			
Duration Module Coordinator	1 semester				Muehe				
Regular Cycle	Winter semester								
Language	English								
Learning- / Teaching Forms	Online Zoom Lecture + Exercise/Tutorial								
Module Content	At the end of your degree program, you will complete a Master's thesis. This course is designed to (i) deepen your understanding of what a thesis entails and how to approach it, (ii) reduce writing-related stress and anxiety, and (iii) equip you with effective scientific writing strategies to improve writing efficiency and the clarity and quality of your work. We will begin by conveying the FAIR principle for scientific work, breaking down the structure of a thesis, with focused training on each section—abstract, introduction, material and methods, data presentation, results, discussion, and conclusions. Using your own data or mock data, you will practice writing each part, enabling you to leave the course with a clear thesis outline and practical tools to support your writing process. The course is exclusively online.								
Qualification Goals	The learning goals are: • To learn how to structure a thesis clearly and logically. • To understand the distinct purpose of each component of a thesis and what information it should communicate. • To develop effective strategies for planning and writing your thesis efficiently. • To practice using a precise, coherent scientific writing style to present your research narrative clearly. • To gain confidence in organizing your ideas and presenting your work in a professional, academically rigorous format. By the end of the course, you will be better prepared to begin and complete your Master's thesis with clarity, purpose, and confidence.								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CR	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting
	Scientific Writing of a Thesis	L/E	c	3	3	A/R	-	g	1
Applicability	M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience, M.Sc. Geoscience								
Prerequisites	From the 3 rd semester onward. By the time you begin this course, you should be close to starting or actively working on your M.Sc. thesis, ideally with two to three datasets already prepared in a graph-ready format.								

Module Number: M 301	Module Title: Physics of the Earth's Surface			Type of Module: M.Sc. Elective						
Credits (ECTS)	6									
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 90 h / 6 SWS		Private Study: 90 h					
Duration Module Coordinator	1 semester			Glotzbach						
Regular Cycle	every winter semester									
Language	English									
Learning- / Teaching Forms	This module includes a combination of lectures and exercises where the exercises include either computer exercises or scientific paper discussions related to the lecture topics.									
Module Content	This module gives an introduction into the physics of Earth's surface, with emphasis on processes shaping the Earth's surface on human and geological timescales. Most importantly an overview of the relevant cycles (energy, water, relevant elements/gases) acting on Earth's surface will be given. Specific topics addressed in the lecture include: • Earth's surface energy balance • Carbon and hydrological cycle and mass balance • How and why tectonics, topography, and climate interact over short and long (million year) timescales. • Physical and mathematical approaches for understanding erosion and sedimentation by rivers, hillslopes, glacial, and biotic processes. • Topics addressed in the exercises and discussion include: • Computer exercises using Arc or Q-GS to visualize and analyze Earth's surface • Computer exercises using Matlab and other software to investigate physical and geochemical processes discussed in lectures.									
Qualification Goals	Goals of this class center around enabling students to: • Understand the physics and relations between Earth's shaping processes on different temporal and spatial scales • Visualize, quantify and model Earth's surface processes using computer software tools. • Develop skills in critically reading scientific literature.									
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study	Duration of Exam	Grading System	Weighting	
		Physics of the Earth's Surface	L	c	4	4	WE	90	g	0,7
			E	c	2	2	R		g	0,3
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience This module compliments other geoscience, applied environmental geoscience and geoecology modules. Students are provided with the context for how the atmosphere (climate), hydrosphere, biosphere, and tectonic processes interact to produce the Earth's surface. It also complements modules in physical geography by providing a physics and math based understanding of surface processes active both human relevant, and geologic (million year) timescales.									
Prerequisites	Introductory geology									

