EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN

Module Handbook

as at: 08.04.24

Geoökologie / Geoecology
Master of Science

Faculty of Science
Department of Geosciences

Contents

1. Admission Requirements

The prerequisites for the study program M.Sc. Geoökologie/Geoecology are

- a Bachelor's degree (or equivalent) in Geoecology or a related program covering basically the same material or an equivalent degree in environmental or natural sciences with an overall grade equivalent to or better than 2,5 (German grading system).
- a proof of knowledge of English at least at the level of B2 of the Common European Framework of Reference for Languages (CEFR)
- broad and fundamental training in natural sciences with a specialisation in Geoecology or environmental sciences which means that the following subjects should be proved by the transcript of the Bachelor's degree:
  At least
  - 6 CP mathematics
  - 6 CP physics
  - 12 CP chemistry
  - 6 CP geology
  - 6 CP biology of organisms
  - 3 CP microbiology
  - 6 CP soil science
  - 6 CP ecology
  - 6 CP hydrology and climatology
  - 3 CP environmental chemistry
  - 6 CP quantitative data processing / modelling / GIS
  - 15 days field work

If courses up to 30 CP are lacking, an admission is possible with the condition to catch up these courses within the framework of a learning agreement.

2. Qualification Goals

The Master's program in Geoökologie / Geoecology aims at a deeper understanding of the complex interactions between the biosphere and the geosphere under the impact of human activities. The study program should enable students to understand natural ecosystems and their alteration by humans, to develop and implement individual mitigation measures and assess their impacts. The study program is research-oriented and builds on a sound quantitative scientific undergraduate education. It addresses advanced students with a special interest in environmental geosciences and ecology, who have acquired profound environmental and natural science knowledge from a Bachelor's degree in geoecology or a similar scientific study program.

In the Master's course, students deepen their understanding of natural and anthropogenically influenced environmental systems and can thus describe and quantify the matter and energy cycles therein. Professorships with strong research skills guarantee a wide range of interesting theses, also in cooperation with international partners.

Based on a broad scientific education, geoecologists can identify environmental problems that arise through human use of the earth's ecosystem and develop sustainable solutions. Towards this end, they apply quantitative scientific methods. Therefore, graduates of the course have good chances on the job market in various areas such as:

- Advice to public decision-makers, private companies and private individuals,
- Public service at ministries and offices at federal, state or municipal level,
- Environmental research or environmental analysis at universities, research institutes or in industry

The wide-ranging and renowned research in the environmental field at the University of Tübingen also offers a variety of doctorate opportunities. The good contacts to universities in Germany and abroad make it easier to access doctoral studies at other institutes as well.

3. Module Overview

The Master's degree in Geoökologie / Geoecology is designed for a standard study period of two years.

For a successful degree, students acquire 120 credit points from a program of compulsory modules (24 CP), elective modules (66 CP) and the Master's thesis (30 CP).

Compulsory Modules and Specializations

The compulsory program for all students of the M.Sc. Geoecology includes the module *Geosphere-Biosphere Interactions* and the *M.Sc. Seminar Geoecology* in the first year. Two modules, *Scientific Practice* and *Scientific Presentation* complete the compulsory courses.

The aim of the *Scientific Practice* module is to impart important practical and methodological skills in the conception, planning and implementation of scientific research projects and to include these within a planned written project, usually representing the Master's thesis. The *Scientific Presentation* module serves to acquire communication and presentation skills. Students learn to communicate and discuss their research using various forms of presentations. This module encompasses three parts: 1) a presentation in a Master's seminar, 2) a prepared lecture within the working group, and 3) the completion of a poster with the results of the Master's thesis which will be presented to an expert audience.

Students are requested to choose one of the following three specializations:

- Biogeoscience of the Land Surface
- Ecology and Nature Conservation
- Environmental Chemistry and Ecotoxicology

In each specialization, five modules are defined that contain basic study content required for the respective subject. To guarantee an interdisciplinary geoecological education, at least one module (6 CP) from the department of biology must be completed.

The specialization in **Biogeoscience of the Land Surface** focuses on geosphere-biosphere interactions under human impacts in soils and on the land surface. In this specialization the following modules are compulsory:

- Biodiversity and Ecosystem Functioning
- Environmental Microbiology and Geomicrobiology
- Geomorphology and Soil-Landscape Modeling
- Physics of the Earth's Surface
- Planetary Boundaries

The specialization in **Ecology and Nature Conservation** focuses on the functioning of ecosystems and their protection. In this specialization the following modules are compulsory:

- Biotic Interactions: Plant-Animal Interaction

- Conservation Palaeoecology
- Field Ecology II
- Global Change Ecology II
- Plant Ecology II

The specialization in **Environmental Chemistry and Ecotoxicology** focuses on the behavior of chemicals in the environment and their effects on biota. In this specialization the following modules are compulsory:

- Advanced Ecotoxicology
- Environmental and Human Health Risk Assessment of Chemicals
- Environmental Chemistry
- Environmental Chemistry Lab
- Experimental and Analytical Methods in Environmental Chemistry and Ecotoxicology

The remaining elective program comprises 36 credit points, that can be chosen among the modules listed in this Module Handbook, including modules that are mandatory for a specialization not taken by the student. This list includes a non-university internship (Module 232, Internship), which is not graded, but counts with 6 CP for the Master's degree.

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. However, only a maximum of 12 credit points from Bachelor's degree programs may be admitted, and only those that were not yet completed in the previous Bachelor's degree.

Medium of Instruction

Modules in the compulsory area and in the specializations are offered in English. In the elective area, modules in German can also be chosen.

Specialization Biogeoscience of the Land Surface

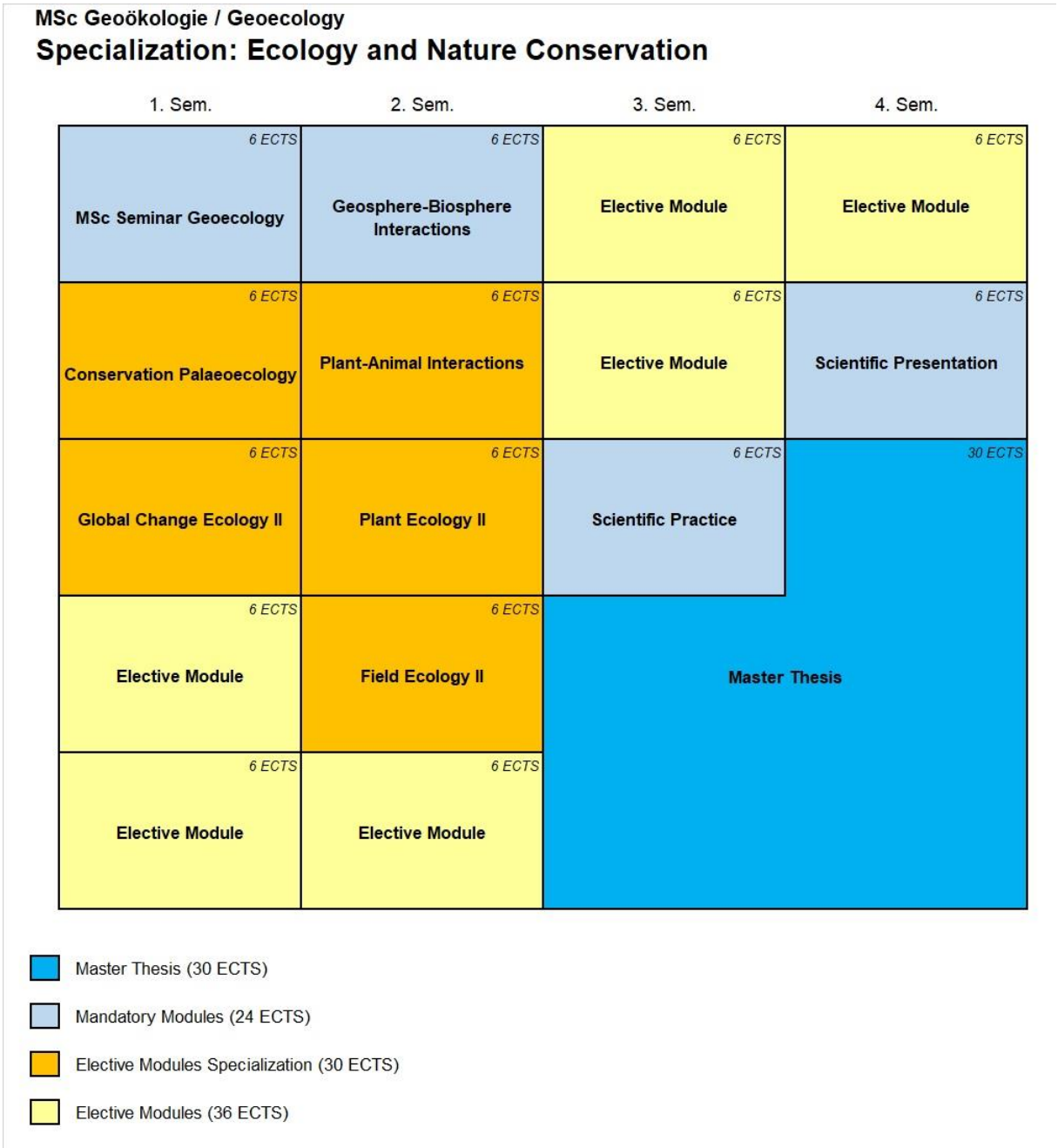
MSc Geoökologie / Geoecology

Specialization: Biogeoscience of the Land Surface

1. Sem.	2. Sem.	3. Sem.	4. Sem.
6 ECTS **MSc Seminar Geoecology**	6 ECTS **Geosphere-Biosphere Interactions**	6 ECTS **Elective Module**	6 ECTS **Elective Module**
6 ECTS **Physics of the Earth's Surface**	6 ECTS **Environmental Microbiology and Geomicrobiology**	6 ECTS **Elective Module**	6 ECTS **Scientific Presentation**
6 ECTS **GEO 77 Geomorphology and Soil-Landscape Modeling**	6 ECTS **GEO 87 Biodiversity and Ecosystem Functioning**	6 ECTS **Scientific Practice**	30 ECTS **Master Thesis**
6 ECTS **Elective Module**	6 ECTS **GEO 85 Planetary Boundaries**		
6 ECTS **Elective Module**	6 ECTS **Elective Module**		

- Master Thesis (30 ECTS)
- Mandatory Modules (24 ECTS)
- Elective Modules Specialization (30 ECTS)
- Elective Modules (36 ECTS)

Specialization Ecology and Nature Conservation



Specialization Environmental Chemistry and Ecotoxicology

MSc Geoökologie / Geoecology

Specialization: Environmental Chemistry and Ecotoxicology

1. Sem.	2. Sem.	3. Sem.	4. Sem.
6 ECTS **MSc Seminar Geoecology**	6 ECTS **Geosphere-Biosphere Interactions**	6 ECTS **Elective Module**	6 ECTS **Elective Module**
6 ECTS **Advanced Ecotoxicology**	6 ECTS **Experimental and Analytical Methods in Environmental Chemistry & Ecotoxicology**	6 ECTS **Elective Module**	6 ECTS **Scientific Presentation**
6 ECTS **Environmental Chemistry**	6 ECTS **Elective Module**	6 ECTS **Scientific Practice**	30 ECTS **Master Thesis**
6 ECTS **Environmental and Human Health Risk Assessment of Chemicals**	6 ECTS **Elective Module**		
6 ECTS **Lab Course Environmental Chemistry**	6 ECTS **Elective Module**		

- Master Thesis (30 ECTS)
- Mandatory Modules (24 ECTS)
- Elective Modules Specialization (30 ECTS)
- Elective Modules (36 ECTS)

4. Module Handbook M.Sc. Geoökologie / Geoecology

This module handbook serves as a comprehensive overview for the Master's Degree in Geoecology in the Geosciences and Biology Departments of the Science Faculty at the University of Tübingen.

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

Legende		**Legend**	
Benotungssystem:	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 = assignment / term paper, written report R = report, presentation LP = lab protocol / journal SP = successful participation
Prüfungsdauer:	Dauer der Prüfung in *min*	**Duration of Assessment:**	Duration of the assessment in *min*
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:**	Credit Points (ECTS)

Compulsory Modules

Module Number	*Module Title*	*Module Coordinator*	*CP*	*Semes-ter*
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 230	Geosphere-Biosphere Interactions	Dippold	6	S
M 231	M.Sc. Seminar Geoecology	Drucker	6	W

Elective Modules

Module Number	*Module Title*	*Module Coordinator*	*CP*	*Semes-ter*
Modules Applied Geosciences				
M 201	Groundwater Modeling 1	Cirpka	6	W
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 207	Environmental Chemistry	Zarfl	6	W
M 208	Environmental Isotope Chemistry	Taubald	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 213	GIS and Remote Sensing	Schäuble, Lörcher	6	W
M 214	Geotechnical Engineering	Leven	6	W
M 218	Environmental Analytical Chemistry	Zwiener	6	W
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 227	Sustainable Environmental Biotechnology Systems 1	Angenent	6	S
M 228	Sustainable Environmental Biotechnology Systems 2	Angenent	6	W
M 229	Global Change	Rehfeld	6	W
M 232	Internship	Glotzbach	6	W / S

M 233	Biotransformation of Pollutants	Joshi	6	W
M 236	Modelling for Sustainable River Management	Zarfl	6	S
M 238	Rhizosphere Processes in a Changing World	Mühe	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 241	Climate Modeling	Rehfeld	6	S
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
Modules Mineralogy and Geology				
M 301	Physics of the Earth's Surface	Glotzbach	6	W
M 308	Isotope Geochemistry	Schönberg	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, Berthold	6	W
M 322	Climate Dynamics	Rehfeld	6	S
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, Berthold	6	S
Modules Biogeology				
M 401	Terrestrial Ecosystems – excavation and laboratory internship	Böhme	6	S
M 402	Evolution of Organisms	Werneburg	6	W
M 403	Palaeoecology of Terrestrial Ecosystems	Bocherens	6	S
M 404	Micropaleontology	Junginger	6	W, every other year
M 405	Palaeoecology of Marine Ecosystems	Nebelsick	6	W
M 407	Conservation Palaeoecology	Bocherens	6	W
M 408	Vertebrates and Plants of the Cenozoic	Böhme	6	W
M 409	Marine Geology und Geochemistry	Schulz	6	W
M 503	Paleobotany/Palynology	Böhme	6	W
Modules Geography				
GEO 75	Klimawandel	Hochschild	6	W
GEO 76	Angewandte Geoinformatik	Braun	6	W

GEO 77	Geomorphology and Soil – Landscape Modeling	Scholten	6	W
GEO 78	Bodenschutz	Lehmann	6	W
GEO 85	Planetary Boundaries	Oelmann	6	W
GEO 87	Biodiversity and Ecosystem Functioning	Oelmann	6	S
GEO 88	Angewandte Fernerkundung	Hochschild	6	S
GEO 97	Isotope-Based Ecosystem Analysis	Oelmann	6	W

Modules of the Department of Biology				
Module Number	*Module Title*	*Module Coordinator*	*CP*	*Semes-ter*
M 234	Experimental and Analytical Methods in Environmental Chemistry & Ecotoxicology	Köhler	6	W / S
M 235	Advanced Ecotoxicology	Köhler, Triebskorn	6	W
M 237	Field Ecology II	Tielbörger	6	S / W
3012	Entomologie I: Evolution und Ökologie der Insekten	Betz	6	S
3013	Entomologie III (Morphologisch Systematische. Übungen)	Weber	6	S
3032	Limnologie	Peschke	6	S
3051	Ökologie und Vegetation der Alpen	Stoll	6	S
3052	Ökologie des Wattenmeers	Triebskorn	6	S
3053	Ökotoxikologie 1	Köhler, Triebskorn	6	W
3054	Ökotoxikologie 2	Köhler, Triebskorn	6	W
3072	Exkursion/Geländepraktikum: Vertebraten II Wirbeltiere im Freiland	Weber	6	S
3074	Scientific Writing Skills	Anthes	6	W
3079	Ökotoxikologie 3	Köhler, Triebskorn	6	W
3081	Vertebraten III: Morphologisch-Systematische Übungen	Weber	12	W
3094	Entomologie II: Morphologie und Systematik der Arthropo-den	Betz	6	W
3098	Biomimetics of Animal Constructions	Betz, Nebelsick	6	W
3099	Bodenökologie	Betz	6	W
3102	Global Change Ecology II	Thomassen	6	W
3108	Theoretical Ecology II / Matrix modeling	Stoll	6	S
3132	Biotic Interactions: Plant-Animal Interaction	Majekova	6	S
3141	Nutzpflanzenkunde	Kehl	6	W
3143	Landscape Genetics	Thomassen	6	W

3150	Invertebraten: Zoologische Übungen an der Meeresbiologischen Station Roscoff	Weber	6	W
3154	Evolutionäre Ökologie der Pflanzen	Bossdorf	6	W
3177	Lebensraum Schwäbische Alb	Peschke	6	S
3186	Botanik II	Kehl	6	S
3197	Entomologie IV	Weber	6	S
4007	Macroevolutionary and Microevolutionary Analysis	Förster	6	W
4008	Advanced Biometry	Tielbörger	6	W
4009	Essentials in Evolutionary Biology	Michiels	6	W
4030	Exkursion nach Schwedisch-Lappland (Abisko)	Harter	9	S
4048	Funktions- und Ökomorpholgie der Invertebraten	Betz	6	W
4052	Behavioural Ecology 1	Förster	6	W
4060	Behavioural Ecology 2	Förster	6	W
4118	Visual Ecology	Michiels, Santon	6	W
4134	Introduction to „R"	Tomiolo	3	W
4144	Vegetationsökologie und Ornithologie in Israel / Dryland Ecology	Tielbörger	9	W
4213	Naturschutz in der Praxis (Applied Nature Conservation)	Tielbörger	6	S
4214	Plant Ecology II	Majekova	6	S
4238	Excursions in Plant Microbe Interactions / Exkursion: Pflanzen-Mikroben-Interaktionen	Kemen	3	S
4239	Communicating Science	Gunn	6	S
Bio-ZMBP	Applications of electron microscopy in cell biology, microbiology and virology	Fischer	6	W
Occasional Modules				
3136	Marine Biodiversity: Indonesia	Michiels	6	W

Additional Elective Modules				
Module Number	*Module Title*	*Module Coordinator*	*CP*	*Semester*
	Umweltrecht I: Allgemeine Lehren und Immissionsschutzrecht	Saurer	6	W
	Umweltrecht II: Naturschutz-, Wasser- und Umweltenergierecht	Saurer	3	S
T@T WiSe 23/24_SoSe 24	Biogeochemistry of Soil Contamination	Mehrnoosh Gol-Soltani	6	W 23/24 / S 24

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 3rd 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 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.	*Courses*	*Type of Lecture*	*Status*	*CH*	*CP*	*Type of Exam / Study Requirement*	*Duration of Exam*	*Grading System*	*Weighting*
	Geosphere-Biosphere Interactions	*V*	*c*	*2*	*6*	*OE*	*20*	*g*	*1*
		Ü	*c*	*4*					
Applicability	Compulsory: M.Sc. Geoökologie/Geoecology; Elective: M.Sc. Applied & Environmental Geoscience								
Prerequisites									

Module Number: **M 231**	Module Title: **M.Sc. Seminar Geoecology**								Type of Module: M.Sc. Compulsory
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				Drucker				
Regular Cycle	every winter semester								
Language	English								
Learning- / Teaching Forms	Lecture, Seminar								
Module Content	The goal of this module is to provide students with an overview of advanced topics in geoecology. To this aim, three sessions will be given by instructors representing the three master specializations "Biogeoscience of the Land Surface", "Environmental Chemistry and Ecotoxicology" and "Ecology and Nature Conservation". This will be followed by student presentations on seminal works or hot topics publications of the covered disciplines and areas of research of the specializations. Students' seminars will consist of an oral presentation followed by discussions and/or debates under the supervision of the involved instructors. Integrative and holistic approaches including both geo – and biological sciences will be highlighted in both lectures and seminars.								
Qualification Goals	By the end of the seminar, students will have in in-depth knowledge of the content and perspectives of the specializations offered by the Master in Geoecology. They will learn about the topics of research and application in the different covered fields								
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*
	Talks by Instructors	*L*	*c*	*2*	*6*	*SP*	*-*		*-*
	Presentation of a Talk	*S*	*c*			*R*	*-*	*g*	*1*
	14 Seminar Attendances	*S*	*c*			*SP*	*-*	*-*	
Applicability	M.Sc. Geoökologie/Geoecology								
Prerequisites									

<table>
<tr><td>Module Number:
M 201</td><td colspan="4">Module Title:
Groundwater Modeling 1</td><td>Type of Module:
M.Sc. Compulsory / Elective</td></tr>
<tr><td>Credits (ECTS)</td><td colspan="5">6</td></tr>
<tr><td>Workload
- Contact Time
- Private Study</td><td colspan="2">Workload:
180 h</td><td colspan="2">Contact Time:
90 h / 6 SWS</td><td>Private Study:
90 h</td></tr>
<tr><td>Duration
Module Coordinator</td><td colspan="3">1 semester</td><td colspan="2">Cirpka</td></tr>
<tr><td>Regular Cycle</td><td colspan="5">every winter semester (1st semester)</td></tr>
<tr><td>Language</td><td colspan="5">English</td></tr>
<tr><td>Learning- / Teaching Forms</td><td colspan="5">Ex-cathedra lecture sessions and computer exercises</td></tr>
<tr><td>Module Content</td><td colspan="5">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</td></tr>
<tr><td>Qualification Goals</td><td colspan="5">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.</td></tr>
<tr><td rowspan="3">Requirements for Obtaining Credit, Grading, Weight if appl.</td><td>Courses</td><td>Type of Lecture</td><td>Status</td><td>CH</td><td>CP</td><td>Type of Exam / Study Requirement</td><td>Duration of Exam</td><td>Grading System</td><td>Weighting</td></tr>
<tr><td rowspan="2">Groundwater Modeling 1</td><td>L</td><td>c</td><td>4</td><td>3</td><td rowspan="2">WE</td><td rowspan="2">90</td><td rowspan="2">g</td><td rowspan="2">1</td></tr>
<tr><td>E</td><td>c</td><td>2</td><td>3</td></tr>
<tr><td>Applicability</td><td colspan="5">Compulsory: M.Sc. Applied & Environmental Geoscience; Elective: M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology</td></tr>
<tr><td>Prerequisites</td><td colspan="5">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.</td></tr>
</table>

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 is 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".								

