

Anlage 2: Modul-Handbuch M.Sc. „Hydrogeology and Environmental Geoscience“

Modul #	Basic	Seite
M-B-00	General Tools	2
M-B-01	Geology	3
M-B-02	Hydrology	4
M-B-03	Hydrogeology I	5
M-B-04	Hydrogeology II	6
M-B-05	Geophysics	7
M-B-06	Hydrogeochemistry	8
Modul #	Specialisation	Seite
M-A-01	Systems Modeling	10
M-A-02	Groundwater Modeling	12
M-A-03	Geothermal Energy	13
M-A-04	Water Pollution Control and Remediation	14
M-A-05	Environmental Monitoring	16
M-A-06	Integrated Water Resources Management	18
M-A-07	Projects	20

Georg-August-Universität Göttingen Studiengang M.Sc. Hydrogeology and Environmental Geoscience Modul M-B-00 Pflichtmodul “General Tools”	
Lernziele, Kompetenzen, Prüfungsanforderungen This module is designed to provide some of the basic prerequisites and general tools for the students to be able to follow the Master Course. Although a course in Mathematics is included, it cannot replace an intensive study of the mathematical foundations for those with less mathematical background. The individual courses comprise fundamentals of mathematics required within the context of groundwater and systems modelling and a programming course. Prüfungsanforderungen: Understanding of basic principles of mathematical procedures in natural sciences and information processing of spatial data	Credits/SWS insgesamt 6 / 4
Lehrveranstaltungen und Prüfungen 1. Teilmodul: Mathematics V/Ü Mathematics R.Brauchler <u>Teilmodulprüfung</u> : Exercises (unevaluated), Exam (evaluated, 60 Min.), Prüfende/r: R. Brauchler 2. Teilmodul: Scientific Programming V/Ü Scientific Programming R.Brauchler <u>Teilmodulprüfung</u> : Exercises (unevaluated), Exam (evaluated, 60 Min.), Prüfende/r: R.Brauchler	Credits/SWS einzeln 3 / 2 3 / 2
Wahlmöglichkeiten Keine	Zugangsvoraussetzungen Keine
Wiederholbarkeit zweimalig	Verwendbarkeit M.Sc. Hydrogeology and Environmental Geoscience (Pflichtmodul)
Angebotshäufigkeit Semesterlage Wintersemester 1. Semester	Dauer Das Modul kann in einem Semester abgeschlossen werden
Sprache Englisch	Maximale Studierendenzahl: 25
Modulverantwortliche/r (Stellvertreter/in) R. Brauchler (M. Sauter)	

Georg-August-Universität Göttingen Studiengang M.Sc. Hydrogeology and Environmental Geoscience Modul M-B-01 Pflichtmodul "Geology"	
Lernziele, Kompetenzen, Prüfungsanforderungen Since the course is open to students with non-geoscientific background the module will provide some of the basic principles of geology and specifically Quaternary Geology. The students will understand how geological formations are built up in space and time and will be able to derive from the geometric and structural geological data information on the heterogeneous distribution of hydraulic parameters. The advanced course on "Aquifersystems" will concentrate on the specifics of fractured aquifers and the particulars of the large variety of aquifer systems in Northern Germany. They can be regarded as representative for a large number of aquifer types. Prüfungsanforderungen: Relationship between geological geometrical structure and hydrogeological parameter distribution, specifics of the large spectrum of aquifer types and methods for their investigations.	Credits/SWS insgesamt 5/5
Teilmodule: Lehrveranstaltungen und Prüfungen 1. Teilmodul Fundamentals of Geology V Fundamentals of Geology A. v.d. Kerkhof <u>Teilmodulprüfung:</u> Exercises (unevaluated), Exam (evaluated, 60 Min.), Prüfende/r: A. v.d. Kerkhof 2. Teilmodul Geology of unconsolidated Sediments V Geology of unconsolidated Sediments L. Iturrizaga <u>Teilmodulprüfung:</u> Exam (evaluated, 60 Min.), Prüfende/r: L. Iturrizaga 3. Teilmodul Geology of Aquifersystems V Geology of Aquifersystems M. Sauter, Elbracht, Struckmeier (LBEG & BGR) <u>Teilmodulprüfung:</u> Exam (evaluated, 60 Min.), Prüfende/r: M.Sauter	Credits/SWS Einzel 2/2 2/2 1/1
Wahlmöglichkeiten Keine	Zugangsvoraussetzungen Keine
Wiederholbarkeit zweimalig	Verwendbarkeit M.Sc. Hydrogeology and Environmental Geoscience (Pflichtmodul)
Angebotshäufigkeit Semesterlage Jedes Wintersemester 1. Semester	Dauer Das Modul kann in einem Semester abgeschlossen werden.
Sprache Englisch	Maximale Studierendenzahl 25
Modulverantwortliche/r (Stellvertreter/in) A. v.d. Kerkhof (M. Sauter)	