Module Number: M 305	Module Title: Advanced Field Methods in Geoscience				Type of Module: M.Sc. Compulsory / Elective				
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h			Contact Time: circa 14 field days			Private Studies: 0-40 h		
Duration Module Coordinator	Block course, circa 14 days				Norton				
Regular Cycle	annual								
Language	English								
Learning- /Teaching Forms	Supervised field exercise in small groups. Mapping and analysis of geological data, in conjunction with report writing and graphical data presentation (geological maps, stratigraphic columns, cross sections, etc.)								
Module Content	One mapping course entails: • Geological mapping of an area, individually or in small groups • Drawing of a geological map, as well a graphical representation of the stratigraphy and/or lithological relationships in the form of stratigraphical columns, cross sections, etc. • Writing of a report that summarizes the observations and interpretation of the geology and geological history of the mapping area • Depending on the duration of the course, credits may need to be gained with additional assignments. This must be defined and announced by the course leader before the mapping course itself. These can be, for example, additional field days, participation in preparation seminars, home work, etc.								
Qualification Goals	Students learn to independently apply geological field methods and techniques and gain practical experience in the geological analysis of a new area. They will undertake measurements, determine lithologies and stratigraphic sequences and will put these in their spatial context. The ability to make geological maps, cross sections and stratigraphical columns is among the core competencies of a geoscientist.								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirements	Duration of Exam	Grading System	Weighting
	Advanced Field Methods in Geoscience	FC	c	6	6	A	-	g	1
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Applied & Environmental Geoscience								
Prerequisites	Successfully completed B.Sc. degree in geosciences								

Module Number: M 308	Module Title: Isotope Geochemistry				Type of Module: M.Sc. Elective				
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 90 h / 6 SWS			Private Study: 90 h			
Duration Module Coordinator	1 semester			Schönberg					
Regular Cycle	every winter semester								
Language	English								
Learning- / Teaching Forms	Lectures, exercises, oral and written presentations								
Module Content	The module consists of 3 main parts: 1. Theory of isotope geochemistry: Detailed view on applications of radiogenic isotope systems as geochemical indicators for assimilation and fractionated crystallization (AFC). U-Th disequilibrium dating and its applications. Heavy 'non-traditional' stable isotope systems (e.g. Cr, Fe, Mo) and their applications. 2. Theory of Mass spectrometry: Basic instrumental set-up of various mass spectrometers, focusing on systems used to determine isotope ratios. Isotope dilution for exact quantitative element concentration analysis. 3. Literature study: The experience gained during parts 1&2 of this module are applied to isotope geochemical literature. Papers published in international journals will be summarized in oral and written presentations.								
Qualification Goals	Upon completion of the module students: • have detailed knowledge how radiogenic isotope ratios can be used for the identification and quantification of magmatic processes • understand how the U-Th disequilibrium can be used in dating young rocks/minerals and those in turn allow statement about changes in climate and bioproductivity understand how stable isotope variations of heavy elements (transition metals) allow statements on the formation mineral deposits as well as in the field of environmental geochemistry can be used to identify sources of contamination • know the basic set-up of a mass spectrometer, the methodological differences with respect to other analytical techniques • will be able to assess the quality of published isotope data and the interpretations drawn from those								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting
	Isotope Geochemistry	L, E	c	3	3	WE	120	g	1
	Mass Spectrometry	L,E	c	2	2				
	Literature Study	E	c	1	1	R	-	-	-
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience								
Prerequisites	Basic knowledge from the B.Sc. Geowissenschaften or from a comparable B.Sc. degree								