<table>
<tr><td>Module Number:
M 203</td><td colspan="4">Module Title:
Groundwater Modeling 2</td><td>Type of Module:
M.Sc. Elective</td></tr>
<tr><td>Credits (ECTS)</td><td colspan="5">6</td></tr>
<tr><td>Workload
- Contact Time
- Private Study</td><td colspan="2">Workload:
180 h</td><td colspan="2">Contact Time:
90 h / 6 SWS</td><td>Private Study:
90 h</td></tr>
<tr><td>Duration
Module Coordinator</td><td colspan="3">1 semester</td><td colspan="2">Yuan</td></tr>
<tr><td>Regular Cycle</td><td colspan="5">every summer semester (recommended 2nd semester)</td></tr>
<tr><td>Language</td><td colspan="5">English</td></tr>
<tr><td>Learning- / Teaching Forms</td><td colspan="5">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.</td></tr>
<tr><td>Module Content</td><td colspan="5">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</td></tr>
<tr><td>Qualification Goals</td><td colspan="5">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).</td></tr>
<tr><td rowspan="3">Requirements for Obtaining Credit, Grading, Weight if appl.</td><td>Courses</td><td>Type of Lecture</td><td>Status</td><td>CH</td><td>CP</td><td>Type of Exam / Study Requirement</td><td>Duration of Exam</td><td>Grading System</td><td>Weighting</td></tr>
<tr><td rowspan="2">Groundwater Modeling 2</td><td>L</td><td>c</td><td>4</td><td>4</td><td rowspan="2">WE</td><td rowspan="2">180</td><td rowspan="2">g</td><td rowspan="2">1</td></tr>
<tr><td>E</td><td>c</td><td>2</td><td>2</td></tr>
<tr><td>Applicability</td><td colspan="5">M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience</td></tr>
<tr><td>Prerequisites</td><td colspan="5">Students have competences corresponding to those of the MSc Module Groundwater Modeling 1. They have basic programing skills in Matlab.</td></tr>
</table>

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 3rd 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 3rd 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/Geoecology, M.Sc. Applied & Environmental Geoscience								
Prerequisites	Competences corresponding to the M.Sc. modules "Grondwater Modeling 1" and "Groundwater Modeling 2"								

<table>
<tr><td>Module Number:
M 207</td><td colspan="5">Module Title:
Environmental Chemistry</td><td colspan="4">Type of Module:
M.Sc. Compulsory / Elective</td></tr>
<tr><td>Credits (ECTS)</td><td colspan="9">6</td></tr>
<tr><td>Workload
- Contact Time
- Private Study</td><td colspan="3">Workload:
180 h</td><td colspan="3">Contact Time:
90 h / 6 SWS</td><td colspan="3">Private Study:
90 h</td></tr>
<tr><td>Duration
Module coordinator</td><td colspan="4">1 semester</td><td colspan="5">Zarfl</td></tr>
<tr><td>Regular Cycle</td><td colspan="9">every winter semester (recommended for 1st semester)</td></tr>
<tr><td>Language</td><td colspan="9">English</td></tr>
<tr><td>Learning- / Teaching Forms</td><td colspan="9">Lectures, Exercises, Tutorial, Team work</td></tr>
<tr><td>Module Content</td><td colspan="9">• Chemical thermodynamics in aqueous systems
• Sorption and partitioning processes of organic and inorganic compounds
• Sorption kinetics
• Practical applications and case studies</td></tr>
<tr><td>Qualification Goals</td><td colspan="9">• 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</td></tr>
<tr><td rowspan="4">Requirements for Obtaining Credit, Grading, Weight if appl.</td><td>Courses</td><td>Type of Lecture</td><td>Status</td><td>CH</td><td>CP</td><td>Type of Exam / Study Requirement</td><td>Duration of Exam</td><td>Grading System</td><td>Weighting</td></tr>
<tr><td>Environmental Chemistry Lecture</td><td>L</td><td>c</td><td>2</td><td rowspan="3">6</td><td rowspan="3">WE</td><td rowspan="3">120</td><td rowspan="3">g</td><td rowspan="3">1</td></tr>
<tr><td>Environmental Chemistry Exercises</td><td>E</td><td>c</td><td>2</td></tr>
<tr><td>Environmental Chemistry Tutorials</td><td>E</td><td>op</td><td>2</td></tr>
<tr><td>Applicability</td><td colspan="9">Compulsory: M.Sc. Applied & Environmental Geoscience, Elective: M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology</td></tr>
<tr><td>Prerequisites</td><td colspan="9">Basic knowledge in chemistry, physics, hydrogeology</td></tr>
</table>

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	Taubald	
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.	*Courses*	*Type of Lecture*	*Status*	*CH*	*CP*	*Type of Exam / Study Requirement*	*Duration of Exam*	*Grading System*	*Weighting*
	Inorganic Environmental Isotope Chemistry	*L*	*c*	*2*	*3*	*WE*	*120*	*g*	*0,5*
	Inorganic Environmental Isotope Chemistry Exercises	*E*	*c*	*1*					
	Organic Environmental Isotope Chemistry	*L*	*c*	*2*	*3*	*A*	*120*	*g*	*0,5*
	Organic Environmental Isotope Chemistry Exercises	*E*	*c*	*1*					

Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience
Prerequisites	Basic knowledge in chemistry and physics for geoscientists

<table>
<tr><td>Module Number:
M 209</td><td colspan="4">Module Title:
Environmental Chemistry Lab
(Environmental Chemistry 3)</td><td colspan="4">Type of Module:
M.Sc. Elective</td></tr>
<tr><td>Credits (ECTS)</td><td colspan="8">6</td></tr>
<tr><td>Workload
- Contact Time
- Private Study</td><td colspan="2">Workload:
180 h</td><td colspan="3">Contact Time:
90 h / 6 SWS</td><td colspan="3">Private Study:
90 h</td></tr>
<tr><td>Duration
Module coordinator</td><td colspan="4">1 semester</td><td colspan="4">Haderlein</td></tr>
<tr><td>Regular Cycle</td><td colspan="8">every winter semester</td></tr>
<tr><td>Language</td><td colspan="8">English</td></tr>
<tr><td>Learning- / Teaching Forms</td><td colspan="8">Lab experiments in small teams; project, seminar</td></tr>
<tr><td>Module Content</td><td colspan="8">• 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</td></tr>
<tr><td>Qualification Goals</td><td colspan="8">• 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.</td></tr>
<tr><td rowspan="4">Requirements for Obtaining Credit, Grading, Weight if appl.</td><td>Courses</td><td>Type of Lecture</td><td>Status</td><td>CH</td><td>CP</td><td>Type of Exam / Study Requirement</td><td>Duration of Exam</td><td>Grading System</td><td>Weighting</td></tr>
<tr><td rowspan="3">Environmental Chemistry Lab</td><td>LC</td><td>c</td><td>5</td><td rowspan="2">6</td><td>SP</td><td>-</td><td>g</td><td>0,4</td></tr>
<tr><td>PR</td><td>c</td><td>1</td><td>LP</td><td>-</td><td>g</td><td>0,6</td></tr>
<tr><td colspan="8">Grading is based on the lab performance, lab protocols and final report; no final exam.</td></tr>
<tr><td>Applicability</td><td colspan="8">M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology,
M.Sc. Applied & Environmental Geoscience</td></tr>
<tr><td>Prerequisites</td><td colspan="8">General chemistry; aquatic chemistry; microbiology on B.Sc. level
M.Sc. module "Environmental Chemistry 1"</td></tr>
</table>

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								

<table>
<tr><td>Module Number:
M 211</td><td colspan="5">Module Title:
Geomicrobiology Lab Course</td><td colspan="4">Type of Module:
M.Sc. Elective</td></tr>
<tr><td>Credits (ECTS)</td><td colspan="9">6</td></tr>
<tr><td>Workload
- Contact Time
- Private Study</td><td colspan="3">Workload:
180 h</td><td colspan="3">Contact Time:
90 h</td><td colspan="3">Private Study:
90 h</td></tr>
<tr><td>Duration
Module coordinator</td><td colspan="5">2 weeks lab course; report writing afterwards</td><td colspan="4">Kappler</td></tr>
<tr><td>Regular Cycle</td><td colspan="9">every summer semester</td></tr>
<tr><td>Language</td><td colspan="9">English</td></tr>
<tr><td>Learning- / Teaching Forms</td><td colspan="9">Lab exercises</td></tr>
<tr><td>Module Content</td><td colspan="9">• 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</td></tr>
<tr><td>Qualification Goals</td><td colspan="9">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</td></tr>
<tr><td rowspan="3">Requirements for Obtaining Credit, Grading, Weight if appl.</td><td>Courses</td><td>Type of Lecture</td><td>Status</td><td>CH</td><td>CP</td><td>Type of Exam / Study Requirement</td><td>Duration of Exam</td><td>Grading System</td><td>Weighting</td></tr>
<tr><td rowspan="2">Geomicrobiology Lab</td><td rowspan="2">LC</td><td rowspan="2">c</td><td rowspan="2">6</td><td rowspan="2">6</td><td>SP</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>R</td><td>-</td><td>g</td><td>1</td></tr>
<tr><td>Applicability</td><td colspan="9">M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience</td></tr>
<tr><td>Prerequisites</td><td colspan="9">Geomicrobiology; basic knowledge in microbial physiology and in microbial ecology</td></tr>
</table>

<table>
<tr><td>Module Number:
M 213</td><td colspan="6">Module Title:
GIS and Remote Sensing</td><td>Type of Module:
M.Sc. Elective</td></tr>
<tr><td>Credits (ECTS)</td><td colspan="7">6</td></tr>
<tr><td>Workload
- Contact Time
- Private Study</td><td colspan="2">Workload:
180 h</td><td colspan="3">Contact Time:
75 h / 5 SWS</td><td colspan="2">Private Study:
105 h</td></tr>
<tr><td>Duration
Module Coordinator</td><td colspan="3">1 semester</td><td colspan="4">Schäuble, Lörcher</td></tr>
<tr><td>Regular Cycle</td><td colspan="7">every winter semester</td></tr>
<tr><td>Language</td><td colspan="7">English</td></tr>
<tr><td>Learning- / Teaching Forms</td><td colspan="7">Lectures and accompanying guided computer exercises, project assignment.</td></tr>
<tr><td>Module Content</td><td colspan="7">• 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</td></tr>
<tr><td>Qualification Goals</td><td colspan="7">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.</td></tr>
<tr><td rowspan="3">Requirements for Obtaining Credit, Grading, Weight if appl.</td><td>Courses</td><td>Type of Lecture</td><td>Status</td><td>CH</td><td>CP</td><td>Type of Exam / Study Requirement</td><td>Duration of Exam</td><td>Grading System</td><td>Weighting</td></tr>
<tr><td rowspan="2">Geographical information systems and Remote Sensing</td><td>L</td><td>c</td><td>2</td><td rowspan="2">6</td><td rowspan="2">A</td><td rowspan="2">-</td><td rowspan="2">g</td><td rowspan="2">1</td></tr>
<tr><td>E</td><td>c</td><td>2</td></tr>
<tr><td>Applicability</td><td colspan="7">M.Sc. Applied & Environmental Geoscience, (M.Sc. Geowissenschaften/Geosciences and M.Sc. Geoökologie/Geoecology if capacity allows)</td></tr>
<tr><td>Prerequisites</td><td colspan="7">Smartphone (Android, iOS or other brand)</td></tr>
</table>

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 geotechnical 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. Geoecology if capacity allows) It is related to other method-oriented modules of applied geosciences (e.g. Hydrogeological Field Investigations Techniques, Haydrogeologie and Water Chemistry, Geophysics).								
Prerequisites	Basic physical, mathematical, and geological knowledge								

<table>
<tr><td>Module Number:
M 218</td><td colspan="4">Module Title:
Environmental Analytical Chemistry</td><td colspan="4">Type of Module:
M.Sc. Elective</td></tr>
<tr><td>Credits (ECTS)</td><td colspan="8">6</td></tr>
<tr><td>Workload
- Contact Time
- Private Study</td><td colspan="2">Workload:
180 h</td><td colspan="3">Contact Time:
90 h / 6 SWS</td><td colspan="3">Private Study:
90 h</td></tr>
<tr><td>Duration
Module Coordinator</td><td colspan="4">1 semester</td><td colspan="4">Zwiener</td></tr>
<tr><td>Regular Cycle</td><td colspan="8">every winter semester (recommended for the 1st semester)</td></tr>
<tr><td>Language</td><td colspan="8">English</td></tr>
<tr><td>Learning- / Teaching Forms</td><td colspan="8">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.</td></tr>
<tr><td>Module Content</td><td colspan="8">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</td></tr>
<tr><td>Qualification Goals</td><td colspan="8">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.</td></tr>
<tr><td rowspan="3">Requirements for Obtaining Credit, Grading, Weight if appl.</td><td>Courses</td><td>Type of Lecture</td><td>Status</td><td>CH</td><td>CP</td><td>Type of Exam / Study Requirement</td><td>Duration of Exam</td><td>Grading System</td><td>Weighting</td></tr>
<tr><td rowspan="2">Environmental Analytical Chemistry</td><td>L</td><td>c</td><td>3</td><td>3</td><td>WE</td><td>120</td><td>g</td><td>0,5</td></tr>
<tr><td>LC</td><td>c</td><td>3</td><td>3</td><td>LP</td><td>-</td><td>g</td><td>0,5</td></tr>
<tr><td>Applicability</td><td colspan="8">M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience</td></tr>
<tr><td>Prerequisites</td><td colspan="8">Basic knowledge in chemistry, environmental analytics and statistics</td></tr>
</table>

<table>
<tr><td>Module Number:
M 221</td><td colspan="4">Module Title:
Environmental and Human Health Risk Assessment of Chemicals</td><td>Type of Module:
M.Sc. Elective</td></tr>
<tr><td>Credits (ECTS)</td><td colspan="6">6</td></tr>
<tr><td>Workload
- Contact Time
- Private Study</td><td colspan="2">Workload:
180 h</td><td colspan="2">Contact Time:
60 h / 2 SWS + 1 week block course</td><td colspan="2">Private Study:
120 h</td></tr>
<tr><td>Duration
Module Coordinator</td><td colspan="3">1 semester + 1st week of March (block course)</td><td colspan="3">Escher</td></tr>
<tr><td>Regular Cycle</td><td colspan="6">every winter semester</td></tr>
<tr><td>Language</td><td colspan="6">English</td></tr>
<tr><td>Learning- / Teaching Forms</td><td colspan="6">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 the first week of 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.</td></tr>
<tr><td>Module Content</td><td colspan="6">• 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</td></tr>
<tr><td>Qualification Goals</td><td colspan="6">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.</td></tr>
<tr><td rowspan="4">Requirements for Obtaining Credit, Grading, Weight if appl.</td><td>Courses</td><td>Type of Lecture</td><td>Status</td><td>CH</td><td>CP</td><td>Type of Exam / Study Requirement</td><td>Duration of Exam</td><td>Grading System</td><td>Weighting</td></tr>
<tr><td rowspan="3">Environmental Risk Assessment</td><td>L</td><td>c</td><td>2</td><td rowspan="3">6</td><td>A</td><td>-</td><td>g</td><td>1</td></tr>
<tr><td>S</td><td>c</td><td>2</td><td>R</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td></td><td></td><td></td><td></td><td>-</td><td>-</td><td>-</td></tr>
</table>

Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, 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".

<table>
<tr><td>Module Number:
M 227</td><td colspan="4">Module Title:
Sustainable Environmental Biotechnology Systems 1</td><td colspan="4">Type of Module:
M.Sc. Elective</td></tr>
<tr><td>Credits (ECTS)</td><td colspan="8">6</td></tr>
<tr><td>Workload
- Contact Time
- Private Study</td><td colspan="2">Workload:
180 h</td><td colspan="3">Contact Time:
90 h (6 SWS)</td><td colspan="3">Private Studies:
90 h</td></tr>
<tr><td>Duration
Module Coordinator</td><td colspan="4">1 semester</td><td colspan="4">Angenent</td></tr>
<tr><td>Regular Cycle</td><td colspan="8">every summer semester</td></tr>
<tr><td>Language</td><td colspan="8">English</td></tr>
<tr><td>Learning- / Teaching Forms</td><td colspan="8">The module combines class room lectures and field trips.</td></tr>
<tr><td>Module Content</td><td colspan="8">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.</td></tr>
<tr><td>Qualification Goals</td><td colspan="8">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.</td></tr>
<tr><td rowspan="3">Requirements for Obtaining Credit, Grading, Weight if appl.</td><td>Courses</td><td>Type of Lecture</td><td>Status</td><td>CH</td><td>CP</td><td>Type of Exam / Study Requirements</td><td>Duration of Exam</td><td>Grading System</td><td>Weighting</td></tr>
<tr><td rowspan="2">Sustainable Environmental Biotechnology Systems 1</td><td>L</td><td>c</td><td>3</td><td rowspan="2">6</td><td>A</td><td>-</td><td>g</td><td>0,5</td></tr>
<tr><td>E</td><td>c</td><td>3</td><td>A</td><td>-</td><td>g</td><td>0,5</td></tr>
<tr><td>Applicability</td><td colspan="8">M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience, M.Sc. Biologie</td></tr>
<tr><td>Prerequisites</td><td colspan="8">Basic knowledge in microbiology or chemistry or physics or geosciences or engineering</td></tr>
</table>

<table>
<tr><td>Module Number:
M 228</td><td colspan="4">Module Title:
Sustainable Environmental Biotechnology Systems 2</td><td>Type of Module:
M.Sc. Elective</td></tr>
<tr><td>Credits (ECTS)</td><td colspan="5">6</td></tr>
<tr><td>Workload
- Contact Time
- Private Study</td><td colspan="2">Workload:
180 h</td><td colspan="2">Contact Time:
90 h (6 SWS)</td><td>Private Studies:
90 h</td></tr>
<tr><td>Duration
Module Coordinator</td><td colspan="3">1 semester</td><td colspan="2">Angenent</td></tr>
<tr><td>Regular Cycle</td><td colspan="5">every winter semester</td></tr>
<tr><td>Language</td><td colspan="5">English</td></tr>
<tr><td>Learning- / Teaching Forms</td><td colspan="5">The module combines class room lectures and a group design project.</td></tr>
<tr><td>Module Content</td><td colspan="5">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.</td></tr>
<tr><td>Qualification Goals</td><td colspan="5">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.</td></tr>
<tr><td rowspan="3">Requirements for Obtaining Credit, Grading, Weight if appl.</td><td>Courses</td><td>Type of Lecture</td><td>Status</td><td>CH</td><td>CP</td><td>Type of Exam / Study Requirements</td><td>Duration of Exam</td><td>Grading System</td><td>Weighting</td></tr>
<tr><td rowspan="2">Sustainable Environmental Biotechnology Systems 2</td><td>L</td><td>c</td><td>2</td><td rowspan="2">6</td><td rowspan="2">A</td><td rowspan="2">-</td><td rowspan="2">g</td><td rowspan="2">1</td></tr>
<tr><td>E</td><td>c</td><td>4</td></tr>
<tr><td>Applicability</td><td colspan="5">M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience, M.Sc. Biologie</td></tr>
<tr><td>Prerequisites</td><td colspan="5">Basic knowledge in microbiology or chemistry or physics or geosciences or engineering
"Sustainable Environmental Biotechnology Systems 1"</td></tr>
</table>

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	Compulsory: M.Sc. Applied & Environmental Geoscience; Elective: M.Sc. Geoökologie/Geoecology								
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 aquire 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.	*Courses*	*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				Joshi				
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/Geoecology, M.Sc. Applied & Environmental Geoscience								
Prerequisites	Content from M.Sc. module "Environmental Chemistry" Basic knowledge about environmental microbiology (recommended)								

<table>
<tr><td>Module Number:
M 236</td><td colspan="4">Module Title:
Modelling for Sustainable River Management</td><td>Type of Module:
M.Sc. Elective</td></tr>
<tr><td>Credits (ECTS)</td><td colspan="5">6</td></tr>
<tr><td>Workload
- Contact Time
- Private Study</td><td colspan="2">Workload:
180 h</td><td colspan="2">Contact Time:
60 h / 4 SWS</td><td>Private Study:
120 h</td></tr>
<tr><td>Duration
Module Coordinator</td><td colspan="3">1 semester</td><td colspan="2">Zarfl</td></tr>
<tr><td>Regular Cycle</td><td colspan="5">every summer semester</td></tr>
<tr><td>Language</td><td colspan="5">English</td></tr>
<tr><td>Learning- / Teaching Forms</td><td colspan="5">Lecture and accompanying seminar (exercises, presentations, discussions)</td></tr>
<tr><td>Module Content</td><td colspan="5">• 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</td></tr>
<tr><td>Qualification Goals</td><td colspan="5">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.</td></tr>
<tr><td rowspan="3">Requirements for Obtaining Credit, Grading, Weight if appl.</td><td>Courses</td><td>Type of Lecture</td><td>Status</td><td>CH</td><td>CP</td><td>Type of Exam / Study Requirement</td><td>Duration of Exam</td><td>Grading System</td><td>Weighting</td></tr>
<tr><td rowspan="2">Modelling and Simulation for Environmental Process Understanding</td><td>L</td><td>c</td><td>2</td><td rowspan="2">6</td><td>A</td><td>-</td><td>g</td><td>0.5</td></tr>
<tr><td>S</td><td>c</td><td>2</td><td>R</td><td>-</td><td>g</td><td>0.5</td></tr>
<tr><td>Applicability</td><td colspan="5">M.Sc. Geoökologie/Geoecologie, M.Sc. Applied & Environmental Geoscience</td></tr>
<tr><td>Prerequisites</td><td colspan="5">recommended: B.Sc. course "Modellierung in den Geo- und Umweltwissenschaften"</td></tr>
</table>

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				Mühe				
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 transfering 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.)	*Courses*	*Type of Lecture*	*Status*	*CH*	*CP*	*Type of Exam / Study Requirement*	*Duration of Exam*	*Grading System*	*Weighting*
	Field Course on Geo-Bio-Interactions in tropical landscapes of Kenya	*L,S* *FC*	*c* *c*	*2* *6*	*6*	*R*	*2 x 15 min*	*g*	*1*
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									

<table>
<tr><td>Module Number:
M 241</td><td colspan="4">Module Title:
Climate Modelling</td><td colspan="4">Type of Module:
M.Sc. Elective</td></tr>
<tr><td>Credits (ECTS)</td><td colspan="8">6</td></tr>
<tr><td>Workload
- Contact Time
- Private Study</td><td colspan="2">Workload:
180 h</td><td colspan="3">Contact Time:
60 h / 4 SWS</td><td colspan="3">Private Study:
120 h</td></tr>
<tr><td>Duration
Module Coordinator</td><td colspan="4">1 semester</td><td colspan="4">Rehfeld</td></tr>
<tr><td>Regular Cycle</td><td colspan="8">every summer semester</td></tr>
<tr><td>Language</td><td colspan="8">English</td></tr>
<tr><td>Learning- / Teaching Forms</td><td colspan="8">Climate models are a powerful tool for understanding climate change, and are continuously growing more detailed and accurate. Models help us to work through complicated problems and understand complex systems.
Lectures introduce how the climate system is represented in models. In the *exercises*, students experiment with models, and learn the practical programming required for climate data analysis and scientific understanding of global warming. The exercise includes *tutorials* that enable students to run simulations with an Earth System Model of Intermediate Complexity. Students document and present their results at the end of the course in a *term paper*.</td></tr>
<tr><td>Module Content</td><td colspan="8">The module will cover fundamentals of climate systems, climate components, energy balance, key climate drivers and the hierarchy of climate models. This will include box models, models of intermediate complexity and fully coupled models. It will explain the underlying basics and the numerical formulation of the fundamental equations in climate models, including parameterisation of processes not directly resolved by the climate model. This module will further emphasize on radiation and convection schemes in model and the aspects determining climate sensitivity to greenhouse gas increase.
Specifically, this module will address the following questions:
• What equations do climate models solve?
• How do climate models solve these equations?
• What components of the climate system are represented in climate models?
• What are the capabilities and limitations of these models?
• How do we evaluate the performance of climate models?</td></tr>
<tr><td>Qualification Goals</td><td colspan="8">At the end of this course students will be able to:
• Understand the fundamental physics in climate models.
• Assess the quality of model results.
• Analyze the output and document their findings.</td></tr>
<tr><td rowspan="3">Requirements for Obtaining Credit, Grading, Weight if appl.</td><td>Courses</td><td>Type of Lecture</td><td>Status</td><td>CH</td><td>CP</td><td>Type of Exam / Study Requirement</td><td>Duration of Exam</td><td>Grading System</td><td>Weighting</td></tr>
<tr><td rowspan="2">Climate Modelling</td><td>L</td><td>c</td><td>2</td><td>2</td><td rowspan="2">A/R</td><td rowspan="2">25</td><td rowspan="2">g</td><td rowspan="2">1</td></tr>
<tr><td>E</td><td>c</td><td>2</td><td>2</td></tr>
<tr><td>Applicability</td><td colspan="8">M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience</td></tr>
<tr><td>Prerequisites</td><td colspan="8">Advanced knowledge on the climate system *or* advanced programming experience is required.</td></tr>
</table>

<table>
<tr><td>Module Number:
M 242</td><td colspan="4">Module Title:
Modeling of Reactions, Microbial Dynamics and Bioreactive Transport</td><td>Type of Module:
M.Sc. Elective</td></tr>
<tr><td>Credits (ECTS)</td><td colspan="5">6</td></tr>
<tr><td>Workload
- Contact Time
- Private Study</td><td colspan="2">Workload:
180 h</td><td colspan="2">Contact Time:
60 h / 4 SWS</td><td>Private Study:
120 h</td></tr>
<tr><td>Duration
Module Coordinator</td><td colspan="3">1 semester</td><td colspan="2">Cirpka</td></tr>
<tr><td>Regular Cycle</td><td colspan="5">every summer semester</td></tr>
<tr><td>Language</td><td colspan="5">English</td></tr>
<tr><td>Learning- / Teaching Forms</td><td colspan="5">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.</td></tr>
<tr><td>Module Content</td><td colspan="5">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:
o Mass balance considerations in mixed systems
o Speciation calculation
o Competitive sorption in equilibrium
o Mass-transfer kinetics
o Stoichiometry of bioreactions
o Rate laws of microbial dynamics
o Numerical simulation of isotope fractionation
• Modeling of bioreactive transport
o Coupled simulation of 1-D transport, microbial dynamics and turnover of reactants
o Multi-dimensional, mixing-controlled bioreactive transport
o Analysis of controlling factors</td></tr>
<tr><td>Qualification Goals</td><td colspan="5">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.</td></tr>
<tr><td rowspan="3">Requirements for Obtaining Credit, Grading, Weight if appl.</td><td>Courses</td><td>Type of Lecture</td><td>Status</td><td>CH</td><td>CP</td><td>Type of Exam / Study Requirement</td><td>Duration of Exam</td><td>Grading System</td><td>Weighting</td></tr>
<tr><td rowspan="2">Modeling of Reactions, Microbial Dynamics and Bioreactive Transport</td><td>L</td><td>c</td><td>2</td><td>3</td><td>WE</td><td rowspan="2">120</td><td rowspan="2">g</td><td>0.5</td></tr>
<tr><td>E</td><td>c</td><td>2</td><td>3</td><td>A</td><td>0.5</td></tr>
<tr><td>Applicability</td><td colspan="5">M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geoscience</td></tr>
<tr><td>Prerequisites</td><td colspan="5">Students have competences corresponding to those of the M.Sc. Modules "Groundwater Modeling 1" and "Environmental Chemistry". They have basic programing skills in Matlab.</td></tr>
</table>

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 n 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*
	Geoecological 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								

<table>
<tr><td>Module Number:
M 301</td><td colspan="4">Module Title:
Physics of the Earth’s Surface</td><td>Type of Module:
M.Sc. Elective</td></tr>
<tr><td>Credits (ECTS)</td><td colspan="6">6</td></tr>
<tr><td>Workload
- Contact Time
- Private Study</td><td colspan="2">Workload:
180 h</td><td colspan="2">Contact Time:
90 h / 6 SWS</td><td colspan="2">Private Study:
90 h</td></tr>
<tr><td>Duration
Module Coordinator</td><td colspan="3">1 semester</td><td colspan="3">Glotzbach</td></tr>
<tr><td>Regular Cycle</td><td colspan="6">every winter semester</td></tr>
<tr><td>Language</td><td colspan="6">English</td></tr>
<tr><td>Learning- / Teaching Forms</td><td colspan="6">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.</td></tr>
<tr><td>Module Content</td><td colspan="6">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.</td></tr>
<tr><td>Qualification Goals</td><td colspan="6">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.</td></tr>
<tr><td rowspan="3">Requirements for Obtaining Credit, Grading, Weight if appl.</td><td>Courses</td><td>Type of Lecture</td><td>Status</td><td>CH</td><td>CP</td><td>Type of Exam / Study Require-</td><td>Duration of Exam</td><td>Grading System</td><td>Weighting</td></tr>
<tr><td rowspan="2">Physics of the Earth’s Surface</td><td>L</td><td>c</td><td>4</td><td>4</td><td>WE</td><td>90</td><td>g</td><td>0,7</td></tr>
<tr><td>E</td><td>c</td><td>2</td><td>2</td><td>R</td><td></td><td>g</td><td>0,3</td></tr>
<tr><td>Applicability</td><td colspan="6">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.</td></tr>
<tr><td>Prerequisites</td><td colspan="6">Introductory geology</td></tr>
</table>