Georg-August-Universität Göttingen
Studiengang M.Sc. Hydrogeology and Environmental Geoscience
Modul M-B-02
Pflichtmodul "Hydrology"

Lernziele, Kompetenzen, Prüfungsanforderungen		Credits/SWS insgesamt
The first sub module focuses on probability and statistics. Main topics are: descriptive statistics, regression and correlation, probability distribution, parameter estimation methods, statistical tests, frequency analysis and time series analysis. Examples and exercises on applied statistics in hydrology are provided. The second sub module gives an overview about the fundamentals of surface water hydrology. Main topics are: climates, hydrologic cycle, river basin characterization, precipitation, surface runoff and river discharge, unsaturated zone assessment, evapotranspiration, river morphology, erosion and sediment transport, precipitation-runoff processes and modeling (UH-related concepts and others), water balance, surface water quality assessment, hydrometry, regionalization and hydrological mapping, open channel hydraulics and fundamentals of hydraulic modeling. The third sub module provides knowledge about GIS techniques (e.g. spatial data models, data input techniques, spatial analysis) applied in hydrologic, geological and environmental studies. Students gain practical skills by computer exercises with state of the art software. Prüfungsanforderungen: Understanding of basic principles and application of state of the art methods in surface water hydrology and applied statistics. Familiar with GIS techniques.		7/5
Lehrveranstaltungen und Prüfungen		Credits/SWS Einzel
1. Teilmodul Applied Statistics in Hydrology V/Ü Applied Statistics in Hydrology W. Willems <u>Teilmodulprüfung:</u> Exercises (unevaluated), Exam (evaluated, 60 Min.), Prüfende/r: W. Willems		2/1
2. Teilmodul Surface Water Hydrology V/Ü Surface Water Hydrology B. Rusteberg <u>Teilmodulprüfung:</u> Exercises (unevaluated), Exam (evaluated, 60 Min.), Prüfende/r: B. Rusteberg		3/2
3. Teilmodul Geographic Information Systems V/Ü Geographic Information Systems B. Wagner <u>Teilmodulprüfung:</u> Exam (evaluated, 60 Min.), Prüfende/r: B. Wagner		2/2
Wahlmöglichkeiten Keine	Zugangsvoraussetzungen Keine	
Wiederholbarkeit zweimalig	Verwendbarkeit M.Sc. Hydrogeology and Environmental Geoscience (Pflichtmodul)	
Angebotshäufigkeit Semesterlage Wintersemester 1. Semester	Dauer Das Modul kann in einem Semester abgeschlossen werden.	
Sprache Englisch	Maximale Studierendenzahl 25	
Modulverantwortliche/r (Stellvertreter/in) B. Rusteberg (M. Sauter)		

Georg-August-Universität Göttingen Studiengang M.Sc. Hydrogeology and Environmental Geoscience Modul M-B-03 Pflichtmodul "Hydrogeology I"	
Lernziele, Kompetenzen, Prüfungsanforderungen This module is intended to convey the fundamentals of the theory of groundwater flow and transport and to apply them in practical exercises in the field and in the laboratory. The students should be able to organise and conduct test procedures as well as to assess the specific hydrogeological site conditions. The contents of the module comprise the hydrological water balance, groundwater recharge estimation techniques, groundwater hydrology, pumping test evaluation and principles of solute transport. Relevance of this fundamental material is illustrated with examples from the hydrogeological practice, e.g. water resources exploration, and groundwater remediation. A one weeks field seminar will introduce the students into the most important techniques of the daily practice of a hydrogeologist. Prüfungsanforderungen: Theory and practice of groundwater flow and solute transport processes, implementation in the field.	Credits/SWS insgesamt 6/5
Lehrveranstaltungen und Prüfungen 1. Teilmodul Introduction to Hydrogeology V/Ü Introduction to Hydrogeology M. Sauter <u>Teilmodulprüfung</u> : Exam (evaluated, 60 Min.), Prüfende/r: M. Sauter 2. Teilmodul Field Seminar GÜ Hydrogeological Field Seminar (Block) Th. Ptak <u>Teilmodulprüfung</u> : Report (evaluated), Prüfende/r: Th. Ptak	Credits/SWS Einzel 4/3 3/3
Wahlmöglichkeiten Keine	Zugangsvoraussetzungen Keine
Wiederholbarkeit zweimalig	Verwendbarkeit M.Sc. Hydrogeology and Environmental Geoscience (Pflichtmodul)
Angebotshäufigkeit Semesterlage TM 1: Wintersemester, TM 2: als Block im Sommersemester 1./2. Semester	Dauer Das Modul kann in zwei Semestern abgeschlossen werden.
Sprache Englisch	Maximale Studierendenzahl 25
Modulverantwortliche/r (Stellvertreter/in) M. Sauter (T. Ptak)	