Module Number: M 312	Module Title: Advanced Sedimentology			Type of Module: M.Sc. Elective					
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 90 h / 6 SWS			Private Study: 90 h			
Duration Module Coordinator	1 semester			NN					
Regular Cycle	Every winter semester								
Language	English								
Learning- / Teaching Forms	The range of sedimentary environments will be introduced in the seminars (4 ECTS). Homework exercises will include preparation for the exercises and will assist students to learn the lecture material. Accompanying exercises (2 ECTS) will involve the active discussion of case studies and exploration of methods for investigating sediments and sedimentary rocks.								
Module Content	This course will focus on modern (and Quaternary) sediments, by: • Reviewing the various environmental and climatic settings for the production, transport and deposition of different sediment types • Gaining familiarity with the range of analytical techniques used to characterise and quantify modern sedimentary environments • Placing sedimentary environments in the context of land-water-atmosphere interactions • Investigating changes in sedimentary environments through time, including Anthropocene and potential future changes Exercises will include the identification of different sediment types, exposure to a range of analytical techniques, and journal club discussions relating to the above.								
Qualification Goals	Students will gain familiarity with the different types of modern (and Quaternary) sedimentary environments as analogues for the sedimentary rocks covered in the Bachelor degree. They will be exposed to the various analytical techniques used for investigating and quantifying modern and Quaternary sedimentary processes. The skills learnt in this course will prepare students for dealing with a range of geological problems in active sedimentary environments, including addressing Anthropocene and future change.								
Requirements for Obtaining Credit, Grading, Weight if appl.	<i>Courses</i>	<i>Type of Lecture</i>	<i>Status</i>	<i>CH</i>	<i>CP</i>	<i>Type of Exam / Study Requirement</i>	<i>Duration of Exam</i>	<i>Grading System</i>	<i>Weighting</i>
	<i>Advanced sedimentology</i>	<i>S</i>	<i>c</i>	<i>4</i>	<i>4</i>	<i>A</i>	<i>-</i>	<i>g</i>	<i>1</i>
		<i>E</i>	<i>c</i>	<i>2</i>	<i>2</i>				
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Applied & Environmental Geoscience								
Prerequisites	Successfully completed B.Sc. degree in Geosciences or Advanced Environmental Geosciences.								

Module Number: M 315	Module Title: Glaciology			Type of Module: M.Sc. Elective					
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 90 h / 6 SWS		Private Studies: 90 h				
Duration Module Coordinator	1 semester			Weikusat					
Regular Cycle	every winter semester								
Language	English/German (can be held in German depending on students)								
Learning- / Teaching Forms	Two weeks block course including lectures, tutorials and exercises. Poster presentations								
Module Content	Topics covered in lectures and exercises: • Components of the earth's cryosphere in recent and palaeo-time scales • Cryosphere and climate (sea level) • Ice cores (palaeo-climate records) • Material ice (modifications, crystal structure, defects, physical properties) • Micro-dynamics of ice (deformation and recrystallization mechanisms) • Formation processes of natural ice (e.g. meteoric glacial ice, sea ice, ice shelf ice, marine ice) • Mass balance of glaciers and ice sheets (ablation and accumulation measurements and processes, e.g. melting, calving) • Ice dynamics (stress and strain, deformation modes, flow features, flow law) • Poster session on hot topics in glaciological research (exam): • basics poster preparation and presentation techniques • present a topic / recent research paper on a poster and a 5 min. oral presentation and 5 min questions / discussion								
Qualification Goals	During the course the students will: • Gather general knowledge of the field about the cryosphere and the related glaciological subtopics • Develop an understanding of the physical processes relevant for the cryosphere • Acquire an up to date overview of current glaciological research topics and being able to evaluate conclusions in a critical way • Acquire expertise in assessing cryosphere related information with respect to modern climate change discussions • Gather practical experience in simple ice core data processing and ice dynamic modelling (exercises and tutorials).								
Requirements for Obtaining Credit, Grading, Weight if appl.	<i>Courses</i>	<i>Type of Lecture</i>	<i>Status</i>	<i>CH</i>	<i>CP</i>	<i>Type of Exam / Study Requirement</i>	<i>Duration of Exam</i>	<i>Grading System</i>	<i>Weighting</i>
		<i>L</i>	<i>c</i>	<i>4</i>	<i>4</i>	<i>R</i>	<i>-</i>	<i>g</i>	<i>1</i>
		<i>E</i>	<i>c</i>	<i>1</i>	<i>1</i>				
		<i>S</i>	<i>c</i>	<i>1</i>	<i>1</i>				
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Applied & Environmental Geoscience The module covers topics related to the material of the core modules mineralogy, geodynamics and applied geosciences.								
Prerequisites	Fundamentals in geology/mineralogy and physics								