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								

<table>
<tr><td>Module Number:
M 317</td><td colspan="3">Module Title:
Data Analysis and Modeling Methods in Geo-science and Environmental Science</td><td>Type of Module:
M.Sc. Compulsory / Elective</td></tr>
<tr><td>Credits (ECTS)</td><td colspan="4">6</td></tr>
<tr><td>Workload
- Contact Time
- Private Study</td><td>Workload:
180 h</td><td colspan="2">Contact Time:
3 x 20 h / 4 SWS</td><td>Private Study:
3 x 40 = 120 h</td></tr>
<tr><td>Duration
Module Coordinator</td><td colspan="2">1-2 semester</td><td colspan="2">Drews</td></tr>
<tr><td>Regular Cycle</td><td colspan="4">every semester</td></tr>
<tr><td>Language</td><td colspan="4">English</td></tr>
<tr><td>Learning- / Teaching Forms</td><td colspan="4">Lectures and Computer Exercises for Data Analysis and Modeling</td></tr>
<tr><td>Module Content</td><td colspan="4">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, which include:
Finite Element Method
Fourier- and Laplace-Transform Techniques
Geographical Information Systems
Introduction Scientific Programming (Matlab)
Introduction Scientific Programming (Python)
Introduction to R
Introduction to Time Series Analysis
Machine Learning 1
Machine Learning 2
Principles of Model Calibration
Remote Sensing of River Systems
Each unit counts for two credits. Students are free to select 3 units out of the units offered. Another 3 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).</td></tr>
<tr><td>Qualification Goals</td><td colspan="4">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</td></tr>
<tr><td>Requirements for Obtaining Credit, Grading, Weight if appl.</td><td colspan="4"><table>
<tr><th>Courses</th><th>Type of Lecture</th><th>Status</th><th>CH</th><th>CP</th><th>Type of Exam / Study Require-</th><th>Duration of Exam</th><th>Grading System</th><th>Weighting</th></tr>
<tr><td>Variable Topics</td><td>L,E</td><td>c</td><td>2</td><td>2</td><td>R,A</td><td>-</td><td>g</td><td>1/3</td></tr>
<tr><td>Variable Topics</td><td>L,E</td><td>c</td><td>2</td><td>2</td><td>R,A</td><td>-</td><td>g</td><td>1/3</td></tr>
</table></td></tr>
</table>

	Variable Topics	*L,E*	*c*	*2*	*2*	*R,A*	*-*	*g*	*1/3*
Applicability	Compulsory: M.Sc. Geowissenschaften/Geosciences, Elective: 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 Geoscience and Environmental Science**					Type of Module: M.Sc. Compulsory / Elective			
Credits (ECTS)	6 (3x2)								
Workload - Contact Time - Private Study	Workload: 180 h	Contact Time: 90 h				Private Study: 90 h			
Duration Module Coordinator	1 semester	Schulz, Berthold							
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". Units are: • Environmental Nanoscience • Instrumental Chemical Analysis Methods • Introduction to Dating Rocks and Sediments • Introduction to Electron Microscopy • Material Characterization Methods • 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	Compulsory: M.Sc. Geowissenschaften/Geosciences, Elective: M.Sc. Geoökologie/Geoecology, M.Sc. Applied & Environmental Geosciences								
Prerequisites	-								

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: 3 x 20 h / 4 SWS		Private Study: 3 x 40 = 120 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 3 units out of the units offered in M317 can be used to fill module M325 (each unit counts for two 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.	(see table below)			
Applicability	Compulsory: M.Sc. Geowissenschaften/Geosciences, Elective: 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)			

Requirements for Obtaining Credit, Grading, Weight if appl.:

Courses	*Type of Lecture*	*Status*	*CH*	*CP*	*Type of Exam / Study Require-*	*Duration of Exam*	*Grading System*	*Weighting*
Variable Topics	*L,E*	*c*	*2*	*2*	*R,A*	*-*	*g*	*1/3*
Variable Topics	*L,E*	*c*	*2*	*2*	*R,A*	*-*	*g*	*1/3*
Variable Topics	*L,E*	*c*	*2*	*2*	*R,A*	*-*	*g*	*1/3*

Module Number: **M 326**	Module Title: **Experimental and Analytical 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: 90 h						Private Study: 90 h
Duration Module Coordinator	1 semester			Schulz, Berthold					
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. Units are: • Advanced Electron Microscopy • Advanced Methods for Dating Rocks and Sediments • Quaternary Case Studies: Putting together the Story of Lake Filling and Drying in the Australian Desert • Dating Quaternary Sediments • Introduction to Mössbauer Spectroscopy • Material Orientated Computer Tomography • The Geology of Building Stones (starting summer semester 2024) 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 401**	Module Title: **Terrestrial Ecosystems – Excavation and Laboratory Internship**								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				Böhme				
Regular Cycle	every summer semester								
Language	English								
Learning- /Teaching Forms	During the excavation and laboratory internship students learn in the field basic techniques of excavating and recovering fossils. It includes common techniques of sediment treatment and subsequent analytical procedures in the laboratory. The results have to be documented in excavation- and lab reports.								
Module Content	• Fundamentals of paleontological excavation methods • Types of continental sediments and their description • Analytical field methods • Fossil recovery, documentation, sampling • Treatment of continental sediments (wet sieving) • Preparation of fossil vertebrates • Isotope laboratory, preparation of fossil material for geochemical isotope analyses								
Qualification Goals	The methodical search for fossils in a systematic paleontological excavation requires basic competences in methodology and practical experience. The students know the practical and methodical procedure of prospecting continental fossil assemblages. They have practical experience in paleontological excavation methods, treatments and analyses including the isotope geochemistry. This comprehensive knowledge enable them to participate on future excavation campaigns and are a fundamental requirement for their own advanced research activities.								
Requirements for Obtaining Credit, Grading, Weight if appl.	*Courses*	*Type of lecture*	*Status*	*CH*	*CP*	*Assessment / Study requirement*	*Duration of assessment*	*Grading system*	*weighting*
	Field course (7 field days)	*FC*	*c*	*5*	*3*	*A*	*-*	*ng*	*0,5*
	Laboratory internship (5 days)	*LC*	*c*	*3*	*3*	*LP*	*-*	*g*	*0,5*
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology								
Prerequisites	Basics in palaeontology and sedimentary geology								

Module Number: **M 402**	Module Title: **Evolution of Organisms**								Type of Module: Elective
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 90 h						Private Studies: 90 h
Duration Module Coordinator	1 semester			Werneburg					
Regular Cycle	every winter semester								
Language	English								
Learning- /Teaching Forms	Lecture and practical								
Module Content	The lecture provides an overview about the comparative anatomy of all major vertebrate groups (fishes, amphibians, reptiles, and mammals). We focus on 10 prominent features of vertebrate anatomy (skeleton, eyes, skin, etc.), discuss major transitions in evolution, and study variation in form and function. Aspects of embryology, zoology, and paleontology are always considered. The practical contains the observation of a variety of animal organ preparations and microscopy to learn about fundamental aspects of vertebrate morphology. An excursion and/or the dissection of a vertebrate will be offered. The zoological, paleontological, and embryonic collections of Tübingen University will be consulted to gain first-hand observations.								
Qualification Goals	Explaining and evaluating the composition of the vertebrate body; being able to trace variation in form and function through evolution and embryology and to derive paleoecological conclusions based on anatomical features.								
Requirements for Obtaining Credit, Grading, Weight if appl.	*Courses*	*Type of Lecture*	*Status*	*CH*	*CR*	*Type of Exam / Study Requirements*	*Duration of Exam*	*Grading System*	*Weighting*
	Evolutionary Vertebrate Morphology	*L*	*c*	*4*	*4*	*WE/ OE*	*45*	*g*	*2/3*
	Evolutionary Vertebrate Morphology	*E*	*c*	*2*	*2*	*SP/L P/R*	*30*	*g*	*1/3*
Applicability	M.Sc. Geowissenschaften/Geosciences (obligatory for the specialization in paleontology), M.Sc. Geoökologie/Geoecology Student of other disciplines (Biologie, Ökogeologie, Archäologie, etc.) are most welcome to join.								
Prerequisites	Basic knowledge on animal evolution and anatomy.								

Module Number: **M 403**	Module Title **Palaeoecology of Terrestrial Ecosystems**								Type of Module: M.Sc. Elective
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 90h / 6 SWS						Private Study: 90 h
Duration Module Coordinator	1 semester				Bocherens				
Regular Cycle	every summer semester								
Language	English								
Learning- / Teaching Forms	A wide range of teaching methods are used. Subject specific theoretical and practical skills are presented during lectures and in exercise sessions. Seminar sessions introduce presentation and reporting elements which address generic communication and presentation skills.								
Module Content	• Important characteristics of terrestrial ecosystems nowadays and in the past • Description of the main approaches (autoecology, synecology, geochemical tracers) • Taphonomy, diagenesis and palaeoecology of terrestrial ecosystems • Initial adaptations and the early terrestrial record • Terrestrial ecosystems through time • The role of biotic and abiotic factors in the evolution of terrestrial ecosystems • The impact of mass extinctions on terrestrial ecosystems • Changes in terrestrial ecosystems and human evolution								
Qualification Goals	• Students are familiar with the history of life on land and can apply the methods used to reconstruct this history. • They have the ability to critically assess specialized literature related to this field and to appropriately present research topics in written and oral 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*
	Paleoecology of Terrestrial Ecosystems	*L*	*o*	*3*	*3*	*WE*	*120*	*g*	*1*
		S	*o*	*2*	*2*	*R*	-	-	-
		E	*o*	*1*	*1*	*A*	-	-	-
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology								
Prerequisites	B.Sc. courses "History of the Earth", "Palaeontology", "Palaeobiology" or equivalent								

Module Number: **M 404**	Module Title: **Micropaleontology**								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				Junginger				
Regular Cycle	winter semester (every other year)								
Language	English								
Learning- / Teaching Forms	Lectures are accompanied by practical laboratory and microscopy exercises.								
Module Content	The module introduces the biology, ecology, morphology and geological significance and evolution of important microfossil groups. The role of microfossils as paleoenvironmental indicators and in industrial micropalaeontology and biostratigraphy is discussed. Students learn the practical skills of processing and analyzing micropaleontological samples.								
Qualification Goals	Students are familiar with the process of identification and classification of microfossils and understand the evolutionary history and geological significance of microfossil-producing organisms. They are able to independently carry out paleoenvironmental analyses and age determinations with microfossils and are able to critically evaluate micropaleontological data. Practical skills in processing of micropaleontological material from sampling to interpretation and the understanding of the potential industrial applications of micropalaeontology are a key competence needed exploration of oil and gas reservoirs.								
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*
	Micropaleontology	*L*	*c*	*2*	*3*	*WE*	*90*	*g*	*1*
		E	*c*	*2*	*3*				
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology The module covers topics related the fields of sedimentology and stratigraphy.								
Prerequisites	B.Sc. modules "Erdgeschichte", "Sedimente & Stratigraphie", "Paläontologie" or equivalent								

Module Number: **M 405**	Module Title: **Palaeoecology of Marine Ecosystems**								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				Nebelsick				
Regular Cycle	every winter semester								
Language	English								
Learning- / Teaching Forms	The necessary knowledge basis will be mediated during lectures. In the practical part of the course, the students will learn to analyze relevant ecological parameters using information contained in fossil material. Ancient marine environments will be reconstructed using fossils, depositional fabrics and associated sediments.								
Module Content	Relationships between organisms and their environment Analysis of organism relationships between taxa Ecosystem analysis of marine depositional systems								
Qualification Goals	The students will obtain the following qualifications: Basic knowledge will be attained with respect to functional morphology, organism-relationships and ecosystems in fossil depositional systems. After attending the module, the participants will be able to make ecological interpretations of individual marine fossils, to analyze the species interactions as well as reconstruct ancient ecosystems. They will be able to apply their knowledge to recognize the reciprocal interaction of biological and physical parameters in marine ecosystems using relevant data from the geological record. The participants will be able to apply different methods for paleontological interpretations. They will be able to solve complex problems with respect to functional morphology, actualistic paleontology, animal relationships such as predation and encrustations as well as the paleoecology of marine ecosystems.								
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*
	Palaeoecology of Marine Ecosystems	*L*	*c*	*4*	*3*	*A*	*-*	*g*	*1*
		E	*c*	*2*	*3*				
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Biologie								
Prerequisites	Basics in palaeontology and biology								

Module Number: **M 407**	Module Title **Conservation Palaeoecology**								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				Bocherens				
Regular Cycle	every winter semester								
Language	English								
Learning- / Teaching Forms	A wide range of teaching methods are used. Subject specific theoretical and practical skills are presented during lectures and in exercise sessions. Seminar sessions introduce presentation and reporting elements which address generic communication and presentation skills.								
Module Content	• Conservation of species and ecosystems needs to consider knowledge from their past, since most ecosystems today are strongly impacted by current and past human impact and most endangered species are relicts or refugee species. • Description of the main approaches (palaeobiogeography, palaeogenetics, geochemical tracers, niche reconstruction) • Reconstruction of fundamental niche of endangered species • Holocene and Pleistocene rewilding for sustainable future ecosystems • Evolution of human impact in the Pleistocene and Holocene • Lessons from deep time ecosystems (greenhouse Earth, mass extinction recovery)								
Qualification Goals	• Students are familiar with the importance of taking information from paleobiology to help in conservation decision making. • They have the ability to critically assess specialized literature related to this field and to appropriately present research topics in written and oral 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*
	Conservation Palaeoecology	*L*	*o*	*3*	*3*	*WE*	*120*	*g*	*1*
		S	*o*	*2*	*2*	*R*	-	-	-
		E	*o*	*1*	*1*	*A*	-	-	-
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology								
Prerequisites	B.Sc. module "Climatology and Ecosystems of the Earth" or equivalent								

<table>
<tr><td>Module Number:
M 408</td><td colspan="4">Module Title:
Vertebrates and Plants of the Cenozoic</td><td>Type of Module:
M.Sc. Elective</td></tr>
<tr><td>Credits (ECTS)</td><td colspan="5">6</td></tr>
<tr><td>Workload
- Contact Time
- Private Study</td><td colspan="2">Workload:
180 h</td><td colspan="2">Contact Time:
90 h / 6 SWS</td><td>Private Study:
90 h</td></tr>
<tr><td>Duration
Module Coordinator</td><td colspan="3">1 semester</td><td colspan="2">Böhme</td></tr>
<tr><td>Regular Cycle</td><td colspan="5">every winter semester</td></tr>
<tr><td>Language</td><td colspan="5">English</td></tr>
<tr><td>Learning- / Teaching Forms</td><td colspan="5">Lectures are combined with exercises using the extensive palaeontological teaching and exercise collection.</td></tr>
<tr><td>Module Content</td><td colspan="5">• Principles of terrestrial stratigraphy (biostratigraphy) and taphonomy
• Plants as proxy for vegetation, climate and environments
• Vertebrates as climate and environmental proxies
• Plant morphology and botanical taxonomy
• Fundamentals of osteology and evolution of continental vertebrates of the Cenozoic
• Exercises for the determination of Cenozoic vertebrates and macroflora</td></tr>
<tr><td>Qualification Goals</td><td colspan="5">• Understanding biological interactions of continental processes
• Fundamentals of morphology and evolution of Cenozoic vertebrates and plants
• Insight into the variety of reconstruction methods (climate, environment, vegetation)
• Experience in the determination of continental fossils (vertebrates, plants)</td></tr>
<tr><td rowspan="3">Requirements for Obtaining Credit, Grading, Weight if appl.</td><td>Courses</td><td>Type of Lecture</td><td>Status</td><td>CH</td><td>CP</td><td>Type of Exam / Study Requirement</td><td>Duration of Exam</td><td>Grading System</td><td>Weighting</td></tr>
<tr><td rowspan="2">Vertebrates and Plants of the Cenozoic</td><td>L</td><td>c</td><td>3</td><td>3</td><td rowspan="2">OE</td><td rowspan="2">30</td><td rowspan="2">g</td><td rowspan="2">1</td></tr>
<tr><td>E</td><td>c</td><td>3</td><td>3</td></tr>
<tr><td>Applicability</td><td colspan="5">M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology</td></tr>
<tr><td>Prerequisites</td><td colspan="5">Basics in paleontology</td></tr>
</table>

<table>
<tr><td>Module Number:
M 409</td><td colspan="3">Module Title:
Marine Geology and Geochemistry</td><td>Type of Module:
M.Sc. Elective</td></tr>
<tr><td>Credits (ECTS)</td><td colspan="4">6</td></tr>
<tr><td>Workload
- Contact Time
- Private Study</td><td>Workload:
180 h</td><td colspan="2">Contact Time:
90 h / 6 SWS</td><td>Private Studies:
90 h</td></tr>
<tr><td>Duration
Module Coordinator</td><td colspan="2">1 semester</td><td colspan="2">Schulz</td></tr>
<tr><td>Regular Cycle</td><td colspan="4">every winter semester</td></tr>
<tr><td>Language</td><td colspan="4">English</td></tr>
<tr><td>Learning- /Teaching Forms</td><td colspan="4">Teacher-centered teaching; studying literature on the subject, talk/exposé, handouts, laboratory practice.</td></tr>
<tr><td>Module Content</td><td colspan="4">• 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</td></tr>
<tr><td>Qualification Goals</td><td colspan="4">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.</td></tr>
<tr><td rowspan="4">Requirements for Obtaining Credit, Grading, Weight if appl.</td><td>Courses</td><td>Type of Lecture</td><td>Status</td><td>CH</td><td>CP</td><td>Type of Exam / Study Requirements</td><td>Duration of Exam</td><td>Grading System</td><td>Weighting</td></tr>
<tr><td>Marine Geochemistry</td><td>L,S</td><td>c</td><td></td><td>2</td><td rowspan="3">R</td><td rowspan="3">-</td><td rowspan="3">g</td><td rowspan="3">1</td></tr>
<tr><td>Marine Geology</td><td>L,S</td><td>c</td><td></td><td>2</td></tr>
<tr><td>Marine Geology</td><td>E</td><td>c</td><td></td><td>2</td></tr>
<tr><td>Applicability</td><td colspan="4">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"</td></tr>
<tr><td>Prerequisites</td><td colspan="4">B.Sc. modules "Einführung in die Geowissenschaften", "Erdgeschichte", "Sedimente und Stratigraphie", "Paläontologie"
Course limited to 14 students.</td></tr>
</table>

Module Number: **M 503**	Module Title: **Paleobotany/Palynology**								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				Böhme				
Regular Cycle	every winter semester								
Language	English								
Learning- / Teaching Forms	The course is being held as a block module, which flexibly combines lectures with practical training units in the laboratory, at the microscope and on the computer.								
Module Content	• Plant fossils as a basis for paleoecological reconstructions • Fundamentals in terrestrial palynology: preparation, microscopy, determination of extant and fossil pollen • Quantitative methods to reconstruct climate and vegetation • Discussion of current research topics in paleobotany.								
Qualification Goals	After completing the module, the participants have the knowledge to use plant fossils for environmental reconstructions. With the ability to evaluate the potential of plant fossils as environmental indicators in different contexts, as well as the practical experience in palynological methods of treatments and analyses, the students acquire important basic skills in the field of palynology. Practical exercises of quantitative methods for climate and vegetation analyses will be a fundamental part of the course as well as their application on an individual topic elaborated on in a written module thesis. Together, this will enable the participants to better understand, analyse, and handle scientific research questions in the field of paleobotany and palynology.								
Requirements for Obtaining Credit, Grading, Weight if appl.	*Courses*	*Type of Lecture*	*Status*	*CH*	*CP*	*Type of Exam / Study Require-*	*Duration of Exam*	*Grading System*	*Weighting*
	Paleobotany/Palynology	*L*	*o*	*3*	*3*	*A*	*-*	*g*	*1*
		E	*o*	*2*	*3*				
Applicability	M.Sc. Geowissenschaften/Geosciences, M.Sc. Geoökologie/Geoecology, M.Sc. Naturwissenschaftliche Archäologie								
Prerequisites	Basics in palaeontology, archaeology, biology								

<table>
<tr><td>Modulnummer
GEO 75</td><td colspan="3">Modultitel:
Klimawandel</td><td colspan="4">Art des Moduls:
M.Sc. Wahlpflicht</td></tr>
<tr><td>ECTS-Punkte</td><td colspan="7">6</td></tr>
<tr><td>Arbeitsaufwand
- Kontaktzeit
- Selbststudium</td><td colspan="2">Arbeitsaufwand:
180 h</td><td colspan="2">Kontaktzeit:
30 h / 2 SWS</td><td colspan="3">Selbststudium:
150 h</td></tr>
<tr><td>Moduldauer
Modulkoordination</td><td colspan="3">1 Semester</td><td colspan="4">Hochschild</td></tr>
<tr><td>Häufigkeit
des Angebots</td><td colspan="7">jedes Wintersemester</td></tr>
<tr><td>Unterrichtssprache</td><td colspan="7">Deutsch / Englisch</td></tr>
<tr><td>Lehr- / Lernformen</td><td colspan="7">Seminar
Die zu erbringenden Studienleistungen werden zu Semesterbeginn von den Dozierenden bekannt gegeben.</td></tr>
<tr><td>Modulinhalt</td><td colspan="7">Das Modul „Klimawandel" untersucht umweltrelevante Themen der Physischen Geographie unter dem Einfluss des Globalen Klimawandels. Die Studierenden werden mit neuesten Forschungsansätzen der Physischen Geographie, neuen Beobachtungs- und Analysemethoden sowie Vermeidungsstrategien im Hinblick auf die globale Klimaerwärmung in Form von Referatsthemen konfrontiert. Dabei werden aktuelle, anwendungsbezogene Themen wie beispielsweise Hochwasser, gravitative Massenbewegungen, hochmontaner Wasserhaushalt oder auch die Ausbreitung von Wüsten in ihrer gesamten methodischen Bandbreite (Prozessanalyse, Auslösemechanismen, Modellierungen, Geotechnik, Schutzverbauungen, etc.) immer unter den Aspekten der zukünftigen Klimaentwicklung bearbeitet und diskutiert.</td></tr>
<tr><td>Qualifikationsziele</td><td colspan="7">Die Studierenden sollen zeigen, dass sie in der Lage sind räumliche Fragestellungen als Querschnittsaufgaben der Physischen Geographie zu erkennen, die damit verbundenen Prozesse zu verstehen und dies an regionalen Beispielen sowie aktuellen Fragestellungen der globalen Klimaerwärmung sachgerecht darzustellen.
• Stärkung der Voraussetzung für ein sicheres Selbststudium und fachlichen Vertiefung im Bereich Angewandte Physische Geographie
• Kennenlernen aktueller Beobachtungs- und Analysemethoden zur Stärkung der physisch-geographischen Bewertungskompetenz
• Kenntnisse der möglichen Berufs- und Arbeitsfelder im Bereich der angewandten Physischen Geographie
• Vermittlung des Anwendungsbezugs für die spätere Berufstätigkeit
• Einblicke in die klassische physisch-geographische Forschungstätigkeit</td></tr>
<tr><td rowspan="3">Voraussetzung für die Vergabe von Leistungspunkten / Benotung (ggf. Gewichtung)</td><td>Titel</td><td>Art der Lernform</td><td>Status</td><td>SWS</td><td>LP</td><td>Prüfungsform</td><td>Prüfungsdauer</td><td>Benotungssystem</td><td>Berechnung Modulnote</td></tr>
<tr><td rowspan="3">Klimawandel</td><td rowspan="3">S</td><td rowspan="3">o</td><td rowspan="3">2</td><td rowspan="3">2</td><td rowspan="3">PF</td><td>45</td><td rowspan="3">b</td><td>40</td></tr>
<tr><td>-</td><td>40</td></tr>
<tr><td>-</td><td>20</td></tr>
<tr><td colspan="9">Im Rahmen des Moduls findet eine formative Prüfung statt, die sich aus den folgenden Elementen zusammensetzt: ein mündlicher Seminarvortrag (40%) und einer schriftlichen Ausarbeitung (40%) sowie einem Artikelreview mit Koreferat (20%). Dabei müssen alle Elemente erbracht werden.</td></tr>
<tr><td>Verwendbarkeit</td><td colspan="7">M.Sc. Geoökologie/Geoecology, M.Sc Physische Geographie, M.Ed. Geographie</td></tr>
<tr><td>Teilnahmevoraussetzungen</td><td colspan="7">Keine</td></tr>
</table>

Modulnummer **GEO 76**	Modultitel: **Angewandte Geoinformatik**		Art des Moduls: M.Sc. Wahlpflicht
ECTS-Punkte	6		
Arbeitsaufwand - Kontaktzeit - Selbststudium	Arbeitsaufwand: 180 h	Kontaktzeit: 90 h / 6 SWS	Selbststudium: 90 h
Moduldauer Modulkoordination	1 Semester	Braun	
Häufigkeit des Angebots	jedes Wintersemester		
Unterrichtssprache	Deutsch (in Absprache auch in Englisch möglich)		
Lehr- / Lernformen	Vorlesung, Seminar, Übung Die zu erbringenden Studienleistungen werden zu Semesterbeginn von den Dozierenden bekannt gegeben.		
Modulinhalt	Das Modul "Angewandte Geoinformatik" vermittelt Wissen über den aktuellen Stand der Wissenschaft sowie der technischen Methoden in der räumlichen Informationsverarbeitung (Geodaten). Es werden Themen aus der Physischen und der Humangeographie bearbeitet, bei denen der Einsatz Geographischer Informationssysteme (GIS) eine Rolle spielt. Es werden sowohl Grundlagen wie auch Anwendungsbeispiele zu folgenden Themen bearbeitet (Auswahl): Geodateninfrastruktur, Aufbau eines Web-GIS, Verfahren der GIS-gestützten Geosimulation, Landschaftsstrukturmasse, räumliche Interpolation, digitale Geländemodelle und Reliefanalyse, Geomarketing, ethische Aspekte von GIS, GIS im Gesundheitswesen und der Katastrophenhilfe, Logistik, UrbanGIS, Decision Support Systems, Data Mining etc. Darüber hinaus erlernen die Studierenden in den EDV-Übungen im Computer-Labor sowie der eigenen Projektarbeit die praktischen Umsetzungsmöglichkeiten durch den Einsatz aktuellster GIS-Software kennen.		
Qualifikationsziele	Die Studierenden besitzen am Ende dieses Moduls • analytische und technische Fähigkeiten für den sachgerechten Einsatz Geographischer Informationssysteme (GIS) im Bereich angewandter geowissenschaftlicher Projekte • spezifische Kenntnisse über integrierte, raumbezogene Techniken der Datenanalyse als Basis für eine interdisziplinäre Projektarbeit • die Fähigkeit, komplexe raumbezogene Mensch-Umwelt-Probleme zu analysieren und die lösungsorientierten methodischen Aspekte des Einsatzes Geographischer Informationssysteme in diesem Rahmen einzuschätzen und praktisch umzusetzen • die Fähigkeit GIS-gestützte Projekte korrekt einzuschätzen, zu planen, sowie die erforderlichen GIS-methodische Verfahrens- und Arbeitsschritte zu koordinieren (GIS-Projektmanagement) • spezialisierte Fähigkeiten in der Kommunikation und Präsentation wissenschaftlicher Erkenntnisse sowie der wissenschaftlichen Argumentation • die Fähigkeit, in einem Team zu arbeiten und Verantwortung zu übernehmen. Die Studierenden erarbeiten sich im Modul die verschiedenen Inhalte in Einzelarbeit (persönliche Vorbereitung durch Lektüre wissenschaftlicher Texte). Durch gemeinsam abgesprochene Zeitpläne lernen Sie Selbst- und Zeitmanagement und können ihren persönlichen Arbeitsstil dadurch besser einschätzen. Die praktischen EDV-Übungsaufgaben werden in Kleingruppen mit 2-3 Personen erstellt. Diese präsentieren die Ergebnisse als Gemeinschaftsarbeit vor der Gruppe. Sie lernen dabei neben den oben genannten fachlich-methodischen Fähigkeiten einerseits ihre personalen und sozialen Kompetenzen sowie Möglichkeiten und Grenzen der Teamarbeit besser zu beurteilen.		