Georg-August-Universität Göttingen Studiengang M.Sc. Hydrogeology and Environmental Geoscience Modul M-B-04 Pflichtmodul "Hydrogeology II"	
Lernziele, Kompetenzen, Prüfungsanforderungen This module builds on the foundations of „Hydrogeology I“ and concentrates on specific relevant fields, such as isotope hydrology, well design and innovative hydrogeological characterisation techniques. The isotope hydrology course is intended to provide the techniques to differentiate between different types of water of variable origins. Fundamentals of fractionation effects and the limitations of the methods are discussed. During the “Advanced Hydrogeological Investigation Techniques” course, new assessment techniques for the hydraulic characterisation of aquifers are presented and demonstrated using practical examples. The third course will convey principles of well design and well construction, using classical and direct push techniques. Prüfungsanforderungen: Theory and practical application of advanced hydrogeological characterisation techniques using hydrogeological and isotope techniques, basic principles of well construction methods.	Credits/SWS insgesamt 6/6
Teilmodule: Lehrveranstaltungen und Prüfungen 1. Teilmodul Isotope Hydrology V/Ü Isotope Hydrology M. Lodemann <u>Teilmodulprüfung:</u> Exam (evaluated, 60 Min.), Prüfende/r: M. Lodemann 2. Teilmodul Advanced Hydrogeological Investigation Techniques V Advanced Hydrogeological Investigation Techniques R. Brauchler 3. Teilmodul Well Design and Construction V Well Design and Construction R. Brauchler Modulprüfung für die Teilmodule 2 und 3: Report (evaluated), Exam (evaluated, 60 Min.), Prüfende/r: R.Brauchler	Credits/SWS Einzel 2/2 3/3 1/1
Wahlmöglichkeiten Keine	Zugangsvoraussetzungen Hydrogeology I
Wiederholbarkeit zweimalig	Verwendbarkeit M.Sc. Hydrogeology and Environmental Geoscience (Pflichtmodul)
Angebotshäufigkeit Semesterlage Jedes Sommersemester 2. Semester	Dauer Das Modul kann in einem Semester abgeschlossen werden.
Sprache Englisch	Maximale Studierendenzahl 25
Modulverantwortliche/r (Stellvertreter/in) R. Brauchler (M. Sauter)	

Georg-August-Universität Göttingen
Studiengang M.Sc. Hydrogeology and Environmental Geoscience
Modul M-B-05
Pflichtmodul "Geophysics"

Lernziele, Kompetenzen, Prüfungsanforderungen		Credits/SWS insgesamt
In this module the students will learn to understand in how far the methods of Applied Geophysics can assist in the hydraulic characterisation of aquifers, the detection of different quality waters as well as general concepts of parameter regionalisation in three-dimensional space. The module is composed of a lecture, concentrating on the theory and the presentation of the basic techniques employed in Applied Geophysics, i.e. seismics, resistivity techniques, magnetics, gravimetry and borehole geophysics. Their relevance for hydrogeological problems is illustrated with examples. The field course builds on this foundation and demonstrates practical application of the various techniques in the field. Prüfungsanforderungen: Theory and practical application of applied geophysical methods in the solution of hydrogeological problems.		4/4
Teilmodule: Lehrveranstaltungen und Prüfungen		Credits/SWS Einzel
1. Teilmodul Applied Geophysics and Hydrogeophysics V/Ü Applied Geophysics and Hydrogeophysics A.Weller <u>Teilmodulprüfung</u>: Exam (evaluated, 60 Min.), Prüfende/r: A. Weller		2/2
2. Teilmodul Geophysical Field Seminar GÜ Geophysical Field Seminar A.Weller <u>Teilmodulprüfung</u>: Report (evaluated), Prüfende/r: A.Weller		2/2
Wahlmöglichkeiten Keine	Zugangsvoraussetzungen Keine	
Wiederholbarkeit zweimalig	Verwendbarkeit M.Sc. Hydrogeology and Environmental Geoscience (Pflichtmodul)	
Angebotshäufigkeit Semesterlage Jedes Sommersemester 2. Semester	Dauer Das Modul kann in einem Semester abgeschlossen werden.	
Sprache Englisch	Maximale Studierendenzahl 25	
Modulverantwortliche/r (Stellvertreter/in) M. Sauter (A.Weller)		