Module Number: M 317	Module Title: Data Analysis and Modeling Methods in Geoscience and Environmental Science				Type of Module: M.Sc. Compulsory / Elective				
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 2 x 24 h			Private Study: 2 x 66 h			
Duration Module Coordinator	1-2 semester				Drews				
Regular Cycle	every semester								
Language	English								
Learning- / Teaching Forms	Lectures and Computer Exercises for Data Analysis and Modeling								
Module Content	World-wide technical advances in monitoring the surface and sub-surface result in a new data environment for modern Geo- and Environmental sciences. Problem solving increasingly requires rigorous models and also integration of observations varying in space and time. Extracting the relevant information is achieved with computational methods that also require an understanding of the underlying mathematical principles. It is subdivided into units, such as: • Finite Element Method • Fourier- and Laplace-Transform Techniques • Geographical Information Systems • Introduction Scientific Programming (Python) • Introduction to Time Series Analysis • Principles of Model Calibration • Remote Sensing of River Systems Each unit counts for three credits. Students are free to select 2 units out of the units offered. Another 2 units can be used to fill a second container module M325 (Data-Analysis and Modeling Methods in Geo- and Environmental Sciences 2). The individual units are offered either over four weeks within the lecturing period of the semester, or as one-week block course. The selection of units may vary with the instructors from year to year. Some units require prior participation in other units of this module (check with instructors beforehand).								
Qualification Goals	The goals of this module are • that students are able to understand selected mathematical concepts • that they can implement them computationally, that they can apply them to geo- and environmental related problems • develop relevant technical skills for data analysis and modelling • applied problem solving skills using Matlab / Python / R								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study	Duration of Exam	Grading System	Weighting
	Variable Topics	L,E	c	2	3	R,A	-	g	1/2
	Variable Topics	L,E	c	2	3	R,A	-	g	1/2
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geosciences This module compliments other geology, geoecology, and environmental sciences courses (e.g. Advanced Geophysics, Climate Dynamics, Physics of the Earth's Surface) by providing a background for quantitative data analysis and modelling.								
Prerequisites	(TBD w.r.t. Python, Matlab, R)								

Module Number: M 321	Module Title: Experimental and Analytical Methods in Geo-science and Environmental Science			Type of Module: M.Sc. Compulsory / Elective					
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h	Contact Time: 90 h		Private Study: 90 h					
Duration Module Coordinator	1 semester		Schulz						
Regular Cycle	every winter semester								
Language	English								
Learning- / Teaching Forms	Laboratory exercises and lectures								
Module Content	The module is designed to advanced students to gain access to and knowledge of selected and frequently used analytical methods in geosciences, lectured by analytical experts/groups of the institute in theory and "hands on the machines". It is subdivided into units, such as: • Instrumental Chemical Analysis Methods • Introduction to Dating Rocks and Sediments • Introduction to Electron Microscopy • Methods of Structural Analysis: X-ray Diffraction and Infrared/Raman Spectroscopy • Wet Chemical Analysis of Major and Trace Elements Each unit counts for 2 credits. Students are free to select 3 units out of the units offered. More advanced techniques are offered in module M326 (Experimental and Analytical Methods in Geoscience and Environmental Science 2). The individual units are offered either over 4 weeks within the lecturing period of the semester, or as one-week block course. In small groups, the units allow direct contact to staff scientists, advanced laboratories and institute infrastructure. Group sizes are limited, based on the maximum available staff and laboratory capacities.								
Qualification Goals	The courses are designed to learn and test a variety of instrumental methods and to get familiar with the laboratory work flows and routines.								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting
	Variable Topics	L,E	c	2	2	R,A,OE	-	g	1/3
	Variable Topics	L,E	c	2	2	R,A,OE	-	g	1/3
	Variable Topics	L,E	c	2	2	R,A,OE	-	g	1/3
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geosciences								
Prerequisites	-								