	Titel	*Art der Lern-form*	*Status*	*SWS*	*LP*	*Prüfungsform*	*Prüfungsdauer*	*Benotungs-system*	*Berechnung Modulnote*
Voraussetzung für die Vergabe von Leistungs-punkten / Benotung (ggf. Gewichtung)	*Angewandte Geoinformatik*	*VL*	*o*	*2*	*2*	*-*	*-*	*kP*	*-*
		S	*o*	*1*	*1*	*PF*	*30*	*b*	*50*
		S	*o*	*1*	*1*		*-*		
		Ü	*o*	*2*	*2*		*-*		*50*
	Im Rahmen des Moduls findet eine Portfolioprüfung statt, die sich aus den folgenden Elementen zusammensetzt: Ein mündlicher Seminarvortrag und seine schriftliche Ausarbeitung (zusammen 50%) und eine darauf aufbauende EDV-praktische Projekt-arbeit (50%). Es müssen alle Elemente erbracht werden.								
Verwendbarkeit	M.Sc. Geoökologie/Geoecology, M.Sc. Physische Geographie, M.A. Humangeogra-phie – Global Studies								
Teilnahmevoraussetzungen	Grundlegende Kenntnisse Geographischer Informationssysteme								

Module Number **GEO 77**	Module Title: **Geomorphology and Soil-Landscape Modelling**		Type of Module: M.Sc. Elective
Credits (ECTS)	6		
Workload	Contact time: 90 h	Pre- and post-processing: 45 h	Written draft and presentation: 45 h
Duration	1 Semester		
Regular Cycle	every winter semester		
Language	German or English (as required)		
Group Size	20		
Teaching Forms	Lecture, seminar, practical exercise		
Module Content	GEO 77 (Geomorphology and Soil-Landscape Modelling) teaches basic concepts, processes and methods of soil science, geomorphology and soil landscape modelling. Based on interactions between soil and topography, this course covers the genesis of soils, their distribution within the landscape and functions as well as their analysis with machine learning methods. The morning lecture covers and repeats advanced basics of soil science and geomorphology. The seminar will present and discuss recent scientific developments in soil science, geomorphology, pedometrics, soil-landscape modelling and machine learning. The afternoon exercise addresses the function of soils and their distribution with state-of-the-art statistical methods of machine learning and spatial interpolation using the open access software R. This course thus combines an in-depth soil science-geomorphology process understanding with applied statistical methodology.		
Qualification Goals	Students are able to • link in-depth soil science-geomorphological process understanding with statistical methods of machine learning • scientifically analyse soil and geomorphological data sets in a quantitative way against the background of current research questions • understand the interrelationships between soil distribution and topography, climate, parent material and land cover • relate and apply pedological and geomorphological theories and concepts to current environmental issues • understand the relationships between spatial and scale-dependent processes • analyse, present and explain pedological and geomorphological processes in complex geo-ecosystems • argue and discuss scientifically • work in a team and take responsibility • plan and coordinate methodological processes and associated work steps		
Weighting for the Allocation of Credits	Short presentation (33 %), seminar paper (33 %), result presentation (33 %)		
Applicability	M.Sc. Geoökologie/Geoecology, M.Sc. Physical Geography, M.Ed. Geography, M.Ed. NWT		
Prerequisites	None		
Module Coordinator	Thomas Scholten		
Lecturers	Thomas Scholten, Steffen Seitz, Tobias Rentschler		
References	Course-specific announcement at the beginning of the semester		

Modulnummer **GEO 78**	Modultitel: **Bodenschutz**								Art des Moduls: M.Sc. Wahlpflicht
ECTS-Punkte	6								
Arbeitsaufwand - Kontaktzeit - Selbststudium	Arbeitsaufwand: 180 h		Kontaktzeit: 60 h / 4 SWS						Selbststudium: 120 h
Moduldauer Modulkoordination	1 Semester					Scholten			
Häufigkeit des Angebots	jedes Wintersemester								
Unterrichtssprache	Deutsch								
Lehr- / Lernformen	Vorlesung, Seminar, Geländeübung, Übung Die zu erbringenden Studienleistungen werden zu Semesterbeginn von den Dozierenden bekannt gegeben.								
Modulinhalt	In diesem Modul werden die Fähigkeiten zur Bodenbewertung, zum Ermitteln der Empfindlichkeit und Schutzwürdigkeit von Böden im gesamten Nutzungsspektrum, hin bis zum Bodenschutz auf Baustellen (Bodenkundliche Baubegleitung) vermittelt und trainiert. Zur Egalisierung der Vorkenntnisse und auf die Fragestallung des Bodenschutzes spezifiziert werden allgemeine Grundlagen der Bodenkunde und im Besonderen wiederholt und geübt. Insbesondere die Fähigkeit zur sicheren ad hoc-Einordnung und Bewertung eines Standorts wird vermittelt. Technische und organisatorische Grundlagen von Maßnahmen des Naturschutzes, der Land- und Forstwirtschaft sowie der Bauausführung und deren jeweiligen Bezüge zum Bodenschutz werden vermittelt. Ethische, rechtliche und administrative Inhalte des Bodenschutzes werden erarbeitet und eingeordnet: Die Kommunikation von Inhalten des Bodenschutzes bei Beteiligung verschiedener Interessensgruppen wird geübt. Die vermittelten Kenntnisse werden von den Studierenden im Rahmen von Gekändeübungen und Seminarvorträgen angewandt.								
Qualifikationsziele	Die Studierenden • können Böden und ihre Schutzbedürftigkeit im Landschafts- und Nutzungsbezug systematisch einordnen und interpretieren sowie Schutzmaßnahmen diskutieren, d.h. sie können den Praxisbezug ihrer Bodenkundlichen Kenntnisse herstellen, die sie in dieser und vorrangegangenen Veranstaltungen erworben haben • können Verantwortung in Gruppenarbeiten übernehmen und methodologische Abläufe und Arbeitsschritte planen und koordinieren • sind mit feldbodenkundlichen Techniken vertraut, können den Bedarf an bodenchemischen und bodenphysikalischen Untersuchungen abschätzen sowie entsprechende Ergebnisse interpretieren • haben die Prinzipien der Umweltverwaltung verstanden • sind in der Lage zu Bodenschutzfragen im Sinne eines Interessensausgleich Stellung zu nehmen • können in angemessener Weise Themen des Bodenschutzes kommunizieren und präsentieren								
Voraussetzung für die Vergabe von Leistungspunkten / Benotung (ggf. Gewichtung)	*Titel*	*Art der Lernform*	*Status*	*SWS*	*LP*	*Prüfungsform*	*Prüfungsdauer*	*Benotungssystem*	*Berechnung Modulnote*
	Bodenschutz	*VL*	*o*	*1,5*	*6*	*H*	*-*	*b*	*100*
		S	*o*	*1*					
		Ü,G	*o*	*1,5*					
Verwendbarkeit	M.Sc. Geoökologie/Geoecology, M.Sc. Physische Geographie, M.Ed. Geographie, M.Ed. Naturwissenschaft und Technik								
Teilnahmevoraussetzungen	Keine								

<table>
<tr><td>Module Number
GEO 85</td><td colspan="4">Module title:
Planetary Boundaries</td><td colspan="4">Type of Module:
M.Sc. Elective</td></tr>
<tr><td>Credits (ECTS)</td><td colspan="8">6</td></tr>
<tr><td>Workload
- Contact Time
- Private Study</td><td colspan="3">Workload:
180 h</td><td colspan="3">Contact time:
30 h / 2 SWS</td><td colspan="2">Private study:
150 h</td></tr>
<tr><td>Duration
Module coordinator</td><td colspan="4">1 Semester</td><td colspan="4">Oelmann</td></tr>
<tr><td>Regular cycle</td><td colspan="8">every summer semester</td></tr>
<tr><td>Language</td><td colspan="8">German or Englisch (as required)</td></tr>
<tr><td>Learning- / Teaching Forms</td><td colspan="8">Seminar</td></tr>
<tr><td>Module Content</td><td colspan="8">The Earth system has a constrained capacity to buffer forces and maintain a steady state. The thresholds which indicate an irreversible state change are coined „planetary boundaries". Planetary boundaries were quantified für different forces. In this course, the following forces will be tackled:
• Biosphere integrity,
• Land use,
• Biogeochemical cycles,
• Atmospheric Aerosol loading,
• Novel entities.
In the course Planetary Boundaries, students use the state-of-the-art of literature to characterize the situation for the single forces and to infer and discuss the resulting risks concerning an irreversible state change. Based on this, the students write an extensive term paper.</td></tr>
<tr><td>Qualification Goals</td><td colspan="8">Goals of this course center around enabling students to:
• Understand environmental problems the Earth is confronted with,
• Realize the constrained capacity of the Earth concerning envrionmental problems;
• Collect scientific papers in international journals and prepare an oral presentation containing the main paper results and their interpretation;
• Analyze and evaluate complex issues;
• Deliver a criticial opinion;
• Write a concise and logically structured term paper on scientific research questions.</td></tr>
<tr><td rowspan="2">Requirements for Obtaining Credit, Grading, Weight if appl.</td><td>Courses</td><td>Type of Lecture</td><td>Status</td><td>CH</td><td>CP</td><td>Type of Exam/ Study Rquire.</td><td>Duration of Exam</td><td>Grading System</td><td>Weighting</td></tr>
<tr><td>Planetary Boundaries</td><td>S</td><td>c</td><td>2</td><td>6</td><td>A</td><td>-</td><td>g</td><td>100</td></tr>
<tr><td>Applicability</td><td colspan="8">M.Sc. Geoökologie/Geoecology, M.Sc. Physische Geographie</td></tr>
<tr><td>Prerequisites</td><td colspan="8">None</td></tr>
</table>

<table>
<tr><td>Modul Number
GEO 87</td><td colspan="3">Module title:
Biodiversity and Ecosystem Functioning</td><td colspan="4">Type of Module:
M.Sc. Elective</td></tr>
<tr><td>Credits (ECTS)</td><td colspan="7">6</td></tr>
<tr><td>Workload
- Contact Time
- Private Study</td><td colspan="2">Workload:
180 h</td><td colspan="2">Contact Time:
60 h / 4 SWS</td><td colspan="3">Selbststudium:
120 h</td></tr>
<tr><td>Duration
Module coordinator</td><td colspan="3">1 Semester</td><td colspan="4">Oelmann</td></tr>
<tr><td>Regular cycle</td><td colspan="7">every summer semester</td></tr>
<tr><td>Language</td><td colspan="7">German or Englisch (as required)</td></tr>
<tr><td>Learning- / Teaching Forms</td><td colspan="7">Seminar, Field course, Laboratory course</td></tr>
<tr><td>Module Content</td><td colspan="7">The global loss of biodiversity continues at an alarming rate and is of concern for researchers of different disciplines. Whether a reduced biodiversity indeed compromises the functioning of ecosystems is controversially discussed. The course „Biodiversity and Ecosystem Functioning" will shed light on this issue based on the state-of-the-art of literature. Theoretical basics will be put into practice during a field trip and a laboratory exercise. The course will tackle the following topics in detail:
Overview of biodiversity experiments worldwide also including the different experimental designs,
Mechanisms underlying potential biodiversity effects,
Examples of biodiversity effects on components of and processes in ecosystems,
Sample collection in a German biodiversity experiment followed by laboratory analyses and statistical evaluation of biodiversity effects.</td></tr>
<tr><td>Qualification Goals</td><td colspan="7">Goals of this course focus on enabling students to:
Understand the complexity inherent to biotic and abiotic factors and develop a mechanistic understanding of biodiversity effects;
Critically evaluate the interplay between scientific findings and their political implementation;
Collect environmental samples in an advanced manner;
Plan and conduct laboratory work;
Apply advanced methods of chemical analyses and of complex statistical models to analyze biodiversity effects on laboratory results;
Act as a chair of group discussions;
Illustrate, describe and interprete laboratory results in conjunction with scientific literature in a term paper.</td></tr>
<tr><td rowspan="4">Requirements for Obtaining Credit, Grading, Weight if appl.</td><td>Courses</td><td>Type of Lecture</td><td>Status</td><td>CH</td><td>CP</td><td>Type of Exam/ Study Rquire.</td><td>Duration of Exam</td><td>Grading System</td><td>Weighting</td></tr>
<tr><td rowspan="3">Biodiversity and Ecosystem Functioning</td><td>S</td><td>c</td><td>2</td><td>3</td><td>R</td><td>-</td><td>ng</td><td>-</td></tr>
<tr><td>E</td><td>c</td><td>1</td><td>1,5</td><td rowspan="2">A</td><td rowspan="2">-</td><td rowspan="2">g</td><td rowspan="2">100</td></tr>
<tr><td>L</td><td>c</td><td>1</td><td>1,5</td></tr>
<tr><td>Applicability</td><td colspan="7">M.Sc. Geoökologie/Geoecology, M.Sc. Physische Geographie</td></tr>
<tr><td>Prerequisites</td><td colspan="7">None</td></tr>
</table>

<table>
<tr><td>Modulnummer
GEO 88</td><td colspan="4">Modultitel:
Angewandte Fernerkundung</td><td colspan="3">Art des Moduls:
M.Sc. Wahlpflicht</td></tr>
<tr><td>ECTS-Punkte</td><td colspan="7">6</td></tr>
<tr><td>Arbeitsaufwand
- Kontaktzeit
- Selbststudium</td><td colspan="2">Arbeitsaufwand:
180 h</td><td colspan="2">Kontaktzeit:
90 h / 6 SWS</td><td colspan="3">Selbststudium:
90 h</td></tr>
<tr><td>Moduldauer
Modulkoordination</td><td colspan="3">1 Semester</td><td colspan="4">Hochschild</td></tr>
<tr><td>Häufigkeit
des Angebots</td><td colspan="7">jedes Sommersemester</td></tr>
<tr><td>Unterrichtssprache</td><td colspan="7">Deutsch, Englisch</td></tr>
<tr><td>Lehr- / Lernformen</td><td colspan="7">Vorlesung, Seminar, Übung
Die zu erbringenden Studienleistungen werden zu Semesterbeginn von den Dozierenden bekannt gegeben.</td></tr>
<tr><td>Modulinhalt</td><td colspan="7">Das Modul vermittelt Beispiele aus der Angewandten Fernerkundung. Wie wird die Fernerkundung zur Lösung geowissenschaftlicher Probleme eingesetzt? Es besteht aus Themenfeldern wie Fernerkundungsanwendungen zur Atmosphäre, zur Ozeanographie, zur Geologie/Geomorphologie, Landnutzung, Vegetation, Hydrologie, Schnee/Eis, Naturkatastrophen, Stadtgeographie und Digitalen Geländemodellen. Die Studierenden bekommen eine Einführung in die Nutzung verschiedener flugzeug- bzw. satellitengetragener Sensorsysteme zur Ableitung aktueller flächenhafter Parameter.</td></tr>
<tr><td>Qualifikationsziele</td><td colspan="7">• Analytische und technische Fähigkeiten bei der Nutzung von Fernerkundungsdaten zur Lösung geowissenschaftlicher Probleme
• Spezifische Kenntnisse über die neuesten Fernerkundungsentwicklungen und deren Potenzial für zukünftige geowissenschaftliche Anwendungen
• Fähigkeit zur Ableitung aktueller, flächendeckender Parameter aus Fernerkundungsdaten als spezielle Qualifikation für den Master Physische Geographie
• Spezifische Kenntnisse in wissenschaftlichen Kommunikations- und Präsentationstechniken
• Fähigkeit zum verantwortungsbewussten Teamwork
• Fertigkeiten in der wissenschaftlichen Argumentation
• Fähigkeiten methodische Abläufe und einzelne Arbeitsschritte zu planen und zu koordinieren</td></tr>
<tr><td rowspan="5">Voraussetzung für die Vergabe von Leistungspunkten / Benotung (ggf. Gewichtung)</td><td>Titel</td><td>Art der Lernform</td><td>Status</td><td>SWS</td><td>LP</td><td>Prüfungsform</td><td>Prüfungsdauer</td><td>Benotungssystem</td><td>Berechnung Modulnote</td></tr>
<tr><td rowspan="3">Angewandte Fernerkundung</td><td>VL</td><td>o</td><td>2</td><td>2</td><td>-</td><td>-</td><td>kP</td><td>-</td></tr>
<tr><td>S</td><td>o</td><td>2</td><td>2</td><td>PF</td><td>45
-</td><td>b</td><td>70
30</td></tr>
<tr><td>Ü</td><td>o</td><td>2</td><td>2</td><td>ÜA</td><td>-</td><td>kP</td><td>-</td></tr>
<tr><td colspan="8">Im Rahmen des Moduls findet eine Portfolioprüfung statt, die sich aus den folgenden Elementen zusammensetzt: Ein mündlicher Seminarvortrag (70%) und seine schriftliche Ausarbeitung (30%). Es müssen alle Elemente erbracht werden.</td></tr>
<tr><td>Verwendbarkeit</td><td colspan="7">M.Sc. Geoökologie/Geoecology, M.Sc. Physische Geographie, M.Ed. Naturwissenschaften und Technik</td></tr>
<tr><td>Teilnahmevoraussetzungen</td><td colspan="7">Grundlegende Kenntnisse der Fernerkundung</td></tr>
</table>

<table>
<tr><td>Module
GEO 97</td><td colspan="4">Module title
Isotope-Based Ecosystem Analysis</td><td colspan="4">Module type
M.Sc. Wahlpflicht</td></tr>
<tr><td>ECTS-Points</td><td colspan="8">6</td></tr>
<tr><td>Work effort
- Contact time
- Self-study</td><td colspan="3">workload
180 h</td><td colspan="3">Contact time:
60 h / 4 SWS</td><td colspan="2">Self-study:
120 h</td></tr>
<tr><td>Duration
Module coordinator</td><td colspan="4">1 Semester</td><td colspan="4">Oelmann</td></tr>
<tr><td>Frequency</td><td colspan="8">every winter term</td></tr>
<tr><td>Language</td><td colspan="8">German, English upon request</td></tr>
<tr><td>Teaching form</td><td colspan="8">Seminar, Exercise
Details will be announced at the beginning of the semester via the alma-portal.</td></tr>
<tr><td>Module content</td><td colspan="8">Solving complex environmental problems requires a detailed understanding of processes, which can be obtained by stable isotope analysis. Therefore, students will learn the latest methods of isotope-based ecosystem analysis via short lectures and apply them in small projects in the laboratory.
The laboratory course is mainly focused on isotope analysis and hands-on-training.
In summary, the module includes the following topics:
• Introduction to isotope-based ecosystem analytics,
• Theoretical basics of isotope analyses,
• Practical implementation in the laboratory,
• Comparison with reference databases/standardized laboratory experiments.</td></tr>
<tr><td>Qualification aims</td><td colspan="8">By completing the module, the students
• possess advanced skills of practical preparation and execution of isotope analyses.
• are able to independently develop and apply new and complex methods including the planning of work steps in the laboratory.
• are able to link complex methods with applied questions.
• are able to present analysis results in a didactically structured manner and are able to defend them scientifically in a critical discussion with the lecturer and fellow students.</td></tr>
<tr><td rowspan="5">Requirements for Obtaining Credit, Grading, Weight if appl.</td><td>Title</td><td>Art der Lernform</td><td>Status</td><td>SWS</td><td>LP</td><td>Prüfungsform</td><td>Prüfungsdauer</td><td>Benotungssystem</td><td>Berechnung Modulnote</td></tr>
<tr><td rowspan="3">Isotope-based ecosystem analysis</td><td>VL</td><td>o</td><td>1</td><td>1,5</td><td>-</td><td>-</td><td>kP</td><td>-</td></tr>
<tr><td>S</td><td>o</td><td>1</td><td>1,5</td><td rowspan="2">PF</td><td>30</td><td rowspan="2">b</td><td>50</td></tr>
<tr><td>Ü</td><td>o</td><td>2</td><td>3</td><td>-</td><td>50</td></tr>
<tr><td colspan="8">The portfolio examination includes a talk and a written report.</td></tr>
<tr><td>Applicability</td><td colspan="8">M.Sc. Physische Geographie; M.Sc. Geoökologie/Geoecology</td></tr>
<tr><td>Prerequisites</td><td colspan="8">GEO 85</td></tr>
</table>

Elective Modules Department of Biology

Module Number: **M 234**	Module Title: **Experimental and Analytical Methods in Environmental Chemistry & Ecotoxicology**					Type of Module: M.Sc. Elective			
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h	Contact Time: 150 h / 11 SWS				Private Study: 30 h			
Duration Module Coordinator	4 weeks	Köhler							
Regular Cycle	every semester								
Language	English								
Learning- / Teaching Forms	Practical exercises, lectures								
Module Content	The course concentrates on practical skills. Experimental and analytical methods currently applied in ecotoxicology and/or environmental chemistry will be taught, both theoretically and, predominantly, practically. The work focusses on an experimental onset which will be conducted and/or sampled and/or analysed.								
Qualification Goals	Gaining profound knowledge about selected experimental and analytical methods currently applied in ecotoxicology and/or environmental chemistry at the state-of-the-art level.								
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*
	Methods in ecotoxicology and environmental chemistry	*L*	*o*	*1*	*1*	*WE/ OE*	*-*	*g*	*10%*
		LC/ FC	*o*	*10*	*5*	*R/LP*	*-*	*g*	*90%*
Applicability	M.Sc. Geoökologie/Geoecology								
Prerequisites	-								

Module Number: **M 235**	Module Title: **Advanced Ecotoxicology**								Type of Module: M.Sc. Elective
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 150 h / 11 SWS						Private Study: 30 h
Duration Module Coordinator	1 Semester				Köhler, Triebskorn				
Regular Cycle	every winter semester 4 weeks block course, alternating every other year Ecotoxicology II or Ecotoxicology III								
Language	English (optional)								
Learning- / Teaching Forms	Seminars, Laboratory Exercises, Field Courses								
Module Content	The course focuses on the application of ecotoxicology in practice. Either samples taken from an exposure experiment will be analysed for selected biomarkers (Ecotoxycology III) or standard toxicity tests will be conducted following international guidelines (Ecotoxicology II). The theoretical background, respectively, will be summarized by the students. Students will give a congress-style presentation. The course also involves excursions to institutions (regulation/academics/industry).								
Qualification Goals	Gaining detailed theoretical and practical knowlegde on either the biomarker concept regarding sublethal toxicity of chemicals (Ecotoxiocology III) or standardized methods for toxicity testing (Ecotoxicology II).								
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*
	Ecotoxicology 2 (every other year)	*S*	*c*	*1*	*1*	*R*	*-*	*g*	*33%*
		LC	*c*	*8*	*3*	*A*	*-*	*g*	*67%*
		FC	*c*	*2*	*2*	*-*	*-*	*-*	*-*
	Ecotoxicology 3 (every other year)	*S*	*c*	*0,5*	*0,5*	*R*		*g*	*33%*
		LC	*c*	*10,5*	*5,5*	*a*		*g*	*67%*
Applicability	M.Sc. Geoökologie/Geoecology								
Prerequisites	Lecture series (VL) "Ecotoxicology" that is part of the "Ecotoxicology I" and "Ecotoxicology and Environmental Chemistry" modules, or equivalent.								