Georg-August-Universität Göttingen
Studiengang M.Sc. Hydrogeology and Environmental Geoscience
Modul M-B-06
Pflichtmodul "Hydrogeochemistry"

Lernziele, Kompetenzen, Prüfungsanforderungen		Credits/SWS insgesamt 10/8
The module intends to convey an understanding for the role of chemical processes in water-rock interaction. The first sub module introduces the essential thermodynamics to understand basic and coupled electrolyte equilibria (i.e. redox processes, acid/base reactions, solubility, complexation, ion exchange) in a natural environment and is accompanied by simple and complex calculations of real world problems as well as coursework. Specific methods as applied for hydrochemical data presentation and data interpretation are included. The second sub module focuses on the classification of organic compounds and pollutants and pollutants in the subsurface. Relevant properties are discussed together with property-structure-relationships. The environmental and subsurface behaviour of organic compounds is introduced in terms of relevant distribution equilibria and kinetically controlled processes. Complex examples are provided as coursework helping to apply gained knowledge. The third sub module is a practical, including field sampling, data acquisition, data interpretation and presentation. A short modelling course will improve data interpretation skills. Prüfungsanforderungen: Knowledge about basic inorganic equilibrium water chemistry, water chemistry data interpretation, contaminant classes, structure-properties relationships for organic compounds, distribution equilibria, transient transport phenomena, sampling and hydrogeochemical modeling.		
Teilmodule: Lehrveranstaltungen und Prüfungen		Credits/SWS Einzel
1. Teilmodul Inorganic Hydrogeochemistry V/Ü Inorganic Hydrogeochemistry T. Licha		4/3
2. Teilmodul Hydrogeochemistry of Organic Contaminants V/Ü Hydrogeochemistry of Organic Contaminants T. Licha		4/3
3. Teilmodul Practical with field work and data interpretation/modeling 3.1 Field work/sampling (1 days) 3.2 Data acquisition/ chemical analysis (1 day) 3.3 Hydrogeochemical modelling (2 days) A. Reimer, V. Karius <u>Gesamtmodulprüfung:</u> Exercises (unevaluated), Exam (evaluated, 180 Min.), Prüfende/r: T. Licha		2/2
Wahlmöglichkeiten Keine	Zugangsvoraussetzungen Keine	
Wiederholbarkeit zweimalig	Verwendbarkeit M.Sc. Hydrogeology and Environmental Geoscience (Pflichtmodul)	
Angebotshäufigkeit Semesterlage	Dauer	

Jedes Wintersemester 1. Semester	Das Modul kann in einem Semester abgeschlossen werden.
Sprache Englisch	Maximale Studierendenzahl 25
Modulverantwortliche/r (Stellvertreter/in) T. Licha (M. Sauter)	

Georg-August-Universität Göttingen
Studiengang M.Sc. Hydrogeology and Environmental Geoscience
Modul M-A-01
Pflichtmodul "Systems Modeling"

Lernziele, Kompetenzen, Prüfungsanforderungen The first sub module deals with the analysis of spatially distributed data and with geostatistical simulation techniques. Environmental modeling often requires the generation of continuous spatially variable data fields based on local measurements. The lecture focuses on: statistical methods, regionalization, numerical stochastic simulation, etc.. Practical skills are obtained through examples and computer exercises. The second sub module focuses on operations research methods applied to water resources management. The course introduces important approaches for optimization and uncertainty assessment: e.g. linear, non-linear, dynamic programming, fuzzy theory, multi-criteria decision analysis and multi-objective optimization. The lecture includes practical exercises in the field of water resources and environment. The third sub module focuses on unsaturated zone processes. Lectured topics include: soil-water-plant-atmosphere system, soil-water, energy and solute balance, soil physics, soil water flow and reactive transport, mathematical models, groundwater recharge and protection, environmental monitoring. The fourth sub module focuses on surface water modeling for river basin management and pollution control. The lecture presents different modeling concepts and shows by means of case studies how river catchment models can be applied to analyse the impact of man's activity, water resources development strategies or scenarios of socio-economic development and global change on run-off, water balance and environment. Prüfungsanforderungen: Knowledge about theoretic background and state of the art techniques in geostatistics and applied operations research. Understanding of main concepts of unsaturated zone processes and river catchment modeling as well as practical skills.	Credits/SWS insgesamt 7/6
Teilmodule: Lehrveranstaltungen und Prüfungen 1. Teilmodul Spatial Analysis and Geostatistical Simulation V/Ü Spatial Analysis and Geostatistical Simulation U. Haberlandt (Univ. Hannover) <u>Teilmodulprüfung:</u> Exercises (unevaluated), Exam (evaluated, 60 Min.), Prüfende/r: U. Haberlandt 2. Teilmodul Applied Operations Research V/Ü Applied Operations Research B. Rusteberg <u>Teilmodulprüfung:</u> Exercises (unevaluated), Exam (evaluated, 60 Min.), Prüfende/r: B. Rusteberg 3. Teilmodul Modeling of unsaturated Zone Processes V/Ü Modeling of unsaturated Zone Processes W. Durner (TU Braunschweig) <u>Teilmodulprüfung:</u> Exercises (unevaluated), Exam (evaluated, 60 Min.), Prüfende/r: W. Durner 4. Teilmodul Surface Water Modeling V/Ü Surface Water Modeling G. Meon (TU Braunschweig) <u>Teilmodulprüfung:</u> Exercises (unevaluated), Exam (evaluated, 60 Min.), Prüfende/r: G. Meon	Credits/SWS Einzel 1/1 2/1 2/2 2/2