Module Number: M 322	Module Title: Climate Dynamics			Type of Module: M.Sc. Elective					
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 60 h / 4 SWS			Private Study: 120 h			
Duration Module Coordinator	1 semester			Rehfeld					
Regular Cycle	every summer semester								
Language	English								
Learning- / Teaching Forms	Lectures introduce fundamental concepts of climatology, the physical processes governing the climate system on different space and time scales, and empirical ways to describe and detect climate change. In computer exercises, students learn to model basic physical processes in the atmosphere and apply classic and modern mathematical-statistical methods to describe, explain and predict different elements of the climate system.								
Module Content	This module offers an introduction to atmospheric processes, factors governing climate and climate change, links between climate and other Earth systems, and climate change of the past, present and future. Furthermore, it teaches the theoretical and practical knowledge of numerical models and mathematical-statistical techniques required for the description, explanation and prediction of climate. Module core content includes: • processes governing the climate system on different scales: from orbital and tectonic controls to fast local feedbacks • interactions between climate and other Earth systems (e.g. oceans and biosphere) • climate change and its causes in the past, present and future • physics-based numerical modelling of the atmosphere • common empirical tools for climatology								
Qualification Goals	Students have a basic understanding of the physical processes governing climate and climate change and are able to understand and apply basic numerical models and common empirical techniques to typical problems in climatology. The students will be able to apply these models and implement these tools as self-developed programming code.								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting
	Climate Dynamics	L	c	2	2	R	25	g	1
		E	c	2	2				
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience, M.Sc. Geographie								
Prerequisites	Knowledge of statistics and programming is useful, but not strictly required. No prior knowledge of climatology or meteorology is required.								

Module Number: M 324	Module Title: Economic Geology			Type of Module: M.Sc. Elective					
Credits (ECTS)	6								
Workload - Contact Time - Private Time	Workload: 180 h		Contact times: 90 h / 6 SWS			Private Studies: 90 h			
Duration Module Coordinator	1 semester				Walter				
Regular Cycle	every other summer semester								
Language	English / German (can be held in German depending on students)								
Learning- /Teaching Forms	The module consists of lectures, complemented by exercises, and reflected light microscopy practice								
Module Content	This module gives insights into the exploration and mining practices used by geologists in the mineral and metal mining sector. The lecture will cover initial theoretical exploration praxis to practical greenfield and brownfield exploration, mining development stages, and mining geology. The focus is set on drilling (methods, planning, supervising, logging), data handling (databases, QAQC – Quality Assurance Quality Control, modelling) and data reporting (JORC code). The practical part focusses on ore textures and their interpretation and the identification of ore and gangue minerals and frequent mineral assemblages by reflected light microscopy.								
Qualification Goals	In this module the students learn the methods and procedures of the international exploration and mining industry, independently of the commodity. A main aim is to learn the importance of data quality and data management throughout the exploration and mining stages. Graduates will be able to analyse ore minerals and their textures to establish genetic interpretations and identify economic and ecologic impacts.								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting
	Applied Economic Geology	L	c	3	3	WE	120	g	0.5
	Ore Petrology and Reflected Light Microscopy	L	c	1	3				0.5
		E	c	2					
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Applied & Environmental Geoscience The module is in close context to the M.Sc. module "Igneous Processes"								
Prerequisites	The completion of the B.Sc. module "Georessourcen" (or similar lecture, including basics in reflected light microscopy) is required.								

Module Number: M 325	Module Title: Data Analysis and Modeling Methods in Geoscience and Environmental Science 2				Type of Module: M.Sc. Elective				
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 2 x 24 h		Private Study: 2 x 66 h				
Duration Module Coordinator	1 semester			Drews					
Regular Cycle	every semester								
Language	English								
Learning- / Teaching Forms	Lectures and Computer Exercises for Data Analysis and Modeling								
Module Content	This module is for students who want to increase their knowledge about data analysis and modeling methods acquired in module M317 (Data Analysis and Modeling Methods in Geoscience and Environmental Science 1). The content of the module is described in module M317. The individual units are offered either over four weeks within the lecturing period of the semester, or as one-week block course. The selection of additional 2 units out of the units offered in M317 can be used to fill module M325 (each unit counts for three credits). Some units require prior participation in other units of this module (check with instructors beforehand).								
Qualification Goals	The goals of this module are • that students are able to understand selected mathematical concepts • that they can implement them computationally, that they can apply them to geo- and environmental related problems • develop relevant technical skills for data analysis and modelling • applied problem solving skills using Matlab / Python / R								
Requirements for Obtaining Credit, Grading, Weight if appl.	<i>Courses</i>	<i>Type of Lecture</i>	<i>Status</i>	<i>CH</i>	<i>CP</i>	<i>Type of Exam / Study</i>	<i>Duration of Exam</i>	<i>Grading System</i>	<i>Weighting</i>
	<i>Variable Topics</i>	<i>L,E</i>	<i>c</i>	<i>2</i>	<i>3</i>	<i>R,A</i>	<i>-</i>	<i>g</i>	<i>1/2</i>
	<i>Variable Topics</i>	<i>L,E</i>	<i>c</i>	<i>2</i>	<i>3</i>	<i>R,A</i>	<i>-</i>	<i>g</i>	<i>1/2</i>
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geosciences This module compliments other geology, geoecology, and environmental sciences courses (e.g. Advanced Geophysics, Climate Dynamics, Physics of the Earth's Surface) by providing a background for quantitative data analysis and modelling.								
Prerequisites	(TBD w.r.t. Python, Matlab, R)								