<table>
<tr><td>Module Number:
M 237</td><td colspan="5">Module Title:
Field Ecology II</td><td colspan="4">Type of Module:
M.Sc. Elective</td></tr>
<tr><td>Credits (ECTS)</td><td colspan="9">6</td></tr>
<tr><td>Workload
- Contact Time
- Private Study</td><td colspan="3">Workload:
180 h</td><td colspan="3">Contact Time:
130 h / 3 SWS</td><td colspan="3">Private Study:
50 h</td></tr>
<tr><td>Duration
Module Coordinator</td><td colspan="4">2-3 weeks plus pre-and post-excursion seminars</td><td colspan="5">Tielbörger / various lecturers</td></tr>
<tr><td>Regular Cycle</td><td colspan="9">summer or winter semester (mostly summer)</td></tr>
<tr><td>Language</td><td colspan="9">English</td></tr>
<tr><td>Learning- / Teaching Forms</td><td colspan="9">Field exercises, seminars, data collection and analyses</td></tr>
<tr><td>Module Content</td><td colspan="9">• Species (plants and animals) is conveyed through identification exercises, and this knowledge is gained primarily through observation in the field.
• In field exercises, methods of terrestrial, aquatic, and/or marine ecology are learned by designing own experiments or observations.
• Seminars as preparation and follow-up of the field exercises are conducted, in which an experimental design is developed. During the field course, a short seminar about a selected topic is presented. The results of the field exercises are analysed and presented in written or oral form at the end.
• The contents are conveyed via excursions and associated seminars/field exercises offered by the Department of Biology. One of the following courses is recommended, but alternative excursions/field courses may be selected after consultation with the module coordinator: Marine Biodiversity (6ECTS), Tropical Marine Ecology (6ECTS), Alpine Ecology and Vegetation (6ECTS), Tamariu (6 ECTS), Wadden Sea (6ECTS)</td></tr>
<tr><td>Qualification Goals</td><td colspan="9">The students will be acquainted with the biodiversity of plants and animals as well as with the various biotic and abiotic interactions of organisms with their environment. The students are able to recognize the most common plant and animal groups. The students are able to recognize and describe, in a quantitative manner, ecological patterns in the field. They should be able to analyse own data, and interpret the data based on ecological theory. Furthermore, presentation techniques will be practiced.</td></tr>
<tr><td rowspan="2">Requirements for Obtaining Credit, Grading, Weight if appl.</td><td>Courses</td><td>Type of Lecture</td><td>Status</td><td>CH</td><td>CP</td><td>Type of Exam / Study Requirement</td><td>Duration of Exam</td><td>Grading System</td><td>Weighting</td></tr>
<tr><td>Field Ecology 2</td><td>FC, PR, S</td><td>c</td><td>-</td><td>6</td><td>A, R</td><td>-</td><td>g</td><td>-</td></tr>
<tr><td>Applicability</td><td colspan="9">M.Sc. Geoökologie/Geoecology</td></tr>
<tr><td>Prerequisites</td><td colspan="9">Basic knowledge of plant and animal taxonomy and ecology, basic knowledge of statistics and experimental design, basic knowledge of ecological theory</td></tr>
</table>

Modulnummer: **3012**	Modultitel: **Entomologie I: Evolution und Ökologie der Insekten**								Art des Moduls: M.Sc. Wahlpflicht
ECTS-Punkte	6								
Arbeitsaufwand - Kontaktzeit - Selbststudium	Arbeitsaufwand: 180 h		Kontaktzeit: 100 h / 6 SWS						Selbststudium: 80 h
Moduldauer Modulkoordination	1 Semester				Betz				
Häufigkeit des Angebots	jedes zweite Jahr								
Unterrichtssprache	Deutsch								
Lehr- / Lernformen	Vorlesung, Seminar, Exkursion								
Modulinhalt	Das Modul gibt einen Überblick über einen großen Bereich der Entomologie. Dabei werden vor einem evolutionsbiologischen Hintergrund Aspekte der Morphologie, Physiologie und Ökologie dieser größten Tiergruppe behandelt. Grundlegende Konzepte und Mechanismen werden anhand von Fallbeispielen einzelner Insektentaxa erläutert. Auch der Bereich der angewandten Entomologie findet in der Vorlesung Berücksichtigung. In dem begleitenden Seminar werden wichtige Aspekte der Ökologie der Insekten anhand einschlägiger Originalpublikationen besprochen. Es findet zudem eine einwöchige entomologische Exkursion statt. Neben terrestrischen und aquatischen Insekten werden auch allgemein naturkundliche Fragen behandelt.								
Qualifikationsziele	Erlangung einer Übersicht über den Insektenstammbaum, verbunden mit den Leistungen, der ökologischen Bedeutung und Anwendungsrelevanz der einzelnen Gruppen. Kennenlernen und Ansprache terrestrischer und aquatischer Insekten im Feld. Auseinandersetzung mit entomologischen Fachpublikationen und deren Aufarbeitung im Rahmen einer Präsentation. Mündliche Diskussion fachspezifischer Inhalte.								
Voraussetzung für die Vergabe von Leistungspunkten/ Benotung (ggf. Gewichtung)	*Lehrveranstaltungen*	*Art der Lehr form*	*Status*	*SWS*	*LP*	*Prüfungsform/ Studienleistung*	*Prüfungsdauer*	*Benotungssystem*	*Gewichtung*
	Modulbestandteil	*V*	*o*	*2*	*2*	*K*	*2 h*	*b*	*0,5*
	Modulbestandteil	*S*	*o*	*2*	*2*	*R*	*45 min*	*b*	*0,5*
	Modulbestandteil	*GÜ*	*o*	*2*	*2*	*LP*	*-*	*ub*	*-*
Verwendbarkeit	M.Sc. Geoökologie/Geoecology Ergänzung zu Entomologie II und anderen zoologisch-ökologischen Modulen								
Teilnahmevoraussetzungen	Zoologisches Grundpraktikum des ersten Studienjahres								

Modulnummer: **3013**	Modultitel: **Entomologie III: Morphologisch systematische Übungen**								Art des Moduls: M.Sc. Wahlpflicht
ECTS-Punkte	6								
Arbeitsaufwand - Kontaktzeit - Selbststudium	Arbeitsaufwand: 140 h		Kontaktzeit: 80 h, 6 SWS						Selbststudium: 60 h
Moduldauer Modulkoordination	1 Semester				Weber				
Häufigkeit des Angebots	jedes Sommersemester								
Unterrichtssprache	Deutsch								
Lehr- /Lernformen	Vorlesung, Übung, Geländeübung								
Modulinhalt	Das Modul besteht aus einer zweistündigen Vorlesung und insgesamt vierstündigen Übungen sowie mehreren halbtägigen Exkursionen. Themen: Phylogenie, Evolution und Systematik der Insekten, Biodiversität, mitteleuropäische Insektenfauna								
Qualifikationsziele	• Kenntnisse zu Bau, Funktion und Evolution der Insekten. • Verstehen der Biodiversität als Ergebnis eines konkreten historischen Vorgangs unter ökologischen und konstruktiven Rahmenbedingungen. • Kenntnis und Anwendung phylogenetischer Verfahren und hierzu nötiger Konzepte. • Kenntnis der heimischen Insektenfauna, Fähigkeit sich auch in andere Faunen einzuarbeiten. • Beherrschen und Anwenden entsprechender Bestimmungstechniken. • Einführung in Sammel-, Konservierungs- und Präparationstechniken. • Kritisches Arbeiten und Herausbilden eines fundierten fachlichen Urteilsvermögens zu allen behandelten Themen.								
Voraussetzung für die Vergabe von Leistungspunkten/ Benotung (ggf. Gewichtung)	*Lehrveranstaltungen*	*Art der Lehrform*	*Status*	*SWS*	*LP*	*Prüfungsform/ Studienleistung*	*Prüfungsdauer*	*Benotungssystem*	*Gewichtung*
	Vorlesung	*V*	*o*	*2*	*3*	*K*	*45*		*50*
	Bestimmungsübungen	*Ü*	*o*	*4*	*3*	*K*	*45*		*50*
	1-tägige Exkursionen	*GÜ*	*f*						
Verwendbarkeit	M.Sc. Geoökologie/Geoecology Nützlich für Veranstaltungen der Zoologie, Geoökologie und Paläontologie, welche Insekten oder Arthropoden behandeln, insbesondere für entsprechende Geländeübungen.								
Teilnahmevoraussetzungen	„Zoologie II" oder vergleichbare Kenntniss "Entomologie I" und "Entomologie II" sind hilfreich, werden aber nicht vorausgesetzt								

Modulnummer: **3032**	Modultitel: **Limnologie**								Art des Moduls: M.Sc. Wahlpflicht
ECTS-Punkte	6								
Arbeitsaufwand - Kontaktzeit - Selbststudium	Arbeitsaufwand: 180 h		Kontaktzeit: 130 h / 9 SWS						Selbststudium: 50 h
Moduldauer Modulkoordination	4 Wochen im Block (Mo-Do), Vollzeit			Peschke					
Häufigkeit des Angebots	jedes Sommersemester								
Unterrichtssprache	Deutsch								
Lehr- /Lernformen	Seminar, Praktikum								
Modulinhalt	Im Rahmen eines Seminars sowie von Freilandarbeiten und Bestimmungsübungen sollen Grundlagen der Ökologie der Fließ- und Stillgewässer erarbeitet werden. Die Teilnehmer/innen halten einen Seminarvortrag und erstellen ein Protokoll zum praktischen Teil. Das Modul endet mit einem Abschlusskolloquium.								
Qualifikationsziele	Vermittlung detaillierte Kenntnisse zur Ökologie und Artenvielfalt der Fließ- und Stillgewässer.								
Voraussetzung für die Vergabe von Leistungspunkten/ Benotung (ggf. Gewichtung)	*Lehrveranstaltungen*	*Art der Lehrform*	*Status*	*SWS*	*LP*	*Prüfungsform/ Studienleistung*	*Prüfungsdauer*	*Benotungssystem*	*Gewichtung*
	Seminar	*S*	*o*	*1*	*2*	*R*	*-*	*b*	*33%*
	Praktikum	*P*	*o*	*8*	*4*	*H + mündl. Kolloquium*	*-*	*b*	*67%*
Verwendbarkeit	M.Sc. Geoökologie/Geoecology, B.Sc. Biologie, M.Sc. Evolution und Ökologie								
Teilnahmevoraussetzungen	keine								

Modulnummer: **3051**	Modultitel: **Ökologie und Vegetation der Alpen**					Art des Moduls: M.Sc. Wahlpflicht			
ECTS-Punkte	6								
Arbeitsaufwand - Kontaktzeit - Selbststudium	Arbeitsaufwand: 180 h		Kontaktzeit: 60 h / 4 SWS			Selbststudium: 120 h			
Moduldauer Modulkoordination	eine Woche ganztags				Koltzenburg, Stoll, Tielbörger				
Häufigkeit des Angebots	jedes zweite Sommersemester								
Unterrichtssprache	Deutsch								
Lehr- / Lernformen	Vorlesung, Übung, Geländeübung								
Modulinhalt	Allgemeine Einführung in die Biologie und Ökologie der Alpen, Einführung in die häufigen Tier- und Pflanzengruppen des Gebirgsökoystems der Alpen. Einführung in Vegetation und Klima der Alpen. Bestimmungsübungen und Vorlesung in Tübingen, Geländeübung vor Ort (sechs Tage ganztags)								
Qualifikationsziele	Die Studierenden • können das Ökosystem Alpen und seine Zonierung beschreiben • kennen die wichtigsten Vegetationstypen der Alpen • kennen die häufigsten Pflanzenarten der Alpen								
Voraussetzung für die Vergabe von Leistungspunkten / Benotung (ggf. Gewichtung)	*Lehrveranstaltungen*	*Art der Lehrform*	*Status*	*SWS*	*LP*	*Prüfungsform/ Studienleistung*	*Prüfungsdauer*	*Benotungssystem*	*Gewichtung*
	Einführungsvorlesung	*V*	*O*	*0,5*	*-*	*ET*	*-*	*ub*	*-*
	Übung	*Ü*	*O*	*0,5*	*-*	*ET*	*-*	*ub*	*-*
	Geländeübung	*GÜ*	*O*	*3*	*-*	*H*	*-*	*b*	*100%*
Verwendbarkeit	Biologie/Geoökologie: alle Studiengänge								
Teilnahmevoraussetzungen	erfolgreiche Teilnahme an "Botanik" und "Botanik II" körperliche Fitness								

Modulnummer: **3052**	Modultitel: **Ökologie des Wattenmeers**								Art des Moduls: M.Sc. Wahlpflicht
ECTS-Punkte	6								
Arbeitsaufwand - Kontaktzeit - Selbststudium	Arbeitsaufwand: 180 h		Kontaktzeit: 100 h/ 6,5 SWS						Selbststudium: 80 h
Moduldauer Modulkoordination	2 Wochen Exkursion, Feldübung und Seminar			Triebskorn					
Häufigkeit des Angebots	jedes zweite Sommersemester								
Unterrichtssprache	Deutsch								
Lehr- / Lernformen	Exkursion, Geländeübungen, Seminar,								
Modulinhalt	Vermittlung grundlegender Kenntnisse zur Ökologie des Wattenmeers in Theorie und Praxis. Hierzu Besuch von Forschungseinrichtungen im norddeutschen Raum, Ausfahrten mit Forschungsschiffen, Vor-Ort-Übungen im Wattenmeer, Bestimmungsübungen, Durchführung und Vorstellung kleiner Experimente (in Kleingruppen) zur Ökologie des Wattenmeeres. Seminarvorträge der Studierenden zur Ökologie des Wattenmeeres: Entstehung, Bedeutung, Bewohner, Lebensgemeinschaften, Seminarvorträge vor Ort, während der Exkursion.								
Qualifikationsziele	Vermittlung detaillierte Kenntnisse zur Ökologie des Wattenmeers, Verständnis der Interaktion von abiotischen Voraussetzungen, Fauna und Küstenschutz; Vermittlung von Artenkenntnis								
Voraussetzung für die Vergabe von Leistungspunkten / Benotung (ggf. Gewichtung)	*Lehrveranstaltungen*	*Art der Lehrform*	*Status*	*SWS*	*LP*	*Prüfungsform/ Studienleistung*	*Prüfungsdauer*	*Benotungssystem*	*Gewichtung*
	Seminar	*S*	*o*	*2*	*2*	*R*	*-*	*b*	*33%*
	Geländeübung	*GÜ*	*o*	*4,5*	*4*	*ET/R /H*	*-*	*b*	*67%*
Verwendbarkeit	M.Sc. Geoökologie/Geoecology, B.Sc. Biologie, M.Sc. Evolution und Ökologie								
Teilnahmevoraussetzungen	Module des 1. und 2. Jahres B.Sc. Biologie bzw. Kenntnis der Inhalte derselben								

Modulnummer: **3053**	Modultitel: **Ökotoxikologie** I								Art des Moduls: M.Sc. Wahlpflicht
ECTS-Punkte	6								
Arbeitsaufwand - Kontaktzeit - Selbststudium	Arbeitsaufwand: 180 h		Kontaktzeit: 60 h / 4 SWS						Selbststudium: 120 h
Moduldauer Modulkoordination	4 Stunden wöchentlich als Schiene				Köhler, Triebskorn				
Häufigkeit des Angebots	Jedes WS								
Unterrichtssprache	Deutsch								
Lehr- / Lernformen	Vorlesung / Literaturseminar								
Modulinhalt	Ausgehend von einer historischen Betrachtung der Umwelttoxikologie werden zunächst deren Aufgabengebiete definiert und wichtige Begriffe erläutert. Danach werden Möglichkeiten der Biotransformation von Umweltschadstoffen sowie Vorkommen, Aufnahme in den Organismus und die diversen Wirkungen von Xenobiotica besprochen. In der Ökotoxikologie etablierte Biotests werden exemplarisch vorgestellt sowie Vorteile der suborganismischen Indikation anhand geeigneter Biomarker erläutert (Risikoabschätzung). Abschließend werden Indikationsmöglichkeiten auf ökosystemarer Ebene besprochen.								
Qualifikationsziele	Vermittlung von grundlegenden Kenntnissen zur Ökotoxikologie. Grundverständnis der biotischen Effekte von Umweltschadstoffen. Verständnis von Originalliteratur (Artikel in internationalen Zeitschriften), Moderation von wissenschaftlichen Diskussionen.								
Voraussetzung für die Vergabe von Leistungspunkten / Benotung (ggf. Gewichtung)	*Lehrveranstaltungen*	*Art der Lehrform*	*Status*	*SWS*	*LP*	*Prüfungsform / Studienleistung*	*Prüfungsdauer*	*Benotungssystem*	*Gewichtung*
	Vorlesung	*V*	*o*	*2*	*3*	*K*	*100 min*	*b*	*50%*
	Literaturseminar	*S*	*o*	*2*	*3*	*Moderation*	*90 min*	*b*	*50%*
Verwendbarkeit	M.Sc. Geoökologie/Geoecology, B.Sc. Biologie, verwendbar für M.Sc.-Module im M.Sc. Evolution und Ökologie								
Teilnahmevoraussetzungen	Physiologische und zellbiologische Grundkenntnisse								

Modulnummer: **3054**	Modultitel: **Ökotoxikologie II**								Art des Moduls: M.Sc. Wahlpflicht
ECTS-Punkte	6								
Arbeitsaufwand - Kontaktzeit - Selbststudium	Arbeitsaufwand: 180 h			Kontaktzeit: 150 h / 11 SWS					Selbststudium: 30 h
Moduldauer Modulkoordination	4 Wochen ganztags					Köhler, Triebskorn			
Häufigkeit des Angebots	Jedes WS								
Unterrichtssprache	Deutsch								
Lehr- / Lernformen	Exkursion, Laborübungen, Seminar,								
Modulinhalt	Ziel dieses Kurses ist es, die von Umweltschadstoffen ausgehenden Problematiken zu besprechen und einen Überblick über die möglichen Vorgehensweisen mit diesen Problemen zu erarbeiten. Die Lehrveranstaltung beinhaltet sowohl die Durchführung ökotoxikologischer Standardtests, als auch die Einbeziehung der erhobenen Daten in die Risikobewertung sowie Literaturrecherchen. Es werden Seminarbeiträge zu diversen Spezialthemen vergeben und Exkursionen zu verschiedenen Behörden und ökotoxikologischen Forschungseinrichtungen durchgeführt.								
Qualifikationsziele	Die erworbenen Kenntnisse sollen den Studierenden dazu dienen, einen übergreifenden Einblick in die Ökotoxikologie zu erhalten, sowie die von den Behörden und Forschungsinstitutionen zunehmend geforderten Kenntnisse über den Umgang mit Umweltchemikalien zu erlernen.								
Voraussetzung für die Vergabe von Leistungspunkten / Benotung (ggf. Gewichtung)	*Lehrveranstaltungen*	*Art der Lehrform*	*Status*	*SWS*	*LP*	*Prüfungsform/ Studienleistung*	*Prüfungsdauer*	*Benotungssystem*	*Gewichtung*
	Seminar	*S*	*o*	*1*	*1*	*R*	*-*	*b*	*33%*
	Laborübung	*Ü*	*o*	*8*	*3*	*H*	*-*	*b*	*67%*
	Exkursion	*E*	*o*	*2*	*2*				
Verwendbarkeit	M.Sc. Geoökologie/Geoecology, B.Sc. Biologie, verwendbar für M.Sc.-Module im M.Sc. Evolution und Ökologie								
Teilnahmevoraussetzungen	Grundlagen der Ökotoxikologie								

Modulnummer: **3072**	Modultitel: **Vertebraten II: Wirbeltiere im Freiland**								Art des Moduls: M.Sc. Wahlpflicht
ECTS-Punkte	6								
Arbeitsaufwand - Kontaktzeit - Selbststudium	Arbeitsaufwand: 140 h		Kontaktzeit: 50 h						Selbststudium: 90 h
Moduldauer Modulkoordination	1 Monat				Weber				
Häufigkeit des Angebots	jedes Studienjahr								
Unterrichtssprache	Deutsch								
Lehr- / Lernformen	Geländeübung, Übung								
Modulinhalt	Das Modul besteht aus einwöchigen Bestimmungsübungen sowie einer etwa dreiwöchigen zoologischen Exkursion in ein europäisches Faunengebiet. Themen: terrestrische Biodiversität und Autökologie, Faunistik (einschl. praktischer Erfassung einer Fauna) und Biogeographie								
Qualifikationsziele	• Kenntnis europäischer Tetrapoden und ihrer Autökologie • Fähigkeit sich auch in andere Faunen einzuarbeiten. • Qualitatives und quantitatives Erfassen der Biodiversität im Gelände. • Kenntnis und Anwendung entsprechender Bestimmungstechniken und Kartierungsmethoden. • Kritisches Arbeiten und Herausbilden eines fundierten fachlichen Urteilsvermögens zu allen behandelten Themen.								
Voraussetzung für die Vergabe von Leistungspunkten/ Benotung (ggf. Gewichtung)	*Lehrveranstaltungen*	*Art der Lehrform*	*Status*	*SWS*	*LP*	*Prüfungsform/ Studienleistung*	*Prüfungsdauer*	*Benotungssystem*	*Gewichtung*
	Bestimmungsübung	*Ü*	*O*	*1*	*1*	*K*	*45*		
	Geländepraktikum	*GÜ*	*O*	*5*	*5*	*LP*			
Verwendbarkeit	M.Sc. Geoökologie/Geoecology ergänzt "Vertebraten III" "Vertebraten II" ist nützlich für entsprechende Freilandarbeiten.								
Teilnahmevoraussetzungen	„Vertebraten III" oder vergleichbare Kenntnisse sind hilfreich. Entsprechende Bewerber werden bevorzugt.								