Wahlmöglichkeiten Keine	Zugangsvoraussetzungen Hydrology, Hydrogeology I
Wiederholbarkeit zweimalig	Verwendbarkeit M.Sc. Hydrogeology and Environmental Geoscience (Pflichtmodul)
Angebotshäufigkeit Semesterlage Jedes Sommersemester 2. Semester	Dauer Das Modul kann in einem Semester abgeschlossen werden.
Sprache Englisch	Maximale Studierendenzahl 25
Modulverantwortliche/r (Stellvertreter/in) B. Rusteberg (T.Ptak)	

Georg-August-Universität Göttingen
Studiengang M.Sc. Hydrogeology and Environmental Geoscience
Modul M-A-02
Pflichtmodul "Groundwater Modeling"

Lernziele, Kompetenzen, Prüfungsanforderungen		Credits/SWS insgesamt
This module introduces the student to the commonly used mathematical tools as well as to state of-the-art numerical groundwater modeling techniques, including visualization of the results. Groundwater modeling allows a consistent joining of multiple types of data from laboratory and field investigations, environmental system analysis, process understanding, planning of water management and remedial activities, risk assessment, decision making etc. The first sub module focuses on the numerical modeling of flow and non-reactive as well as reactive transport in porous media (aquifers). It includes topics such as model design, mathematical process formulation (process equations) and numerical methods for solving the governing equations. Simple modeling problems will be discussed and exercised by the students using computer codes in tutorials to complement the presentations given in the lecture. The second sub module deals with special advanced modeling techniques. The focus will be on basin scale integrated hydrosystem modeling, covering porous and fractured media, saturated and unsaturated zones, surface water - groundwater interaction, surface water modeling, hillslope hydrological aspects, including reactive contaminant transport. Students will gain hands on experience with models through computer exercises. Prüfungsanforderungen: Knowledge about theoretic background and state of the art techniques in groundwater modelling, understanding of main concepts of integrated hydrosystem modelling and practical skills.		5/5
Teilmodule: Lehrveranstaltungen und Prüfungen		Credits/SWS Einzel
1. Teilmodul Groundwater Flow and Transport Modeling V/Ü Groundwater Flow and Transport Modeling M. Sauter, T. Ptak		4/4
2. Teilmodul Advanced Modeling Techniques V/Ü Advanced Modeling Techniques E.A. Sudicky (Univ. of Waterloo) , R. Therrien (Univ.Laval)		1/1
Gesamtmodulprüfung: Exam (evaluated, 60 Min.), Prüfende/r: s.a.		
Wahlmöglichkeiten Keine	Zugangsvoraussetzungen Hydrology, Hydrogeology I, Hydro(geo)chemistry	
Wiederholbarkeit zweimalig	Verwendbarkeit M.Sc. Hydrogeology and Environmental Geoscience (Pflichtmodul)	
Angebotshäufigkeit Semesterlage Jedes Sommersemester, TM 2 als Block 2. Semester	Dauer Das Modul kann in einem Semester abgeschlossen werden.	
Sprache Englisch	Maximale Studierendenzahl 25	
Modulverantwortliche/r (Stellvertreter/in) T. Ptak (M.Sauter)		