Module Number: M 326	Module Title: Experimental and Analytical Methods in Geo- science and Environmental Science 2				Type of Module: M.Sc. Elective				
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 90 h			Private Study: 90 h			
Duration Module Coordinator	1 semester			Schulz					
Regular Cycle	every summer semester								
Language	English								
Learning- / Teaching Forms	Lectures and laboratory exercises								
Module Content	The module is for students deeply interested in analytical methods. It offers access to more "advanced" techniques. It is subdivided into units, such as: • Advanced Methods for Dating Rocks and Sediments • Dating Quaternary Sediments • Focused Ion Beam and Volume Electron Microscopy Each unit counts for 2 credits. Students are free to select 3 units out of the units offered, including the units offered in module M321 (Experimental and Analytical Methods in Geoscience and Environmental Science 1). In small groups, the units allow direct contact to staff scientists, advanced laboratories and institute infrastructure. Group sizes are limited, based on the maximum available staff and laboratory capacities. The individual units are offered either over 4 weeks within the lecturing period of the semester, or as one-week block course.								
Qualification Goals	The courses are designed to learn and to test a variety of specific instrumental methods and to get familiar with the laboratory work flows and routines.								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirement	Duration of Exam	Grading System	Weighting
	Variable Topics	L,E	c	2	2	R,A,OE	-	g	1/3
	Variable Topics	L,E	c	2	2	R,A,OE	-	g	1/3
	Variable Topics	L,E	c	2	2	R,A,OE	-	g	1/3
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geosciences								
Prerequisites	-								

Module Number: M 409	Module Title: Marine Geology and Geochemistry				Type of Module: M.Sc. Elective				
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 90 h / 6 SWS			Private Studies: 90 h			
Duration Module Coordinator	1 semester				Schulz				
Regular Cycle	every winter semester								
Language	English								
Learning- /Teaching Forms	Teacher-centered teaching; studying literature on the subject, talk/exposé, handouts, laboratory practice.								
Module Content	• Evolution and structure of ocean basins and –margins • Marine sedimentation and –accumulation • Marine natural resources • Ocean circulation/effects of currents and waves • Chemical evolution of the ocean system • Natural and anthropogenic tracers • Methods of survey and sampling								
Qualification Goals	Students will understand the marine-geological processes between the ocean floor, sedimentation, ocean circulation and the biogeochemical cycles. Candidates learn to analyse and interpret the modern depositional facies, and how to describe elemental fluxes and –fractionations of the oceans. Laboratory and methodological practice on sediment processing and -characterization will provide skills and competence using the large variety of sediment core profiles from the Tübingen repository.								
Requirements for Obtaining Credit, Grading, Weight if appl.	Courses	Type of Lecture	Status	CH	CP	Type of Exam / Study Requirements	Duration of Exam	Grading System	Weighting
	Marine Geochemistry	L,S	c		2	R	-	g	1
	Marine Geology	L,S	c		2				
	Marine Geology	E	c		2				
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience Related M.Sc. modules are "Paleoecology of Marine Systems", "Isotope Geochemistry" and "Carbonate Facies Analysis"								
Prerequisites	B.Sc. modules "Einführung in die Geowissenschaften", "Erdgeschichte", "Sedimente und Stratigraphie", "Paläontologie" Course limited to 14 students.								