Module Number: **3074**	Module Title: **Scientific Writing Skills**								Type of Module: M.Sc. Elective
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 60 h / 2 SWS						Private Study: 120 h
Duration Module Coordinator	4-week block (typically W3)			Nils Anthes					
Regular Cycle	Once per year								
Language	English								
Learning- / Teaching Forms	Lecture, seminar, project								
Module Content	Along the module, we scrutinize the principles of scientific writing in the Life Sciences. Covered topics include (i) steps to initiate a writing task, (ii) the structure and components of scientific texts, (iii) techniques to achieve a consistent, coherent and unambiguous writing style, (iv) approaches to revise and finalize scientific texts, and (v) the publication process in primary journals (including submission and manuscript review). Moreover, we discuss the extent to which writing style or structure differ between scientific papers and student theses, and move on to the specificities of research proposals, funding applications, and job applications. All participants apply the principles developed during the workshop sessions to an individual current writing project, and repeatedly provide and receive structured peer-feedback.								
Qualification Goals	Students acquire the basic principles of scientific writing in the Life Sciences, in particular with respect to text structure and the development of logic flow. Students can apply those principles when drafting their own scientific texts in English, be it for own theses or manuscripts for publication.								
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*
	Lecture + Seminar	*L,S*	*C*	*2*	*2*	*R*		*g*	*30%*
	Project	*PR*	*C*	*4*	*4*	*A*		*g*	*70%*
Applicability	M.Sc. Geoökologie/Geoecology								
Prerequisites	none								

Modulnummer: **3079**	Modultitel: **Ökotoxikologie III**								Art des Moduls: M.Sc. Wahlpflicht
ECTS-Punkte	6								
Arbeitsaufwand - Kontaktzeit - Selbststudium	Arbeitsaufwand: 180 h		Kontaktzeit: 150 h / 11 SWS						Selbststudium: 30 h
Moduldauer Modulkoordination	4 Wochen ganztags				Köhler, Triebskorn				
Häufigkeit des Angebots	Wintersemester, jedes 4. Semester								
Unterrichtssprache	deutsch								
Lehr- /Lernformen	Laborübungen in Kleingruppen, Seminar,								
Modulinhalt	Praxisbezogene Vermittlung des Biomarkerkonzepts in der Ökotoxikologie. Durchführung von Biomarkernachweisen / -quantifikationen im Labor anhand von Originalproben. Erarbeitung des theoretischen Hintergrunds der untersuchten Biomarker. Integration von Ergebnissen verschiedener Kleingruppen und Präsentation in einem Vortrag (Kongress-Stil).								
Qualifikationsziele	Vermittlung detaillierter praktischer und theoretischer Kenntnisse zum Biomarkerkonzept, Erlernen und Durchführung umwelttoxikologischer Methoden zur „Quantifikation von Biomarkerantworten im Labor in einzeln betreuten Gruppenversuchen.								
Voraussetzung für die Vergabe von Leistungspunkten/ Benotung (ggf. Gewichtung)	*Lehrveranstaltungen*	*Art der Lehrform*	*Status*	*SWS*	*LP*	*Prüfungsform/ Studienleistung*	*Prüfungsdauer*	*Benotungssystem*	*Gewichtung*
	Seminar	*S*	*o*	*0,5*	*0,5*	*R*	*-*	*b*	*33%*
	Laborübung	*Ü*	*o*	*10, 5*	*5,5*	*H*	*-*	*b*	*67%*
Verwendbarkeit	M.Sc. Geoökologie/Geoecology, B.Sc. Biologie, verwendbar für M.Sc.-Module im M.Sc. Evolution und Ökologie								
Teilnahmevoraussetzungen	Grundlagen der Ökotoxikologie								

<table>
<tr><td>Modulnummer:
3081</td><td colspan="5">Modultitel:
Vertebraten III: Morphologisch-systematische Übungen</td><td colspan="4">Art des Moduls:
M.Sc. Wahlpflicht</td></tr>
<tr><td>ECTS-Punkte</td><td colspan="9">12</td></tr>
<tr><td>Arbeitsaufwand
- Kontaktzeit
- Selbststudium</td><td colspan="3">Arbeitsaufwand:
230 h</td><td colspan="3">Kontaktzeit:
100 h / 7 SWS</td><td colspan="3">Selbststudium:
130 h</td></tr>
<tr><td>Moduldauer
Modulkoordination</td><td colspan="4">1 Semester</td><td colspan="5">Weber</td></tr>
<tr><td>Häufigkeit
des Angebots</td><td colspan="9">jedes Wintersemester</td></tr>
<tr><td>Unterrichtssprache</td><td colspan="9">Deutsch</td></tr>
<tr><td>Lehr- / Lernformen</td><td colspan="9">Vorlesung, Übung, Geländeübung</td></tr>
<tr><td>Modulinhalt</td><td colspan="9">Das Modul besteht aus einer dreistündigen Vorlesung und insgesamt vierstündigen Übungen sowie zwei eintägigen Exkursionen.
Themen: Phylogenie, Evolution und Systematik der Wirbeltiere, Biodiversität, mitteleuropäische Wirbeltierfauna, vergleichende Osteologie, Funktionsmorphologie</td></tr>
<tr><td>Qualifikationsziele</td><td colspan="9">• Kenntnisse von Bau, Funktion und Evolution der Wirbeltiere.
• Verstehen der Biodiversität als Ergebnis eines konkreten historischen Vorgangs unter ökologischen und konstruktiven Rahmenbedingungen.
• Kenntnis und Anwendung phylogenetischer Verfahren und hierzu nötiger Konzepte.
• Spezifische Kenntnis der heimischen Wirbeltierfauna.
• Fähigkeit sich auch in andere Faunen einzuarbeiten.
• Beherrschen und Anwenden entsprechender Bestimmungstechniken.
• Kenntnis, Anwendung und kritische Würdigung von Artkonzepten.
• Kritisches Arbeiten und Herausbilden eines fundierten fachlichen Urteilsvermögens zu allen behandelten Themen.</td></tr>
<tr><td rowspan="5">Voraussetzung für die Vergabe von Leistungspunkten / Benotung (ggf. Gewichtung)</td><td>Lehrveranstaltungen</td><td>Art der Lehrform</td><td>Status</td><td>SWS</td><td>LP</td><td>Prüfungsform/ Studienleistung</td><td>Prüfungsdauer</td><td>Benotungssystem</td><td>Gewichtung</td></tr>
<tr><td>Vorlesung</td><td>V</td><td>O</td><td>3</td><td>4</td><td>K</td><td>45</td><td></td><td>30</td></tr>
<tr><td>Osteologische Übungen</td><td>Ü</td><td>O</td><td>2</td><td>4</td><td>K</td><td>45</td><td></td><td>30</td></tr>
<tr><td>Bestimmungsübungen</td><td>Ü</td><td>O</td><td>2</td><td>4</td><td>K</td><td>45</td><td></td><td>40</td></tr>
<tr><td>1-tägige Exkursionen</td><td>GÜ</td><td>F</td><td>1</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Verwendbarkeit</td><td colspan="9">M.Sc. Geoökologie/Geoecology
"Vertebraten III" ist nützlich für alle Veranstaltungen der Zoologie, Geoökologie, Zoophysiologie, Paläontologie und Archäozoologie, die Wirbeltiere oder Evolution behandeln, insbesondere auch für entsprechende Geländeübungen.</td></tr>
<tr><td>Teilnahmevoraussetzungen</td><td colspan="9">Modul „Zoologie II" oder vergleichbare Kenntnisse
"Vertebraten I" ist sehr hilfreich, wird aber nicht vorausgesetzt.</td></tr>
</table>

Modulnummer: **3094**	Modultitel: **Entomologie II: Morphologie und Systematik der Arthropoden**					Art des Moduls: M.Sc. Wahlpflicht			
ECTS-Punkte	6								
Arbeitsaufwand - Kontaktzeit - Selbststudium	Arbeitsaufwand: 180 h		Kontaktzeit: 100 h / 6 SWS			Selbststudium: 80 h			
Moduldauer Modulkoordination	4 Wochen, Block während des Semesters			Betz					
Häufigkeit des Angebots	jedes zweite Jahr								
Unterrichtssprache	Deutsch								
Lehr- / Lernformen	Vorlesung, Seminar, Praktikum								
Modulinhalt	In einem vergleichenden Ansatz wird die funktionelle Morphologie der Arthropoden inklusive ihrer Entwicklungsstadien behandelt. Anhand von Alkoholmaterial und histologischen Schnittpräparaten werden die wichtigsten Elemente des Insektenkörpers erarbeitet und vor dem Hintergrund der Evolution, Systematik und Lebensweise der Insekten interpretiert. In zum Teil experimentell ausgerichteten Einzelprojekten werden von den Teilnehmern zudem morphologisch-physiologische Spezialthemen bearbeitet.								
Qualifikationsziele	Kennen lernen der wichtigsten Vertreter der Arthropoda anhand von Alkoholmaterial, histologischen Schnittpräparaten und Lebendbeobachtungen. Erarbeitung der Elemente des Insektenkörpers anhand von Alkoholmaterial und histologischen Schnittserien; Funktionelle Morphologie der Insekten. Selbständige Bearbeitung morphologisch-systematischer Spezialthemen über Milben, Krebse und Insekten.								
Voraussetzung für die Vergabe von Leistungspunkten / Benotung (ggf. Gewichtung)	*Lehrveranstaltungen*	*Art der Lehrform*	*Status*	*SWS*	*LP*	*Prüfungsform/ Studienleistung*	*Prüfungsdauer*	*Benotungssystem*	*Gewichtung*
	Modulbestandteil	*V*	*O*	*2*	*2*	*kP*	*-*	*ub*	*-*
	Modulbestandteil	*LP*	*O*	*1*	*1*	*H, LP*	*-*	*b*	*0,5, 0,5*
Verwendbarkeit	M.Sc. Geoökologie/Geoecology Ergänzung zu "Entomologie I" und anderen zoologisch-ökologischen Modulen								
Teilnahmevoraussetzungen	Zoologisches Grundpraktikum des ersten Studienjahres								

Modulnummer: **3098**	Modultitel: **Biomimetics of Animal Constructions**								Art des Moduls: M.Sc. Wahlpflicht
ECTS-Punkte	6								
Arbeitsaufwand - Kontaktzeit - Selbststudium	Arbeitsaufwand: 180 h		Kontaktzeit: 60h / 2 SWS						Selbststudium: 120 h / 4 SWS
Moduldauer Modulkoordination	als Schiene halb- bis ganztägig nur 6 Termine sind Präsenztermine			Betz					
Häufigkeit des Angebots	jedes Studienjahr								
Unterrichtssprache	englisch								
Lehr- / Lernformen	Interdisziplinäre Projektarbeit zusammen mit Architekturstudenten der Universität Stuttgart								
Modulinhalt	Zusammen mit Architekturstudenten der Institute für Tragkonstruktionen und Konstruktives Entwerfen (Leitung Prof. Jan Knippers) sowie für Computerbasiertes Entwerfen (Leitung Prof. Achim Menges) der Universität Stuttgart soll in einem Gruppenprojekt versucht werden, eine von den Studierenden ausgewählte Tierkonstruktion aus der Gruppe der Invertebraten in eine bionisch inspirierte Gebäudeform zu übersetzen. Die Aufgabe der beteiligten Biologen und Geoökologen besteht darin, ein konkretes biologisches Vorbild auszuwählen und den Architekten in seinen wesentlichen Baumerkmalen zu präsentieren. Auf dieser Grundlage soll gemeinsam mit den Architekturstudenten eine Umsetzung dieses Vorbildes in eine bionische Gebäudekonstruktion (Modell) erarbeitet werden.								
Qualifikationsziele	Kooperation des Biologen / des Geoökologen mit bionisch motivierten Nicht-Biologen (Architekten). Ablauf bionischen Arbeitens von der Planung bis zur modellhaften Umsetzung. Einblick in die Konstruktions- und Baubionik. Abstrahierung zoologischer Konstruktionen für die bionische Umsetzung. Intensive Auseinandersetzung mit tierischen Konstruktionen und Bauplänen und deren Weitervermittlung an Nicht-Biologen.								
Voraussetzung für die Vergabe von Leistungspunkten / Benotung (ggf. Gewichtung)	*Lehrveranstaltungen*	*Art der Lehrform*	*Status*	*SWS*	*LP*	*Prüfungsform*	*Prüfungsdauer*	*Benotungssystem*	*Gewichtung*
	Modulbestandteil	*PR*	*o*	*6*	*6*	*R, H, LP*	*-*	*b, b, b*	*Je 0,33*
Verwendbarkeit	M.Sc. Geoökologie/Geoecology Ergänzung zu anderen biomimetischen Modulen								
Teilnahmevoraussetzungen	Vorbereitendes Lesen von Fachliteratur für das Fachreferat, Zoologisches Grundpraktikum des ersten Studienjahres								

Modulnummer: **3099**	Modultitel: **Bodenökologie**								Art des Moduls: B.Sc. Wahlpflicht
ECTS-Punkte	6								
Arbeitsaufwand - Kontaktzeit - Selbststudium	Arbeitsaufwand: 180 h		Kontaktzeit: 126 h / 8 SWS						Selbststudium: 54 h
Moduldauer Modulkoordination	15 Tage, ganztägig als Block			Betz					
Häufigkeit des Angebots	jedes zweite Jahr								
Unterrichtssprache	Deutsch								
Lehr- / Lernformen	Vorlesung, Seminar, praktische Laborarbeit, Auswertung unter Anleitung, eigenständige Präsentation								
Modulinhalt	Prozesse der Bodenbildung; ökologische Faktoren im Boden; Demonstration und Beproben von Bodentypen im Gelände; Bestimmung bodenkundlicher Parameter mittels Feld- und Labormethoden; Morphologie, Biologie und Ökologie der Bodentiere sowie die funktionelle Rolle der Bodentiergruppen im Teilsystem Boden. Determination von Elementen der Bodenmakrofauna. Typische Vertreter der Bodenfauna sind zu mikroskopieren und zeichnerisch darzustellen. Unterschiedliche Waldstandorte werden über KEMPSON-Extraktion beprobt und synökologisch verglichen. Daneben werden Kleingruppenprojekte zur Autökologie verschiedener Bodenorganismen vergeben. Das Modul besteht aus einem 1-wöchigen Einführungsteil in Tübingen und einem 10-tägigen Feldpraktikum mit Exkursionen in der Federseestation in Bad Buchau.								
Qualifikationsziele	Grundkenntnisse der Bodenökologie mit Schwerpunkt Bodenzoologie, Erlernen grundlegender (Freiland-)Techniken der Bodenkunde, Probenahmetechniken, Bestimmung und Zeichnung typischer Bodentiere; daneben Kennenlernen typischer Landschaftsformen der Schwäbischen Alb und Oberschwabens.								
Voraussetzung für die Vergabe von Leistungspunkten / Benotung (ggf. Gewichtung)	*Lehrveranstaltungen*	*Art der Lehrform*	*Status*	*SWS*	*LP*	*Prüfungsform / Studienleitung*	*Prüfungsdauer*	*Benotungssystem*	*Gewichtung*
	Modulbestandteil	*V*	*o*	*1*	*0,5*	*ET*	*-*	*kP*	*-*
	Modulbestandteil	*S*	*o*	*1*	*0,5*	*R*	*-*	*b*	*33,3%*
	Modulbestandteil	*GP*	*o*	*2*	*1*	*ET*	*-*	*kP*	*-*
	Modulbestandteil	*LP*	*o*	*2*	*2*	*H*		*b*	*33,3%*
	Modulbestandteil	*PR*	*o*	*2*	*2*	*LP*		*b*	*33,3%*
Verwendbarkeit	M.Sc. Geoökologie/Geoecology Ergänzung zu bodenkundlichen, freilandökologischen und zoologischen Modulen								
Teilnahme-voraussetzungen	Vorbereitendes Lesen von Fachliteratur für das Fachreferat, Zoologisches Grundpraktikum des ersten Studienjahres								

Module Number: **3102**	Module Title: **Global Change Ecology II (Conservation Biology)**								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 block				Thomassen				
Regular Cycle	every winter semester								
Language	English								
Learning- / Teaching Forms	The course is a mix of lectures, paper discussions given by the students, the development of a conservation-related project proposal, and presentations.								
Module Content	The course will introduce the concepts and strategies important in addressing biological conservation and sustainable management of natural and managed ecosystems. The main course elements and objectives are: 1) to provide a basic understanding of the ecological, evolutionary, and genetic principles necessary to understand biological diversity, 2) to describe and evaluate the threats to natural habitats, and 3) to explore integrative approaches for addressing solutions to the conservation of biodiversity. Ecological concepts and recent research results are discussed in a sociopolitical, economic, and policy context.								
Qualification Goals	1. An understanding of the concepts and challenges in the conservation of biodiversity. 2. Skills necessary to evaluate threats to biodiversity. 3. Skills in the fields of conservation planning and decision making, and those necessary to develop new ideas in these fields. 4. Critically read research papers and evaluate their scientific merit. 5. To participate in scientific discussions. 6. To present scientific research, including general presentation skills. 7. Scientific writing.								
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 Ecology 2	*L,S,PR*	*o*	*4*	*6*	*WE,A,R,SP*	*120*	*g*	
		The evaluation will be based upon participation in discussions, presentations, readings, written reports, and the final exam.							
Applicability	M.Sc. Geoökologie/Geoecology, B.Sc. Biology, M.Sc. Ecology & Evolution								
Prerequisites	-								

Module Number: **3108**	Module Title: **Theoretical Ecology II / Matrix Modeling**								Type of Module: M.Sc. Elective
Credits (ECTS)	6 Credits.								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 50 h / 4 SWS						Private Studies: 130 h
Duration Module Coordinator	3 weeks			Stoll					
Regular Cycle	every other year								
Language	English								
Learning- / Teaching Forms	Frontal lectures and computer exercise								
Module Content	The goal is an introduction to and consolidation of matrix models (structured population models). PVA's use models (e. g. matrix models) with stochastically varying demographic parameters to assess population dynamics and provide extinction and survival probabilities of populations over time and specific environmental conditions. Thus, this module is interesting for everyone specializing in conservation ecology and/or population biology.								
Qualification Goals	Participants will acquire the competence to apply and critically evaluate the use of matrix models in the context of quantitative population viability analyses (PVA) of plant and animal populations.								
Requirements for Obtaining Credit, Grading, Weight if appl.	*Courses*	*Type of Lecture*	*Status*	*SWS*	*CP*	*Type of Exam*	*Duration of Exam*	*Grading System*	*Weighting*
	Lecture	*L*	*o*	*2*					
	Exercise	*E*	*o*	*2*	*6*	*H*		*g*	*100*
	Homework	*H*	*o*						
Applicability	M.Sc. Geoökologie/Geoecology, M.Sc. Evolution and Ecology, M.Sc. Bioinformatics								
Prerequisites	"Plant Ecology I" is helpful								

Module Number: **3132**	Module Title: **Biotic Interactions: Plant-Animal-Interactions**					Type of Module: M.Sc. Elective			
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h	Contact Time: 42 h / 3 SWS				Private Studies: 138 h			
Duration Module Coordinator	1 Semester				Majekova				
Regular Cycle	every summer semester								
Language	English								
Learning- / Teaching Forms	Lectures, Seminars, Exercises								
Module Content	• Lectures, in which theoretical concepts in ecology are taught, within the framework of herbivory, pollination and seed dispersal at the individual, population, community and ecosystem levels. • Seminars, in which each student gives a lecture on a recent paper relevant to one of the studied subjects of the same week. • Computer and lab exercises in which students can implement the theories they learned at the lectures.								
Qualification Goals	Students will learn fundamental theories in plant ecology and evolution and in animal behavior, learn how to formulate hypotheses in ecology and evolution, learn how to critique and review studies, acquire analytical and statistical skills, and improve their presentation techniques.								
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*
	Lecture	*L*	*c*	*2*	*2*	*WE (SP)*		*g*	*50%*
	Excercises	*E*	*c*	*0,5*	*2*	*A*		*g*	*25%*
	Seminar	*S*	*c*	*0,5*	*2*	*R*		*g*	*25%*
Applicability	M.Sc. Geoökologie/Geoecology, B.Sc. Biologie, applicable in M.Sc. Evolution und Ökologie								
Prerequisites									

Modulnummer: **3141**	Modultitel: **Nutzpflanzenkunde**								Art des Moduls: M.Sc. Wahlpflicht
ECTS-Punkte	6								
Arbeitsaufwand - Kontaktzeit - Selbststudium	Arbeitsaufwand: 180 h		Kontaktzeit: 60 h / 4 SWS						Selbststudium: 120 h
Moduldauer Modulkoordination	1 Semester				Kehl (Botanischer Garten)				
Häufigkeit des Angebots	jedes Wintersemester								
Unterrichtssprache	Deutsch								
Lehr- / Lernformen	Vorlesung: Nahrungsmittel (Kohlenhydrate und Süßstoff liefernde Pflanzen, Obst-liefernde Pflanze, Gemüse, Gewürze, Fett- und Öllliefernde Pflanzen), Technisch genutzte Pflanzen (Energie- und Kraftstofflliefernde Pflanzen, Fasern liefernde Pflanzen), Genussmittel Praktikum/Übung: Anatomie und Morphologie der Nutzpflanzen bzw. der genutzten Organe, mikroskopische und makroskopische Untersuchungen, Vorweisungen im Botanischen Garten. Seminar: Erarbeitung und Vorstellung aktueller Themen aus dem Bereich Nutz-pflanzenkunde.								
Modulinhalt	Biologie, Baupläne, Ökologie, Morphologie und Anatomie von einheimischen und tropischen Nutzpflanzen, ihre Verwendungen und Nutzungen, sowie typische Inhaltsstoffe.								
Qualifikationsziele	Grundkenntnisse und vertiefte Kenntnisse der Botanik, Morphologie und Ökologie, erweiterte Artenkenntnis über die einheimische Pflanzenwelt hinaus, wissenschaftliches Zeichnen und Protokollieren von Beobachtungen am Objekt, Kennenlernen des Botanischen Gartens als Bildungsort.								
Voraussetzung für die Vergabe von Leistungspunkten / Benotung (ggf. Gewichtung)	*Lehrveranstaltungen*	*Art der Lehrform*	*Status*	*SWS*	*LP*	*Prüfungsform/ Studienleistung*	*Prüfungsdauer*	*Benotungssystem*	*Gewichtung*
	Nutzpflanzenkunde	*V*	*o*	*2*					
		S	*o*	*0,5*	*3*	*R*	*-*	*b*	*0,5*
		P/Ü	*o*	*1,5*	*3*	*H/ET*	*-*	*b*	*0,5*
Verwendbarkeit	M.Sc. Geoökologie/Geoecology								
Teilnahmevoraussetzungen	Module des 2. und 4. Semesters aus den Bachelormodulen der Biologie im Rahmen des B. Sc. Geoökologie								

Module Number: **3143**	Module Title: **Landscape Genetics**								Type of Module: M.Sc. Elective
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 64 h / 4SWS						Private Studies: 116 h
Duration Module Coordinator	1 block				Thomassen				
Regular Cycle	every winter semester								
Language	English								
Learning- / Teaching Forms	The course is a mix of lectures, paper discussions given by the students, and practical work.								
Module Content	How are populations different from each other and why? These are questions that have wide relevance to both fundamental evolution and ecology, as well as to conservation issues. Landscape genetics studies these types of questions at the 'landscape scale' in natural populations. It is a rapidly emerging field, investigating the influence of environmental conditions on shaping the spatial patterns of biodiversity. This course will introduce the concepts and approaches important in spatially explicit analyses of evolutionary and ecological mechanisms and conservation efforts. The main course elements and objectives are: 1) to provide a basic understanding of the ecological, evolutionary, and genetic principles necessary to understand biological diversity, and 2) to explore the tools and approaches available in studying spatial patterns of biodiversity. Concepts and recent research results are discussed in theoretical and applied contexts.								
Qualification Goals	1. An understanding of the concepts and challenges in spatially explicit analyses of biodiversity. 2. Skills necessary to develop new ideas in this new, but rapidly developing field. 3. Practical skills necessary to conduct landscape genetic studies. 4. Critically read research papers and evaluate their scientific merit. 5. To participate in scientific discussions. 6. To present scientific research, including general presentation skills. 7. Scientific writing.								
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*
	Landscape Genetics	*L,S, E*	*o*	*4*	*6*	*A,R,S P*		*g*	
		The evaluation will be based upon participation in discussions, presentations, readings, and practical work.							
Applicability	M.Sc. Geoökologie/Geoecology, B.Sc. Biology, M.Sc. Ecology & Evolution								
Prerequisites	-								

Modulnummer: **3150**	Modultitel: **Invertebraten: Zoologische Übungen an der Meeresstation Roscoff**								Art des Moduls: M.Sc. Wahlpflicht
ECTS-Punkte	6								
Arbeitsaufwand - Kontaktzeit - Selbststudium	Arbeitsaufwand: 140 h		Kontaktzeit: 60 h						Selbststudium: 80 h
Moduldauer Modulkoordination	1 Monat			Weber					
Häufigkeit des Angebots	jedes Studienjahr								
Unterrichtssprache	Deutsch								
Lehr- / Lernformen	Vorlesung, Übung, Geländeübung								
Modulinhalt	Das Modul besteht aus einem zweiwöchigen Praktikum an der „Station Biologique de Roscoff" mit täglichen Exkursionen und begleitender Vorlesung sowie einem Seminar. Themen: Marine Biodiversität, Ökologie und Faunistik; Zonierung des Littorals am Beispiel Nord-Atlantik; Bau, Funktion und Evolution der Tiere; Systematik des Tierreichs								
Qualifikationsziele	• Überblick über eine marine Littoralfauna und ihre Ökologie • Fähigkeit sich selbständig auch in andere marine Faunen einzuarbeiten. • Qualitative Aufnahme der Biodiversität im Littoral. • Beherrschen und Anwendung entsprechender Sammel- und Untersuchungsmethoden sowie von entsprechenden Bestimmungstechniken. • Kenntnisse zu Bau, Funktion und Evolution wirbelloser Tiergruppen. • Kritisches Arbeiten und Herausbilden eines fundierten fachlichen Urteilsvermögens zu allen behandelten Themen								
Voraussetzung für die Vergabe von Leistungspunkten/ Benotung (ggf. Gewichtung)	*Lehrveranstaltungen*	*Art der Lehrform*	*Status*	*SWS*	*LP*	*Prüfungsform/ Studienleistung*	*Prüfungsdauer*	*Benotungssystem*	*Gewichtung*
	Vorlesung	*V*	*o*	*1*		*K*	*45*		
	Bestimmungsübungen	*Ü*	*o*	*3*		*LP*			
	Exkursionen	*GÜ*	*o*	*1,5*		*ET*			
	Seminar	*S*	*o*	*0,5*		*R*			
Verwendbarkeit	M.Sc. Geoökologie/Geoecology Dieses Modul ist nützlich für alle Veranstaltungen der Zoologie, Geoökologie und Paläontologie, die marine Tiere oder Meeresökologie behandeln, insbesondere auch für entsprechenden Geländeübungen.								
Teilnahmevoraussetzungen	„Zoologie II" oder vergleichbare Kenntnisse								

<table>
<tr><td>Modulnummer:
3154</td><td colspan="6">Modultitel:
Evolutionäre Ökologie der Pflanzen</td><td>Art des Moduls:
B.Sc. Wahlpflicht</td></tr>
<tr><td>ECTS-Punkte</td><td colspan="7">6</td></tr>
<tr><td>Arbeitsaufwand
- Kontaktzeit
- Selbststudium</td><td colspan="2">Arbeitsaufwand:
180 h</td><td colspan="3">Kontaktzeit:
40 h / 4 SWS</td><td colspan="2">Selbststudium:
140 h</td></tr>
<tr><td>Moduldauer
Modulkoordination</td><td colspan="3">1 Semester</td><td colspan="4">Bossdorf</td></tr>
<tr><td>Häufigkeit
des Angebots</td><td colspan="7">jedes Wintersemester (W-Schiene (Fr))</td></tr>
<tr><td>Unterrichtssprache</td><td colspan="7">Die Kurssprache ist Deutsch oder Englisch, je nachdem was sinnvoller ist. Vorlesungen und Vorträge sind z.B. in der Regel auf Englisch, während bei Diskussionen oder im Praktikumsteil auch Deutsch gesprochen wird.</td></tr>
<tr><td>Lehr- / Lernformen</td><td colspan="7">Der Kurs ist eine Kombination aus Vorlesung, Seminar und Praktikum.</td></tr>
<tr><td>Modulinhalt</td><td colspan="7">Der Kurs bietet einen vertieften Einblick in die evolutionäre Ökologie und Populationsbiologie der Pflanzen. Schwerpunkte des Kurses sind u.a. die innerartliche Vielfalt von Pflanzen, ihre verschiedenen Ursachen (phänotypische Plastizität, Mikroevolution, epigenetische Variation, maternale Umwelteffekte) und ihre Bedeutung für Anpassung und Überleben von Pflanzenpopulationen und deren ökologischen Wechselwirkungen, die Evolution verschiedener Lebens- und Fortpflanzungsstrategien, und die funktionelle Bedeutung von genetischer Diversität. Eine wichtige „hands-on"-Komponente des Kurses ist ein evolutionsökologisches Experiment, das die Studierenden in Teams designen und im Laufe des Semesters selbständig durchführen, auswerten und präsentieren. Der Praktikumsteil beinhaltet auch eine Einführung in die Statistik-Software R.</td></tr>
<tr><td>Qualifikationsziele</td><td colspan="7">• Vertieftes Verständnis evolutionsökologische Konzepte und Methoden
• selbständiges Design und Durchführung eines pflanzenökologischen Experiments
• Auswertung wissenschaftlicher Daten mit der open source Software R
• Präsentation wissenschaftlicher Ergebnisse
• Kritisches Lesen und Diskussion wissenschaftlicher Fachartikel</td></tr>
<tr><td rowspan="3">Voraussetzung für die Vergabe von Leistungspunkten / Benotung (ggf. Gewichtung)</td><td>Lehrveranstaltungen</td><td>Art der Lehrform</td><td>Status</td><td>SWS</td><td>LP</td><td>Prüfungsform / Studienleistung</td><td>Prüfungsdauer</td><td>Benotungssystem</td><td>Gewichtung</td></tr>
<tr><td rowspan="2">Evolutionäre Ökologie der Pflanzen</td><td>V,S,P</td><td>o</td><td>4</td><td>6</td><td>R</td><td></td><td>b</td><td></td></tr>
<tr><td colspan="7">Die Benotung basiert auf der Beteiligung an den Praktika und Qualität der Seminar- und Diskussionsbeiträge.</td></tr>
<tr><td>Verwendbarkeit</td><td colspan="7">M.Sc. Geoökologie/Geoecology, M.Sc. Geoökologie, B.Sc. Biologie, M.Sc. Evolution & Ecology
This course has to be chosen for the Master module 4164: Evolutionary processes in plant populations / Evolutionäre Prozesse in Pflanzenpopulationen</td></tr>
<tr><td>Teilnahmevoraussetzungen</td><td colspan="7">-</td></tr>
</table>