Georg-August-Universität Göttingen Studiengang M.Sc. Hydrogeology and Environmental Geoscience Modul M-A-03 Pflichtmodul "Geothermal Energy"	
Lernziele, Kompetenzen, Prüfungsanforderungen This module intends to convey a general understanding for the relevant processes and the general concepts involved in the exploitation of geothermal energy. The module is subdivided into "Deep Geothermics", concentrating on power and heat production at large depths (> 4000m) "Shallow Geothermics", dealing with heat extraction at shallow depths (< 500m), and the illustration of the use of geothermal energy with case studies. For the assessment and exploitation of geothermal energy, general knowledge of groundwater flow and transport is a prerequisite, provided in modules elsewhere. Course contents of this module comprise some basic principles, the regional assessment of the geothermal potential in Germany and Europe, required site conditions for economical exploitation, generally employed testing procedures, economical assessment methods, fractures and faults, fluid flow in fractured systems, stimulation methods. Prüfungsanforderungen: Prerequisites for the economical exploitation of shallow and deep geothermal energy, design of geothermal plants.	Credits/SWS insgesamt 6/6
Lehrveranstaltungen und Prüfungen 1. Teilmodul Deep Geothermics V/Ü Deep Geothermics N.N. Geothermie <u>Teilmodulprüfung</u> : Exam (evaluated, 60 Min.), Prüfende/r: N.N. Geothermie 2. Teilmodul Shallow Geothermics V/Ü Shallow Geothermics M. Lodemann <u>Teilmodulprüfung</u> : Exam (evaluated, 60 Min.), Prüfende/r: M. Lodemann 3. Teilmodul Fluidtransport in Reservoirs V/Ü Fluidtransport in Reservoirs S. Philipp <u>Teilmodulprüfung</u> : Exam (evaluated, 60 Min.), Prüfende/r: S. Philipp	Credits/SWS Einzel 2/2 1/1 3/3
Wahlmöglichkeiten Keine	Zugangsvoraussetzungen Keine
Wiederholbarkeit zweimalig	Verwendbarkeit M.Sc. Hydrogeology and Environmental Geoscience (Pflichtmodul)
Angebotshäufigkeit Semesterlage Sommersemester 2. Semester	Dauer Das Modul kann in einem Semester abgeschlossen werden.
Sprache Englisch	Maximale Studierendenzahl 25
Modulverantwortliche/r (Stellvertreter/in) M. Sauter (M. Lodemann)	

Georg-August-Universität Göttingen
Studiengang M.Sc. Hydrogeology and Environmental Geoscience
Modul M-A-04
Pflichtmodul "Water Pollution Control & Remediation"

Lernziele, Kompetenzen, Prüfungsanforderungen	Credits/SWS insgesamt
The first sub module comprises topics of environmental geochemistry such as: natural and anthropogenic fluxes and interactions of harmful elements in different environmental spheres (air, water, soil, sediment & biosphere); interactions of these elements with solid water interface; speciation, critical loads and levels, environmental records and global change. The second submodule introduces remediation strategies and basic remediation techniques together with their evaluation and comparison. Prerequisites for remediation strategies such as source apportionment and kinetically controlled contaminant release from different source types are further introduced. To estimate the natural attenuation potential and to help planning remediation schemes, the interpretation of chemical indicators and abiotic and biotic contaminant degradation processes together with metabolic pathways are explained. The third submodule focuses is on the understanding of processes, their interaction and weighting on a river catchment scale. Mass balances for sub systems and their individual impact on the whole mass balance for the catchment are addressed. Several case studies at the watershed and regional scales from major river basins in Europe are presented. The fourth submodule is on innovative remediation techniques such as: surfactant flushing, in-situ redox manipulations, air sparging, alcohol swelling, catalysts, etc. The applicability and economic aspects of remediation technologies are addressed. Furthermore, design, operation and monitoring of waste disposal facilities are discussed. Examples of applications are presented. Prüfungsanforderungen: Understanding of water chemistry relevant processes in natural systems, mass balances on river catchment scale and innovative remediation techniques.	5/5