Modulnummer: **3177**	Modultitel: **Lebensraum Schwäbische Alb**								Art des Moduls: M.Sc. Wahlpflicht
ECTS-Punkte	6								
Arbeitsaufwand - Kontaktzeit - Selbststudium	Arbeitsaufwand: 180 h		Kontaktzeit: 37 h / 2,5 SWS						Selbststudium: 143 h
Moduldauer Modulkoordination	2 Stunden wöchentlich als Schiene + 1 Tag Vollzeit			Peschke					
Häufigkeit des Angebots	jedes Sommersemester								
Unterrichtssprache	Deutsch								
Lehr- /Lernformen	Seminar, Literaturseminar, Exkursion								
Modulinhalt	In diesem Seminar werden die unterschiedlichen Lebensbereiche der Schwäbischen Alb und deren Besonderheiten behandelt. Ein Schwerpunkt liegt dabei auf physiologischen Anpassungen der dort lebenden Tierarten. Im Rahmen einer eintägigen Exkursion werden ausgewählte Gebiete der Schopflocher Alb besucht. Ferner wird die Präsentation von Vorträgen und das fachliche Diskutieren anhand von Seminarvorträgen und wissenschaftlicher Literatur geübt. Das Verfassen wissenschaftlicher Arbeiten wird durch die Erstellung einer Hausarbeit zum gewählten Thema geübt/vertieft.								
Qualifikationsziele	Vermittlung von Kenntnissen zu Lebensräumen und Ökologie der schwäbischen Alb. Erarbeitung und Präsentation eines Vortrags, Erstellung einer Hausarbeit, Verständnis und Diskussion von Originalliteratur (Artikel in internationalen Zeitschriften).								
Voraussetzung für die Vergabe von Leistungspunkten / Benotung (ggf. Gewichtung)	*Lehrveranstaltungen*	*Art der Lehrform*	*Status*	*SWS*	*LP*	*Prüfungsform / Studienleistung*	*Prüfungsdauer*	*Benotungssystem*	*Gewichtung*
	Seminar/Literaturseminar	*S*	*o*	*2*	*5,5*	*R, H*		*b*	*100%*
	Exkursion			*0,5*	*0,5*				
Verwendbarkeit	M.Sc. Geoökologie/Geoecology, B.Sc. Biologie, verwendbar für M.Sc.-Module im M.Sc. Evolution und Ökologie								
Teilnahmevoraus-setzungen	keine								

<table>
<tr><td>Modulnummer:
3186</td><td colspan="5">Modultitel:
Botanik II</td><td colspan="4">Art des Moduls:
B.Sc. Wahlpflicht</td></tr>
<tr><td>ECTS-Punkte</td><td colspan="9">6</td></tr>
<tr><td>Arbeitsaufwand
- Kontaktzeit
- Selbststudium</td><td colspan="3">Arbeitsaufwand:
180 h</td><td colspan="3">Kontaktzeit: 128h
128 h / 9 SWS</td><td colspan="3">Selbststudium:
52 h</td></tr>
<tr><td>Moduldauer
Modulkoordination</td><td colspan="4">4 Wochen Block am Ende des SoSe (S3)</td><td colspan="5">Koltzenburg, Kehl, Tielbörger</td></tr>
<tr><td>Häufigkeit
des Angebots</td><td colspan="9">jedes Sommersemester</td></tr>
<tr><td>Unterrichtssprache</td><td colspan="9">Deutsch</td></tr>
<tr><td>Lehr- / Lernformen</td><td colspan="9">V, Ü, GP</td></tr>
<tr><td>Modulinhalt</td><td colspan="9">Geländeübungsteil (ca. 50%) in verschiedenen Vegetationstypen in der Umgebung Tübingens, Vorlesung zu Naturräumen, Flora, Vegetation und Pflanzenfamilien und Übungsteil, in dem Pflanzen bestimmt und Kartierungs-Methoden angewandt und ausgewertet werden.
Vertiefte Kenntnisse in Botanik und Vegetationskunde werden vermittelt. Inhalt sind u.a. Pflanzenfamilien, die im Modul "Botanik" (2. Semester) nicht oder nicht ausführlich besprochen wurden, darüber hinaus erlangen die TeilnehmerInnen eine Übersicht über Vegetationstypen und Pflanzengesellschaften in Südwest-Deutschland.
Einführung in Habitate und Standortkunde:
• Wiesen,
• Feuchtbiotope
• Xerothermbiotope
• Laubwälder
• Äcker und Ruderalhabitate
Mehrere eintägige Geländeübungen in die Region und eine mehrtägige Exkursion zum Federsee werden durch ausführliche Bestimmungsübungen ergänzt und vertieft. Für die Geländeübung fallen in geringem Umfang Kosten (Übernachtung am Federsee, Buskosten) an!</td></tr>
<tr><td>Qualifikationsziele</td><td colspan="9">• Artenkenntnis der einheimischen Flora und Fähigkeit, unbekannte Pflanzen zu bestimmen
• Kennenlernen und Verwenden verschiedener Bestimmungsschlüssel und weiterer Florenwerke
• Systematische Kenntnisse zu einheimischen Pflanzenfamilien
• Techniken der Präparation und Sammlung von Pflanzen (Herbarium Tubingense)
• Kennenlernen verschiedener Vegetationseinheiten mit wichtigen, typischen Arten
• Bedeutung und Auswirkung standortökologischer Faktoren einschätzen
• Anwenden verschiedener Freiland-Methoden, z. B. pflanzensoziologische Kartierung nach Braun-Blanquet</td></tr>
<tr><td rowspan="4">Voraussetzung für die Vergabe von Leistungspunkten / Benotung (ggf. Gewichtung)</td><td>Lehrveranstaltungen</td><td>Art der Lehrform</td><td>Status</td><td>SWS</td><td>LP</td><td>Prüfungsform/ Studienleistung</td><td>Prüfungsdauer</td><td>Benotungssystem</td><td>Gewichtung</td></tr>
<tr><td rowspan="3">Flora und Vegetation SW-Deutschlands</td><td>V</td><td>o</td><td>1</td><td rowspan="3">6</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Ü</td><td>o</td><td>3,5</td><td>MP</td><td>20</td><td>b</td><td>0,25</td></tr>
<tr><td>GP</td><td>o</td><td>4,5</td><td>H</td><td></td><td>b</td><td>0,75</td></tr>
<tr><td>Verwendbarkeit</td><td colspan="9">B.Sc. Geoökologie, M.Sc. Geoökologie/Geoecology</td></tr>
<tr><td>Teilnahmevoraussetzungen</td><td colspan="9">"Botanik"</td></tr>
</table>

Modulnummer: **3197**	Modultitel: **Entomologie IV: Geländepraktikum**								Art des Moduls: M.Sc. Wahlpflicht
ECTS-Punkte	6								
Arbeitsaufwand - Kontaktzeit - Selbststudium	Arbeitsaufwand: 180 h		Kontaktzeit: 100 h						Selbststudium: 80 h
Moduldauer Modulkoordination	4 Wochen			Weber					
Häufigkeit des Angebots	jedes zweite Sommersemester								
Unterrichtssprache	Deutsch								
Lehr- /Lernformen	Übung, Exkursion								
Modulinhalt	Das Modul besteht aus einer 14-stündigen vorbereitenden Übung sowie einer ca. 15-tägigen entomologischen Exkursion. Themen: Biodiversität und Faunistik der Insekten, entomologische Sammel- und Präparationsmethoden								
Qualifikationsziele	• Anwendung und Vertiefung der im Modul „Entomologie III" erworbenen Kenntnisse im Freiland: • Kenntnis der Biodiversität und Faunistik europäischer Insekten • Anwenden entomologischer Sammel- und Erfassungsmethoden • Anwenden von Konservierungs- und Präparationstechniken zur Dokumentation einer Insektenfauna • Beherrschen von Bestimmungstechniken • Fähigkeit, unterschiedlichste Insektengruppen zu kartieren • Kenntnis relevanter Naturschutzbestimmungen								
Voraussetzung für die Vergabe von Leistungspunkten / Benotung (ggf. Gewichtung)	*Lehrveranstaltungen*	*Art der Lehrform*	*Status*	*SWS*	*LP*	*Prüfungsform/ Studienleistung*	*Prüfungsdauer*	*Benotungssystem*	*Gewichtung*
	vorbereitende Übung	*Ü*	*o*	*2*	*1*	*-*	*-*	*kP*	*-*
	Geländepraktikum	*GÜ*	*o*	*4*	*5*	*MP*	*30*	*b*	*-*
Verwendbarkeit	M.Sc. Geoökologie/Geoecology Grundlage für entomologische Arbeiten im Gelände; berufsqualifizierend								
Teilnahmevoraussetzungen	„Entomologie III"								

<table>
<tr><td>Module Number:
4007</td><td colspan="5">Module Title:
Macroevolutionary and Microevolutionary Analysis</td><td colspan="4">Type of Module:
M.Sc. Elective</td></tr>
<tr><td>Credits (ECTS)</td><td colspan="9">6</td></tr>
<tr><td>Workload
- Contact Time
- Private Study</td><td colspan="3">Workload:
180 h</td><td colspan="3">Contact Time:
104 h / 7 SWS</td><td colspan="3">Private Studies:
76 h / 5 SWS</td></tr>
<tr><td>Duration
Module Coordinator</td><td colspan="4">1 Semester</td><td colspan="5">Foerster</td></tr>
<tr><td>Regular Cycle</td><td colspan="9">every winter semester</td></tr>
<tr><td>Language</td><td colspan="9">English</td></tr>
<tr><td>Learning- / Teaching Forms</td><td colspan="9">Lecture, Excercise</td></tr>
<tr><td>Module Content</td><td colspan="9">Microevolution: This part introduces to the basics of population genetics and quantitative genetics. It deals with population and individual genetic variation, the causes of allele frequency changes, selection, heritability, and adaptation.
Macroevolution: This is an introduction to phylogenetic reconstruction from molecular sequence data. It deals with basic principles such as maximum parsimony, genetic distances, probabilistic methods, and bootstrapping. Participants may individually sample datasets from public databases for the practical exercises.</td></tr>
<tr><td>Qualification Goals</td><td colspan="9">Students know and understand the basic principles of microevolutionary and macroevolutionary processes.
Students know and are able to apply some of the mathematical tools to calculate relevant measures of evolutionary change.
Students gain experience in reading and interpreting original literature that deals with basic research on evolutionary processes.</td></tr>
<tr><td rowspan="4">Requirements for Obtaining Credit, Grading, Weight if appl.</td><td>Courses</td><td>Type of Lecture</td><td>Status</td><td>CH</td><td>CP</td><td>Type of Exam / Study Requirements</td><td>Duration of Exam</td><td>Grading System</td><td>Weighting</td></tr>
<tr><td rowspan="2">Macroevolutionary and Microevolutionary Analysis</td><td>L</td><td>o</td><td>70</td><td>2,5</td><td>A, WE</td><td rowspan="2">2h</td><td rowspan="2">g</td><td rowspan="2">1</td></tr>
<tr><td>E</td><td>o</td><td>110</td><td>3,5</td><td>A, WE</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Applicability</td><td colspan="9">M.Sc. Geoökologie/Geoecology</td></tr>
<tr><td>Prerequisites</td><td colspan="9">none</td></tr>
</table>

Module Number: **4008**	Module Title: **Advanced Biometry**								Type of Module: M.Sc. Elective
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 145 h / 10 SWS						Private Studies: 35 h
Duration Module Coordinator	4 weeks daily (W2)				Tielbörger				
Regular Cycle	every winter semester								
Language	English								
Learning- / Teaching Forms	Frontal lectures and computer labs with supervision.								
Module Content	This course introduces to state-of-the art methods in the statistical analysis of data deriving from biological experiments and observations. It will also touch upon aspects of experimental design. This course builds upon Biostatistics I. The aim of the course is to provide a toolbox of advanced statistics and thus enable students in Evolution and Ecology and other subjects to decide independently which methods are the most appropriate to use for a particular dataset and how to practically apply some of them. The course is composed of lectures introducing the theoretical background and plenty of coursework for getting hands-on experience with the methods. R will be used throughout the course and some prior knowledge would be advantageous.								
Qualification Goals	At the end of the course the students will have a toolbox of statistics and thus be able to decide independently which methods are the most appropriate to use for a particular dataset and how to practically apply some of them. They will know and be able to apply the state-of-the art statistical methods in ecology and evolution.								
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*
	Lecture	*L*	*o*	*3*	*3*				
	Excercises	*E*	*o*	*3*	*3*				
Applicability	M.Sc. Geoökologie/Geoecology, M.Sc. Evolution and Ecology								
Prerequisites	"Biostatistics I" (3010) is highly recommended In general terms, preconditions for participation are a basic knowledge in statistics and experimental design.								

<table>
<tr><td>Module Number:
4009</td><td colspan="6">Module Title:
Essentials in Evolutionary Biology</td><td>Type of Module:
M.Sc. Elective</td></tr>
<tr><td>Credits (ECTS)</td><td colspan="7">6</td></tr>
<tr><td>Workload
- Contact Time
- Private Study</td><td colspan="2">Workload:
180 h</td><td colspan="3">Contact Time:
60 h / 4 SWS</td><td colspan="2">Private Studies:
120 h</td></tr>
<tr><td>Duration
Module Coordinator</td><td colspan="3">1 Semester</td><td colspan="4">Michiels</td></tr>
<tr><td>Regular Cycle</td><td colspan="7">every winter semester</td></tr>
<tr><td>Language</td><td colspan="7">English</td></tr>
<tr><td>Learning- / Teaching Forms</td><td colspan="7">Lecture, Seminar</td></tr>
<tr><td>Module Content</td><td colspan="7">The lecture introduces the students to key concepts and current research fields in evolutionary biology. The seminar complements this by allowing the students to attend presentations of external, in part international scientists from across the field. The students produce concise abstracts of these presentations, which are also graded. This module is in English.</td></tr>
<tr><td>Qualification Goals</td><td colspan="7">The students
• learn to recognise complex concepts and processes in evolution and their how they are interconnected
• know current research fields in evolutionary biology
• develop a well-grounded professional assessment ability
• can critically question current research projects in this field
• can ask questions to international scientists
• can identify the essential components of a scientific presentation
• can generate a concise and factual, yet accessible and understandable summary of a current topic in evolutionary biology in English
• can adhere to text formatting rules</td></tr>
<tr><td rowspan="3">Requirements for Obtaining Credit, Grading, Weight if appl.</td><td>Courses</td><td>Type of Lecture</td><td>Status</td><td>CH</td><td>CP</td><td>Type of Exam / Study Requirements</td><td>Duration of Exam</td><td>Grading System</td><td>Weighting</td></tr>
<tr><td rowspan="2">Essentials in Evolutionary Biology</td><td>L</td><td>c</td><td>2</td><td rowspan="2">6</td><td>WE</td><td>120</td><td rowspan="2">1-5</td><td>60%</td></tr>
<tr><td>S</td><td>c</td><td>2</td><td>R</td><td>-</td><td>40%</td></tr>
<tr><td>Applicability</td><td colspan="7">M.Sc. Geoökologie/Geoecology, Master degrees of the Department of Biology</td></tr>
<tr><td>Prerequisites</td><td colspan="7">Advanced knowledge of Biology</td></tr>
</table>

<table>
<tr><td>Modulnummer:
4030</td><td colspan="4">Modultitel:
Exkursion: Schwedisch-Lappland (Abisko)</td><td>Art des Moduls:
M.Sc. Wahlpflicht</td></tr>
<tr><td>ECTS-Punkte</td><td colspan="5">9</td></tr>
<tr><td>Arbeitsaufwand
- Kontaktzeit
- Selbststudium</td><td>Arbeitsaufwand:
280 h</td><td colspan="2">Kontaktzeit:
180 h / 12 SWS</td><td colspan="2">Selbststudium:
100 h</td></tr>
<tr><td>Moduldauer
Modulkoordination</td><td colspan="3">Blockseminar + 18 Tage Exkursion</td><td colspan="2">N.N. (über Harter)</td></tr>
<tr><td>Häufigkeit
des Angebots</td><td colspan="5">jedes Sommersemester</td></tr>
<tr><td>Unterrichtssprache</td><td colspan="5">Deutsch</td></tr>
<tr><td>Lehr- / Lernformen</td><td colspan="5">Seminar: 30 h / 2 SWS
Exkursion: 150 h / 10 SWS
Vor- und Nachbereitung, Protokolle: 90 Std.</td></tr>
<tr><td>Modulinhalt</td><td colspan="5">Pflanzenleben in arktischen und subarktischen Lebensräumen</td></tr>
<tr><td>Qualifikationsziele</td><td colspan="5">• Arktische und subarktische Ökosysteme
• Flora und Vegetation
• Fauna
• Geologie, Glazialmorphologie
• Ökologische und physiologische Anpassungen an den Lebensraum
Seminarbeitrag, Handout, Exkursionsbericht</td></tr>
<tr><td rowspan="3">Voraussetzung für die Vergabe von Leistungspunkten / Benotung (ggf. Gewichtung)</td><td>Lehrveranstaltungen</td><td>Art der Lehrform</td><td>Status</td><td>SWS</td><td>LP</td><td>Prüfungsform/ Studienleistung</td><td>Prüfungsdauer</td><td>Benotungssystem</td><td>Gewichtung</td></tr>
<tr><td rowspan="2">Exkursion: Schwedisch-Lappland (Abisko)</td><td>GÜ</td><td>o</td><td>10</td><td rowspan="2">9</td><td>H</td><td></td><td></td><td></td></tr>
<tr><td>S</td><td>o</td><td>2</td><td>R</td><td></td><td></td><td></td></tr>
<tr><td>Verwendbarkeit</td><td colspan="5">M.Sc. Geoökologie/Geoecology, Biologie</td></tr>
<tr><td>Teilnahmevoraussetzungen</td><td colspan="5">Gute Konstitution</td></tr>
</table>

Modulnummer: **4048**	Modultitel: **Funktions- und Ökomorphologie der Invertebraten**								Art des Moduls: M.Sc. Wahlpflicht
ECTS-Punkte	6								
Arbeitsaufwand - Kontaktzeit - Selbststudium	Arbeitsaufwand: 180 h		Kontaktzeit: 130 h / 4 SWS						Selbststudium: 50 h
Moduldauer Modulkoordination	4 Wochen als Block ganztägig (Mo-Do)			Betz					
Häufigkeit des Angebots	jedes zweite Jahr								
Unterrichtssprache	Deutsch oder Englisch (nach Bedarf)								
Lehr- / Lernformen	Vorlesung, Seminar, Praktikum								
Modulinhalt	Am Beispiel verschiedener Invertebraten-Gruppen (z.B. Cnidaria, Molluska, Annelida, Arthropoda) werden Form-Funktions-Komplexe (z.B. Lokomotion, Ernährung) vergleichend hinsichtlich ihrer funktionellen Vielfalt und ökologischen Bedeutung (Anpassungsforschung) analysiert. Neben der direkten Arbeit an den wirbellosen Organsimen und ihren Strukturen werden biomechanische Prinzipien und experimentelle Ansätze (Verhaltensexperimente, Methoden der Nischenquantifizierung), Methoden zur Analyse der Merkmalsevolution sowie statistische Verfahren (Multivariate Statistik, Geometrische Morphometrie) vorgestellt, mit deren Hilfe die Bedeutung morphologischer Strukturen für die Ökologie von Organismen analysiert werden kann.								
Qualifikationsziele	• Moderne Methoden der Funktions- und Ökomorphologie • Anpassungsforschung • Vergleichendes Arbeiten • Vertiefte Kenntnisse der Speziellen Zoologie der Wirbellosen • Integratives Denken (= Integration von Morphologie, Ökologie und Phylogenie								
Voraussetzung für die Vergabe von Leistungspunkten / Benotung (ggf. Gewichtung)	*Lehrveranstaltungen*	*Art der Lehr form*	*Status*	*SWS*	*LP*	*Prüfungsform/ Studienleistung*	*Prüfungsdauer*	*Benotungssystem*	*Gewichtung*
	Modulbestandteil	*V*	*O*	*2*	*2*	*kP*	*-*	*ub*	*-*
	Modulbestandteil	*S*	*O*	*1*	*1*	*R*	*45 min*	*b*	*0,5*
	Modulbestandteil	*LP*	*O*	*3*	*3*	*H*	*-*	*b*	*0,5*
Verwendbarkeit	M.Sc. Geoökologie/Geoecology Ergänzung zu "Entomologie I" und "Entomologie II" und anderen zoologisch-ökologischen Modulen								
Teilnahmevoraussetzungen	Zoologisches Grundpraktikum des ersten Studienjahres.								

Module Number: **4052**	Module Title: **Behavioural Ecology 1**								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 / 8 SWS
Duration of Module Module Coordinator	1 Semester				Foerster				
Regular Cycle	every winter semester								
Language	English								
Learning- / Teaching Forms	Lecture, Seminar								
Module Content	The lecture offers a broad introduction to the main topics in behavioural ecology: sexual selection and mate choice, life history (including e.g., survival, foraging, and territoriality) cognition, communication, and social behaviour. The participants will deepen their knowledge on selected topics in the seminar. Each participant will prepare an essay (review) and an oral presentation.								
Qualification Goals	• Students know and understand the basic principles of behavioural ecology theories and methods. • Students know and are able to explain examples of recent research on animal behaviour. • Students gain experience in reading and interpreting original literature that deals with basic research on animal behaviour.								
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*
	Behavioural Ecology 1	*L*	*o*	*90*	*3*	*A, WE*	*2h*	*g*	*0.6*
		S	*o*	*90*	*3*	*R, SP*		*g*	*0.4*
Applicability	M.Sc. Geoökologie/Geoecology								
Prerequisites	none								

Module Number: **4060**	Module Title: **Behavioural Ecology 2**					Type of Module: M.Sc. Elective			
Credits (ECTS)	6								
Workload - Contact Time - Private Study	Workload: 180 h		Contact Time: 45 h / 3 SWS			Private Studies: 135 h / 9 SWS			
Duration Module Coordinator	1 Semester			Foerster					
Regular Cycle	every second summer semester								
Language	English								
Learning- / Teaching Forms	Seminar, Project								
Module Content	Each week, we read literature to a specific topic in behavioural ecology. Participants prepare questions on the topic and design experiments or correlational studies that might further our knowledge on the discussed topic. Project proposals are presented in the course and critically discussed by all participants.								
Qualification Goals	Students further their knowledge on behavioural ecology theories and methods. Students gain experience in project design and in the presentation of project proposals. Students further their experience in reading and interpreting original literature that deals with basic research on animal behaviour.								
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*
	Behavioural Ecology 2	*S*	*o*	*180*	*6*	*R, SP*	*nE*	*ng*	*1*
Applicability	M.Sc. Geoökologie/Geoecology								
Prerequisites	"Behavioural Ecology 1" or otherwise acquainted knowledge of basic theories and methods in Behavioural Ecology.								

Module Number: **4118**	Module Title: **Visual Ecology**								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				Michiels, Santon				
Regular Cycle	every summer semester (Block S4)								
Language	English								
Learning- / Teaching Forms	Lecture, Exercise								
Module Content	The goal of this course is to provide a good background in the evolution of animal visual systems in complex light environments, the role of vision in communication, how animal colouration coevolves with the light environment and more. The focus will be on terrestrial as well as aquatic (marine) systems, with an emphasis on vertebrates. This is a new course which is part of a larger programme in visual ecology. Complementary courses will be developed in the future - in cooperation with other groups in evolutionary ecology and neurobiology. The 2-hour practical part will offer hands-on experience in spectrophotometry, eye anatomy, eye diversity, types pigments, structural colours, as well as discussion of current literature and the design of experiments in this field.								
Qualification Goals	The students • can apply task-specific experimental and statistical methods • develop the ability to plan an independent research project • are capable of reporting/writing down their observations in a scientific manner • can place their own results in a wider context and evaluate and discuss them critically • can carry out a project as part of a team								
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*
	Visual Ecology	*L*	*c*	*2*	*6*	*WE*	*180*	*1-5*	*30%*
		E	*c*	*2*		*A*	*-*		*45%*
		S	*c*	*1*		*OE*	*-*		*10%*
		PR	*c*	*1*		*A*	*-*		*25%*
Applicability	M.Sc. Geoökologie/Geoecology choice for module 4173 "Specific Applications/Spezifische Anwendungen"								
Prerequisites	basic zoology A background in ecology, evolution, neurobiology or physics is advantageous.								

Module Number: **4134**	Module Title: **Introduction to "R"**		Type of Module: M.Sc. Elective
Credits (ECTS)	3		
Workload - Contact Time - Private Study	Workload: 90 h	Contact Time: 40 h / 3 SWS	Private Studies: 50 h
Duration Module Coordinator	4 weeks	Tomiolo	
Regular Cycle	every winter semester		
Language	English		
Learning- / Teaching Forms	Lectures, Participatory live coding, exercises		
Module Content	• Lectures and participatory live-coding to provide the students with the fundamental concepts of coding, and the tools for advancing their learning beyond the course room. • Individual and group assignments in which students apply and implement the tools they have learned in class, to import, manipulate and visualize data, and to produce dynamically-generated reports.		
Qualification Goals	Students will learn fundamentals of reproducible data and project management using R-Studio, R, and a suite of packages called the "tidyverse". In a highly participatory workshop format, students will learn how to manage projects in R Studio, how to import, manipulate, and visualize data using a reproducible workflow. Finally, they will learn to produce publication-ready reproducible and dynamically-generated reports. Though this course provides the basis for learning how to code in an efficient and reproducible way, students will apply the code in the classroom and will become familiar with the most common issues one encounters when coding, how to find a solution to them, and will gain the tools for continued learning beyond the course.		

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*
Lecture and live coding	*L*	*c*	*3*	*2*	*SP*		*g*	*65%*
Excercises	*E*	*c*		*1*	*A*		*g*	*35%*

Applicability	M.Sc. Geoökologie/Geoecology, M.Sc. Evolution und Ökologie, PhD students (if there is space), B.Sc. students can attend This course is recommended for students who intend to take the "Advanced Biometry" course.
Prerequisites	Students should bring their own laptop

Modulnummer: **4144**	Modultitel: **Vegetationsökologie und Ornithologie in Israel / Dryland Ecology**								Art des Moduls: M.Sc. Wahlpflicht
ECTS-Punkte	9								
Arbeitsaufwand - Kontaktzeit - Selbststudium	Arbeitsaufwand: 270 h		Kontaktzeit: 170 h / 12 SWS						Selbststudium: 100 h
Moduldauer Modulkoordination	Teil im Semester, Teil in der VL-freien Zeit			Tielbörger					
Häufigkeit des Angebots	jedes zweite Jahr am Ende des Wintersemesters								
Unterrichtssprache	Deutsch, can be taught in English if needed								
Lehr- / Lernformen	Exkursion, Geländearbeit, Seminar, Projektarbeit und Datenauswertung.								
Modulinhalt	Die Region bietet auf allerkleinstem Raum eine immense Vielfalt von Umweltbedingungen. Aus diesem Grund ist die Vielfalt von Pflanzen und Tieren sehr hoch. Zudem ist der Jordangraben die östliche Hauptroute für den Vogelzug, weshalb neben der Vegetation auch die Ornithologie nicht zu kurz kommen soll. Die besuchten Regionen reichen von der extremen Wüste bis hin zu den feuchten Mediterrangebieten								
Qualifikationsziele	Die Studierenden lernen, wie sich eine Vielfalt von Umweltbedingungen (Regenfall, Boden, Geologie, Landnutzung) auf die Struktur und Diversität von Pflanzengemeinschaften auswirkt, sie erkennen Gemeinsamkeiten und Unterschiede zu Prozessen in heimischen Ökosystemen, sie lernen, wie man Hypothesen erstellt und diese mit gezielten Probennahmen im Gelände prüft, sie lernen Datenauswertung sowie soft skills wie Präsentation und schriftliche Ausarbeitung von Projektarbeiten. Des Weiteren üben sie das Bestimmen von Pflanzen und Vögeln und können eine Vielzahl von Arten unterscheiden.								
Voraussetzung für die Vergabe von Leistungspunkten/ Benotung (ggf. Gewichtung)	*Lehrveranstaltungen*	*Art der Lehrform*	*Status*	*SWS*	*LP*	*Prüfungsform*	*Prüfungsdauer*	*Benotungssystem*	*Gewichtung*
	Seminar	*S*	*o*	*2*	*2*	*R*			*30*
	Übungen/Hausarbeit	*Ü*	*o*	*2*	*3*	*H*			*50*
	Exkursion	*E*	*f*	*5*	*4*	*ET*			*25*
Verwendbarkeit	M.Sc. Geoökologie/Geoecology, M.Sc. Evolution und Ökologie M.Sc. Lehramt Biologie als Exkursionstage bzw. Teil des Moduls Freilandbiologie, bei freien Plätzen Teilnahme von B.Sc. Biologie und B.Sc. Geoökologie möglich								
Teilnahmevoraussetzungen	Gute Grundkenntnisse in Flora, Fauna, Grundkenntnisse in Geologie, Modul Botanik im Biologie Grundstudium und mindestens eine floristische Exkursion								

Module Number: **4213**	Module Title: **Naturschutz in der Praxis / Applied Nature Conservation**		Type of Module: M.Sc. Wahlpflicht
Leistungspunkte (ECTS)	6		
Arbeitsaufwand - Kontaktzeit - Selbststudium	Arbeitsaufwand: 180 h	Kontaktzeit: 60 h / 4 SWS	Selbststudium: 120 h
Moduldauer Modulkoordination	1 Semester	Tielbörger, Koltzenburg	
Häufigkeit des Angebots	jedes Sommersemester		
Language	Deutsch		
Lehr-/ Lehrformen	Vorlesung, Seminar, Geländeübung		
Module Inhalt	Nach einer Einführung in Themen des praktischen Natur- und Umweltschutzes durch einen ganztägigen Workshop mit Impulsreferaten und Diskussionen ist in Kleingruppen eine Biotoptypenkartierung als praktischer Seminarteil durchzuführen. Im Selbststudium werden ein Referat und die verschiedenen Schritte, Inhalte sowie die Dokumentation einer Kartierung (Dokumentation, Präsentation, Kurzgutachten) erarbeitet. Eine Exkursion mit der Naturschutzverwaltung soll konkrete Beispiele aus deren Arbeit illustrieren. • Gesetzgebung und Regelungen im Naturschutz • Kenntnisse von Flora und Vegetation • Biotypenkartierung mit begleitenden gemeinsamen Exkursionen		
Qualifikationsziele	Die Studierenden lernen Zusammenhänge aus dem Bereich des angewandten Naturschutzes wie Naturschutzrecht, Geschichtliches und Schnittmengen von Wissenschaft und Naturschutz kennen. Sie vertiefen ihre Kenntnisse von Flora und Vegetation. Dabei erhalten sie einen Einblick in Standardmethoden, welche im naturschutzrelevanten Berufsalltag zur Anwendung kommen, wie z. B. Biotoptypen zu erfassen und Karten zu erstellen. Auf diesen Grundlagen und anhand dieser Beispiele lernen die Studierenden berufsorientiert Beispiele der aktuellen angewandten Naturschutzarbeit kennen.		

Voraussetzung für die Vergabe von Leistungspunkten/ Benotung (ggf. Gewichtung)

Lehrveranstaltungen	*Art der Lehre*	*Status*	*SWS*	*LP*	*Prüfungsform/ Studienleistung*	*Prüfungsdauer*	*Benotungssystem*	Gewichtung
Vorlesung	*V*	*o*	*2*					
Seminar	*V*	*o*	*2*	*6*	*H/R*		*b*	1
Projekt	*GÜ*	*o*						

Verwendbarkeit	M.Sc. Evolution und Ökologie, M.Sc. Geoökologie/Geoecology
Teilnahmevoraus-setzungen	Grundkenntnisse der heimischen Flora und Vegetation, Vorlesung ÖB2

Module Number: **4214**	Module Title: **Plant Ecology II**							Type of Module: M.Sc. Elective
Credits (ECTS)	6							
Workload - Contact Time - Private Study	Workload: 180 h	Contact Time: 120 h / 8 SWS						Private Studies: 60 h
Duration Module Coordinator	4-week block, S2			Majekova				
Regular Cycle	every summer semester (S2)							
Language	English							
Learning- /Teaching Forms	Lectures in combination with field/lab course and excursions							
Module Content	This course will teach basic and advanced plant ecological field methods and is meant to complement the theory-based Plant Ecology I module. This course will focus on practical student projects, methods in remote sensing and a one-week excursion to state-of-the-art experimental facilities (Jena Experiment; Global Change Experimental Facility, near Halle; Biodiversity Exploratory Swabian Alb). The student projects play a pivotal role in this course and will train students to ask timely questions in plant ecology, to build relevant hypotheses, and adopt appropriate experimental and analytical designs. Students will be given plenty opportunity to collect data in the field, as well as to analyse their collected data and interpret their obtained results. Students will work in small teams with ample mentoring, but will be encouraged to think independently, creatively and critically to solve both theoretical and methodological questions with their peers. Two rounds of presentations are planned to secure sufficient feedback between students and lecturers. Participants have the unique opportunity to start a new long-term grassland experiment near the University, focusing on community, functional and global-change ecology. Students will also learn about modern methods in remote sensing and its applicability in plant ecological research.							
Qualification Goals	After the course students should be able plan, perform, analyse and interpret basic and advanced plant ecological surveys and experiments in the field. They will also gain first-hand experience of team-work coupled with the development of independent ideas. The presented methods cover plant community and trait centered approaches based on manual, computer-aided and remotely sensed measurements.							
Requirements for Obtaining Credit, Grading, Weight if appl.	*Courses*	*Type of Lecture*	*Status*	*CH*	*CP*	*Type of Exam*	*Duration of Exam*	*Grading System*	*Weighting*
	Lecture	*L*	*C*	*2*		*-*	*-*	*nE*	*-*
	Field/Lab course	*F/L C*	*C*	*6*	*6*	*-*	*-*	*nE*	*-*
	Project	*PR*	*C*	*-*		*R*	*45*	*G*	*100*
Applicability	M.Sc. Evolution and Ecology, M.Sc. Geoökologie/Geoecology							
Prerequisites	knowledge of basic principles of (plant) population and community ecology as well as evolutionary ecology (e.g. from modules such as Plant Ecology I, ÖEB 2 or similar courses). Also, basic knowledge of experimental design and statistics would be beneficial.							

Module Number: **4238**	Module Title: **Excursions in Plant Microbe Interactions** **Exkursion: Pflanzen-Mikroben-Interaktionen**								Type of Module: M.Sc. Elective
Credits (ECTS)	3								
Workload - Contact Time - Private Study	Workload: 90 h		Contact Time: 45 h / 3 SWS						Private Studies: 45 h
Duration Module Coordinator	4 days (initial meeting, 1h) + 3 days excursion + 1 day student presentations			Kemen					
Regular Cycle	every summer semester								
Language	if requested, excursion can be held in English, otherwise German								
Learning- /Teaching Forms	Lectures, Seminars, Exercises								
Module Content	• Lectures are given to introduce in general concepts of microbe-plant interactions • The module deals with practical aspects of plant microbe interactions and identification strategies. The symptoms of pathogens and symbionts will be presented in the field and in the lab. The main naturally occurring microbial pathogens will be identified collected and studied. Microbial interactions will be discussed in the field and in the lab. In the practical students will use microscopical and other techniques to get insights into diversity, mechanisms and cell biology of parasitism and symbiosis. • Presentation of a prepared topic during the excursion and contribution to a joint excursion report								
Qualification Goals	Students will learn fundamental theories in plant microbe interactions and learn how to identify symptoms of pathogens and symbionts on macroscopic and microscopic level.								
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*
	Lecture	*L*	*c*	*0,5*	*1*	*SP*		*ng*	-
	Exercises	*E*	*c*	*2*	*1*	*SP*		*ng*	-
	Seminar	*S*	*c*	*0,5*	*1*	*R*		*g*	*1*
Applicability	M.Sc. Geoökologie/Geoecology, B.Sc. Biologie, applicable in M.Sc. Evolution und Ökologie, M. Ed. Biologie								
Prerequisites	Basic knowledge in botany and cell biology is expected								

Module Number: **4239**	Module Title: **Communicating Science**		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	Gunn	
Regular Cycle	every summer semester		
Language	English		
Learning- /Teaching Forms	Lecture/discussion, seminar, exercise/tutorial		
Module Content	This module will provide training on how to effectively engage with science communication. The course will provide the opportunity to discuss and communicate social values associated with scientific research. At the start of the course, each student will select a academic paper that will form the basis for the assessment of this module. This module will be assessed through various coursework tasks, including creating a social media post, an activity for young children, an 'elevator pitch' and a press release for the paper they selected at the start of the module. In the lecture sessions, students will learn how to communicate science in multiple different ways, from giving presentations, designing activities for young children, and creating scientific social media posts. Students will also learn how to write and communicate scientific results for both their peers (e.g. through academic publications) and for the general public (e.g. through blog posts). Students will also learn how to present scientific results concisely and clearly through well designed figures. The exercise sessions will provide an opportunity for students to present materials that will form part of the assessment for this module, as well as a dedicated time to prepare materials and discuss the assignments with their peers. The seminar component of this module will be available to BSc, Masters, PhD students and staff. Attendance of these seminars is compulsory for registered students. The seminar sessions will provide an opportunity to engage in an open conversation about ethical and social values that should be integrated within scientific knowledge. Seminar topcis will include 'Decolonising ecology', 'Diverse science for a diverse world' and 'Inaccessible science'.		
Qualification Goals	After this course, students will have a profound knowledge of how to communicate science effectively to multiple interest groups (school students, general public etc.). Through the lecture and exercise sessions, students will gain experience and understanding in giving scientific presentations to peers, school students and the general public, as well as how to effectively incorporate interactive activities into science communication sessions. Furthermore, students will have obtained substantial knowledge on the social complexities involved with both doing and communicating science through the seminar sessions. These sessions will also provide students with an under-standing that will allow them to incorporate considerations of the social and ethical values of science into their own science communication in the future.		

Requirements for Obtaining Credit, Grading, Weight if appl.	*Courses*	*Type of Lecture*	*Status*	*SWS*	*CP*	*Type of Exam*	*Duration of Exam*	*Grading System*	*Weighting*
	Module session 1	*L*	*C*	*2*	*3*	*A,R*	*-*	*g*	*70*
	Module session 2	*S*	*C*	*1*	*1*	*SP*	*-*	*ng*	
	Module session 3	*E*	*C*	*1*	*2*	*A,R*	*-*	*g*	*30*
Applicability	M.Sc. Evolution und Ökologie, M.Sc. Geoökologie/Geoecology The skills the course will provide concerning engaging and discussion scientific, social and ethical principles will be applicable to multiple other modules, specifically modules that have a seminar/discussion component, such as ‘Essentials in Evolutionary Ecology‘.								
Prerequisites	A willingness to contribute to discussions and participating in group activities is essential for students to achieve the qualification goals of this course.								

<table>
<tr><td>Module Number:
Bio-ZMBP</td><td colspan="3">Module Title:
Applications of electron microscopy in cell biology, microbiology and virology / Anwendung der Elektronenmikroskopie in Zellbiologie, Mikrobiologie und Virologie</td><td>Type of Module:
M.Sc. Elective</td></tr>
<tr><td>Credits (ECTS)</td><td colspan="4">6</td></tr>
<tr><td>Workload
- Contact Time
- Private Study</td><td>Workload:
180 h</td><td>Contact Time:
90 h / 6 SWS</td><td>Private Study:
90 h</td><td></td></tr>
<tr><td>Duration
Module Coordinator</td><td colspan="2">1 Semester</td><td colspan="2">Fischer</td></tr>
<tr><td>Regular Cycle</td><td colspan="4">every winter semester</td></tr>
<tr><td>Language</td><td colspan="4">English</td></tr>
<tr><td>Learning- / Teaching Forms</td><td colspan="4">Lecture, exercise/tutorial, seminar</td></tr>
<tr><td>Module Content</td><td colspan="4">The aim of the practical is to give participants a comprehensive and critical overview of the possibilities of electron microscopy in biological research based on their own preparative experience on selected objects in different institutes (University, University clinics, MPI, NMI):
Preparation of bacterial cells, viruses and proteins: negative contrasting, plunge freezing for cryo-transmission electron microscopy.
Preparation of cells, tissues, organisms: chemical fixation, cryofixation, embedding for ultramicrotomy, ultra-thin section technique, freeze-drying and freeze-breaking, critical point drying; methods of immunolabelling for electron microscopy, correlative light and electron microscopy, cryo-scanning electron microscopy, sample processing with focused ion beam (FIB) in scanning electron microscope, energy dispersive X-ray spectroscopy (EDX).
Design and function of various microscopes: fluorescence and confocal laser scanning microscopes, (cryo)transmission and (cryo)scanning electron microscopes.
Image analysis: Image montages, analysis and evaluation (addressing typical artifacts) of SEM & TEM image material using Open Source Software packages</td></tr>
<tr><td>Qualification Goals</td><td colspan="4">• Introduction to independent microscopic work
• Knowledge of fluorescence microscopy (basics) and transmission and scanning electron microscopic imaging techniques and important preparation methods
• Analysis and interpretation of microscopic images
• Documenting and communicating the results of examinations
• Knowledge of the advantages and disadvantages of the respective techniques and methods
• Critical work and development of a sound professional judgement
• Ability to work in a team
• Presentation of results in English language</td></tr>
<tr><td rowspan="4">Requirements for Obtaining Credit, Grading, Weight if appl.</td><td>Courses</td><td>Type of Lecture</td><td>Status</td><td>CH</td><td>CP</td><td>Type of Exam / Study Requirement</td><td>Duration of Exam</td><td>Grading System</td><td>Weighting</td></tr>
<tr><td rowspan="3"></td><td>L</td><td>c</td><td>1</td><td>1</td><td rowspan="3">LP</td><td rowspan="3">-</td><td rowspan="3"></td><td rowspan="3">1</td></tr>
<tr><td>E</td><td>c</td><td>4</td><td>4</td></tr>
<tr><td>S</td><td>c</td><td>1</td><td>1</td></tr>
<tr><td>Applicability</td><td colspan="4">M.Sc. Geoökologie/Geoecology</td></tr>
<tr><td>Prerequisites</td><td colspan="4">none</td></tr>
</table>

<table>
<tr><td>Module Number:
3136</td><td colspan="5">Module Title:
Marine Biodiversity: Indonesia</td><td colspan="4">Type of Module:
M.Sc. Elective</td></tr>
<tr><td>Credits (ECTS)</td><td colspan="9">6</td></tr>
<tr><td>Workload
- Contact Time
- Private Study</td><td colspan="3">Workload:
180 h</td><td colspan="3">Contact Time:
120 h / 8 SWS</td><td colspan="3">Private Studies:
60 h</td></tr>
<tr><td>Duration
Module Coordinator</td><td colspan="4">Block course (3 weeks)</td><td colspan="5">Michiels</td></tr>
<tr><td>Regular Cycle</td><td colspan="9">every few years</td></tr>
<tr><td>Language</td><td colspan="9">English</td></tr>
<tr><td>Learning- / Teaching Forms</td><td colspan="9">Practical course / field excursion</td></tr>
<tr><td>Module Content</td><td colspan="9">This course takes place at Bangka Island, N Sulawesi, Indonesia at the Coral Eye field station (www.coral-eye.com). Bangka is a reef biodiversity hotspot: The number of coral and fish species is among the highest in the world. We focus on different reef tops, slopes and crests, mangroves, lagoons, hot vents and their inhabitants. While diving or snorkelling we shall photograph, identify and observe. Included are trips to mangroves, the Tangkoko National Park, and a trip to another island. We shall also visit a nearby village.</td></tr>
<tr><td>Qualification Goals</td><td colspan="9">• Ecology of tropical marine habitats: reef top, crest and slope, mangroves, lagoons, hot vents, current-swept pinnacles
• Acquire skills in Fish ID, Coral ID, underwater photography, documenting fluorescence, UW census, reef ecology methods</td></tr>
<tr><td rowspan="3">Requirements for Obtaining Credit, Grading, Weight if appl.</td><td>Courses</td><td>Type of Lecture</td><td>Status</td><td>SWS</td><td>CP</td><td>Type of Exam</td><td>Duration of Exam</td><td>Grading System</td><td>Weighting</td></tr>
<tr><td>Module Session 1</td><td>FE</td><td>c</td><td>2</td><td>3</td><td>OE</td><td>60</td><td>g</td><td>30</td></tr>
<tr><td>Module Session 2</td><td>FE</td><td>c</td><td>6</td><td>3</td><td>SP</td><td></td><td>g</td><td>70</td></tr>
<tr><td>Applicability</td><td colspan="9">M.Sc. Geoökologie/Geoecology
This course is for advanced students in biological sciences with a keen interest in field work in marine habitats. The focus is on identifying fish and coral diversity, and learning different surveying techniques such as transects, scientific diving, point observations, and optimal data sampling under challenging conditions. This also involves documentation skills, such as underwater photography and reef mapping. This module also trains students to be realistic about the chances and limitations of proper field data collection.</td></tr>
<tr><td>Prerequisites</td><td colspan="9">ideally, „Marine Biology" (or "Reef Ecology") and at least one other marine biological field course (e.g. Tropical Marine Ecology)
Participants must be experienced divers ≥ 20 dives. We give priority to participants with at least CMAS or PADI Rescue Diver or VDST Silver.
A valid medical confirmation (dive medical, Tauchtauglichkeitsbescheinigung) as well as a dive insurance (VDST, DAN, Aquamed, ...) are mandatory. Also check your health and travel insurance(s) well in advanced.
German citizens need a valid passport, no visum. If you have another nationality, please check with the Indonesian consulate.</td></tr>
</table>

Additional Modules

Modulnummer:	Modultitel: **Umweltrecht I: Allgemeine Lehren und Immissionsschutzrecht**								Art des Moduls: M.Sc. Wahlpflicht
ECTS-Punkte	6								
Arbeitsaufwand - Kontaktzeit - Selbststudium	Arbeitsaufwand: 180 h			Kontaktzeit: 30 h / 2 SWS					Selbststudium: 150 h
Moduldauer Modulkoordination	1 Semester					Saurer			
Häufigkeit des Angebots	jedes Wintersemester								
Unterrichtssprache	Deutsch								
Lehr- / Lernformen	Vorlesung								
Modulinhalt	• Inhalt der Veranstaltung sind die grundlegenden Ziele sowie die Systematik des Umweltrechts • Behandelt werden unter anderem das Klimaschutzrecht, das Umweltrecht der Europäischen Union, das Umwelthaftungsrecht und das Umweltrecht der Bundesrepublik Deutschland • Auch gibt die Veranstaltung Aufschluss darüber, wie umweltrelevantes Verhalten gesteuert werden kann • Ebenfalls ermöglicht die Veranstaltung Einblicke in das Umweltverfahrensrecht sowie den Rechtsschutz im Umweltrecht • Zudem wird mit dem Immissionsschutzrecht eine der wesentlichen Rechtsmaterien des besonderen Umweltrechts behandelt mit Ausblick auf die weiterführende Veranstaltung Umweltrecht II								
Qualifikationsziele	Interesse an juristischen Fragestellungen								
Voraussetzung für die Vergabe von Leistungspunkten / Benotung (ggf. Gewichtung)	*Lehrveranstaltungen*	*Art der Lehrform*	*Status*	*SWS*	*LP*	*Prüfungsform/ Studienleistung*	*Prüfungsdauer*	*Benotungssystem*	*Gewichtung*
	Umweltrecht I	*V*	*o*	*2*	*6*	*MP*		*b*	*1,0*
Verwendbarkeit	M.Sc. Geoökologie/Geoecology								
Teilnahmevoraussetzungen									

Modulnummer:	Modultitel: **Umweltrecht II: Naturschutz-, Wasser- und Umweltenergierecht**					Art des Moduls: M.Sc. Wahlpflicht			
ECTS-Punkte	3								
Arbeitsaufwand - Kontaktzeit - Selbststudium	Arbeitsaufwand: 90 h	Kontaktzeit: 15 h/ 1 SWS				Selbststudium: 75 h			
Moduldauer Modulkoordination	1 Semester			Saurer					
Häufigkeit des Angebots	jedes Sommersemester								
Unterrichtssprache	Deutsch								
Lehr- / Lernformen	Vorlesung								
Modulinhalt	Die Vorlesung behandelt Grundfragen des Umweltrechts. Systematisch dargestellt werden geschichtliche Entwicklung, Grundprinzipien, Strategien und Instrumente des Rechts der natürlichen Lebensgrundlagen. Weitere Themen der Vorlesung sind die Beteiligung der Öffentlichkeit an umweltrelevanten Projekten, das Umweltinformationsrecht und die gerichtliche Rechtsdurchsetzung durch Einzelpersonen und Umweltverbände. Das deutsche Umweltrecht wird einbezogen in den europäischen und internationalen Kontext.								
Qualifikationsziele	Interesse an juristischen Fragestellungen								
Voraussetzung für die Vergabe von Leistungspunkten / Benotung (ggf. Gewichtung)	*Lehrveranstaltungen*	*Art der Lehrform*	*Status*	*SWS*	*LP*	*Prüfungsform/ Studienleistung*	*Prüfungsdauer*	*Benotungssystem*	*Gewichtung*
	Umweltrecht II	*V*	*o*	*1*	*3*	*MP*		*b*	*1,0*
Verwendbarkeit	M.Sc. Geoökologie/Geoecology								
Teilnahmevoraussetzungen									