Teilmodule: Lehrveranstaltungen und Prüfungen		Credits/SWS Einzeln
1. Teilmodul Environmental Geochemistry V/Ü Environmental Geochemistry H.Ruppert <u>Teilmodulprüfung:</u> Exercises (unevaluated), Exam (evaluated, 60 Min.), Prüfende/r: Ruppert		2/2
2. Teilmodul Attenuation and Remediation Methods V/Ü Attenuation and Remediation Methods T. Licha <u>Teilmodulprüfung:</u> Exercises (unevaluated), Exam (evaluated, 60 Min.), Prüfende/r: T. Licha		1/1
3. Teilmodul Basin Scale Mass Flow V/Ü Basin Scale Mass Flow J. Barth (Univ. Erlangen) <u>Teilmodulprüfung:</u> Exam (evaluated, 60 Min.), Prüfende/r: s.o.		1/1
4. Teilmodul Innovative Remediation Techniques and Waste Deposal V/Ü Innovative Remediation Techniques and Waste Deposal J. Barker (Univ. Waterloo) <u>Teilmodulprüfung:</u> Exam (evaluated, 60 Min.), Prüfende/r: J. Barker		1/1
Wahlmöglichkeiten Keine	Zugangsvoraussetzungen Hydrogeology, Hydro(geo)chemistry	
Wiederholbarkeit zweimalig	Verwendbarkeit M.Sc. Hydrogeology and Environmental Geoscience (Pflichtmodul)	
Angebotshäufigkeit Semesterlage Jedes Wintersemester, TM 3/4 als Block 3. Semester	Dauer Das Modul kann in einem Semester abgeschlossen werden.	
Sprache Englisch	Maximale Studierendenzahl 25	
Modulverantwortliche/r (Stellvertreter/in) T.Licha (T. Ptak)		

Georg-August-Universität Göttingen
Studiengang M.Sc. Hydrogeology and Environmental Geoscience
Modul M-A-05
Pflichtmodul " Environmental Monitoring"

Lernziele, Kompetenzen, Prüfungsanforderungen The first submodule is on environmental risk assessment, including toxicity and exposure assessment, conceptual site modeling, data evaluation etc. Further main topics are: Source-Pathway-Receptor Approach, risk based assessment and screening levels, guidelines, procedures, tools, software for quantitative risk assessment, etc. The second submodule focuses on innovative investigation and monitoring techniques. Both integral and high resolution point scale, non-invasive and invasive investigation techniques are presented, and scale-heterogeneity relationship issues are discussed. The lecture includes: borehole geophysical measurements, construction of multilevel sampling wells, conventional and innovative integral and multilevel groundwater sampling techniques, novel tools to assess pollutant origin and fate, etc. The third submodule addresses the problem of salinity in groundwater, characterisation, mapping, modelling and the management of groundwater resources in presence of salinity, including coastal aquifers and inland aquifers with saline water bodies. One large test case is considered and two participative workshops will be conducted. The fourth sub module provides knowledge about remote sensing techniques (e.g. remote sensing scanning techniques, image processing, interpretation) applied in hydrologic and environmental studies. Students gain practical skills by computer exercises with state of the art software. <u>Prüfungsanforderungen:</u> Skills related to state-of-the-art environmental risk assessment, investigation and monitoring techniques, seawater intrusion control and remote sensing techniques.	Credits/SWS insgesamt 7/7
Teilmodule: Lehrveranstaltungen und Prüfungen 1. Teilmodul Environmental Risk Assessment V/Ü Environmental Risk Assessment D. Chen-Brauchler <u>Teilmodulprüfung:</u> Exercises (unevaluated), Exam (evaluated, 60 Min.), Prüfende/r: D. Chen-Brauchler 2. Teilmodul Investigation Techniques and Monitoring V/Ü Investigation Techniques and Monitoring T. Ptak <u>Teilmodulprüfung:</u> Exercises (evaluated), Exam (evaluated, 60 Min.), Prüfende/r: T. Ptak 3. Teilmodul Saline Groundwater V/Ü Saline Groundwater J. Bensabat (EWRE – Israel) <u>Teilmodulprüfung:</u> Exam (evaluated, 60 Min.), Prüfende/r: J. Bensabat 4. Teilmodul Applied Remote Sensing Techniques V/Ü Applied Remote Sensing Techniques Fachbehörden <u>Teilmodulprüfung:</u> Exam (evaluated, 60 Min.), Prüfende/r: s.a.	Credits/SWS Einzel 2/2 2/2 1/1 2/2
Wahlmöglichkeiten Keine	Zugangsvoraussetzungen GIS, Geophysics, Hydrogeology -

Wiederholbarkeit zweimalig	Verwendbarkeit M.Sc. Hydrogeology and Environmental Geoscience (Pflichtmodul)
Angebotshäufigkeit Semesterlage Jedes Wintersemester, TM 3 als Block 3. Semester	Dauer Das Modul kann in einem Semester abgeschlossen werden.
Sprache Englisch	Maximale Studierendenzahl 25
Modulverantwortliche/r (Stellvertreter/in) T. Ptak (T. Licha)	

Georg-August-Universität Göttingen
Studiengang M.Sc. Hydrogeology and Environmental Geoscience
Modul M-A-06
Pflichtmodul "Integrated Water Resources Management"

Lernziele, Kompetenzen, Prüfungsanforderungen The first submodule focuses on integrated water resources planning and management. The lecture treats: irrigation planning and management, fluvial transport and river regulation, drinking water supply, surface water reservoir planning and operation, conjunctive use of groundwater and surface water resources, water reuse concepts and groundwater artificial recharge, flood and drought management, economic project feasibility, project planning and water master plans, social, political, legal and institutional aspects of IWRM, performance and decision criteria, decision support systems for IWRM, transboundary and conflict management. International case studies are discussed, covering a large variety of different water resources projects. The second submodule focuses on urban hydrology and groundwater management issues. Further important aspects are: e.g. impact of urban development on groundwater, sustainable management and protection of groundwater resources in urban environments, innovative management concepts. Case studies are discussed. The third submodule focuses on Environmental Impact Assessment studies – EIA for water resources development projects. History and development of EIA procedures, regulations and standards in different parts of the world are discussed. Environmental screening and scoping methods are presented and EIA studies are analysed. Prüfungsanforderungen: Understanding of basic principles and state of the art methods for integrated and sustainable water resources planning and management and EIA.	Credits/SWS insgesamt 6/5
Teilmodule: Lehrveranstaltungen und Prüfungen 1. Teilmodul: Water Resources Planning and Management V/Ü Water Resources Planning and Management B. Rusteberg <u>Teilmodulprüfung</u>: Exercises (unevaluated), Exam (evaluated, 60 Min.) Prüfende/r: B.Rusteberg 2. Teilmodul: Urban Hydrology and Groundwater Management V Urban Hydrology and Groundwater Management J. Tellam (Univ. of Birmingham – UK) <u>Teilmodulprüfung</u>: Exam (evaluated, 60 Min.), Prüfende/r: J. Tellam 3. Teilmodul: Environmental Impact Assessment (EIA) V Environmental Impact Assessment (EIA) Consulting und Fachbehörden <u>Teilmodulprüfung</u>: Exam (evaluated, 60 Min.), Prüfende/r: s.a.	Credits/SWS Einzel 4/3 1/1 1/1
Wahlmöglichkeiten Keine	Zugangsvoraussetzungen Hydrology, Hydrogeology I
Wiederholbarkeit zweimalig	Verwendbarkeit M.Sc. Hydrogeology and Environmental Geoscience (Pflichtmodul)

Angebotshäufigkeit Semesterlage Jedes Wintersemester 3. Semester	Dauer Das Modul kann in einem Semester abgeschlossen werden.
Sprache Englisch	Maximale Studierendenzahl 25
Modulverantwortliche/r (Stellvertreter/in) B. Rusteberg (T. Ptak)	

Georg-August-Universität Göttingen Studiengang M.Sc. Hydrogeology and Environmental Geoscience Modul M-A-07 Pflichtmodul "Projects"	
Lernziele, Kompetenzen, Prüfungsanforderungen In the first submodule the students will be able to chose between the draft of a literature review report and the preparation of a computer program. They are designed to lay foundations of the later Master Thesis Project. In the second submodule the student will be assigned to an integrated project which should be related to a course relevant subject and research topics of the Department of Applied Geology. Prüfungsanforderungen: Literature review (report), computer programme (operational code) and assigned project (report and oral presentation) in the context on an open seminar, organized by the students themselves.	Credits/SWS insgesamt 9/7
Teilmodule: Lehrveranstaltungen und Prüfungen 1. Teilmodul: Literatur Review OR Computer Programme S Literature Review OR Computer Project Staff of the Department <u>Teilmodulprüfung:</u> Literature review (report) or preparation of a computer programme (operational code) – evaluated, Prüfende/r: Staff of Department 2. Teilmodul: Assigned Project S Assigned Project Staff of the Department <u>Teilmodulprüfung:</u> Report and oral presentation of the project (evaluated) Prüfende/r: Staff of Department	Credits/SWS Einzel 4/3 5/4
Wahlmöglichkeiten Keine	Zugangsvoraussetzungen keine
Wiederholbarkeit zweimalig	Verwendbarkeit M.Sc. Hydrogeology and Environmental Geoscience (Pflichtmodul)
Angebotshäufigkeit Semesterlage Jedes Wintersemester 3. Semester	Dauer Das Modul kann in einem Semester abgeschlossen werden.
Sprache Englisch	Maximale Studierendenzahl 25
Modulverantwortliche/r (Stellvertreter/in) A.v.d. Kerkhof (Th. Ptak)	