Georg-August-Universität
Göttingen

Directory of Modules

zu der Prüfungs- und Studienordnung für den konsekutiven Master-Studiengang Hydrogeology and Environmental Geoscience (Amtliche Mitteilungen I 10/2011, zuletzt geaendert durch Amtliche Mitteilung I Nr. 39/2014 S. 1265)

Modules

Index by areas of study

I. M.Sc. degree programme "Hydrogeology and Environmental Geoscience"

To successfully complete the Master's degree programme, a total of 120 C must be earned.

1. Specialised studies

The 7 following modules comprising 54 C have to be passed:

2. Professionalisation

Modules comprising 30 C have to be earned prescribed by the following regulations.

a. Compulsory modules I

24 C have to be earned from passing two of the following module groups comprising 12 C each. Licit combinations are: Groups A and B, Groups A and C as well as Groups B and C.

aa. Group A

If Group A is chosen, the 2 following modules comprising 12 C have to be passed:

bb. Group B

If Group B is chosen, the 2 following modules comprising 12 C have to be passed:

cc. Group C

If Group A is chosen, the 2 following modules comprising 12 C have to be passed:

b. Compulsory modules II

One of the following modules comprising 6 C has to be passed:

3. Key Competences

Licit modules comprising at least 6 C must be passed.

4. Master's Thesis

A total of 30 C are awarded for passing the Master's thesis.

Georg-August-Universität Göttingen **Module M.HEG.01: General Tools**	9 C 6 WLH

Learning outcome, core skills: 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. The individual courses comprise fundamentals of mathematics required within the context of groundwater and systems modeling and a programming course. The course in Mathematics cannot replace an intensive study of the mathematical foundations for those with less mathematical background. The course Fundamentals of Geology is comprises a comprehensive review of the history of Earth, the main rock-forming processes, and changes of the Earth surface under atmospheric conditions.	**Workload:** Attendance time: 84 h Self-study time: 186 h

Courses:	
1. Scientific Programming (Exercise, Lecture)	2 WLH
2. Mathematics (Exercise, Lecture)	2 WLH
3. Fundamentals of Geology (Lecture)	2 WLH
Examination: Written examination (90 minutes)	

Examination requirements: Understanding of basic principles of mathematical procedures in natural sciences and information processing of spatial data.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. Alfons M. van den Kerkhof
Course frequency: each winter semester	**Duration:** 1 Semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1
Maximum number of students: 25	

Georg-August-Universität Göttingen **Module M.HEG.02: Hydrogeology I**	8 C 6 WLH

Learning outcome, core skills: 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 field seminar will introduce the students into the most important field techniques of the daily practice of a hydrogeologist. During the “Advanced Hydrogeological Investigation Techniques” course, new assessment techniques for the hydraulic characterisation of aquifers are presented and demonstrated using practical examples. 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.	**Workload:** Attendance time: 84 h Self-study time: 156 h

Courses:	
1. Introduction to Hydrogeology (Exercise, Lecture)	3 WLH
2. Hydrogeological Field Trip and Hydrological Measuring (Excursion)	1 WLH
3. Advanced Hydrogeological Investigation Techniques (Lecture)	1 WLH
4. Geology of Aquifer systems (Lecture, Excursion)	1 WLH
Examination: Written examination (60 minutes)	9 C

Examination requirements: Theory and practice of groundwater flow and solute transport processes, implementation in the field.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Martin Sauter
Course frequency: each winter semester	**Duration:** 1 Semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1
Maximum number of students: 25	

Georg-August-Universität Göttingen **Module M.HEG.03: Hydrogeochemistry**	9 C 7 WLH

Learning outcome, core skills: The module intends to convey an understanding for the role of chemical processes in water-rock interaction. The first lecture introduces the essential thermodynamics to understand basic and coupled electrolyte equilibria (i.e. redox processes, acid/base reactions, solubility, complexation, ion exchange) in the aquatic environment and is accompanied by simple and complex calculations of real world problems as well as coursework. The second lecture focuses on the classification of organic compounds 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 partially as coursework helping to apply gained knowledge. 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.	**Workload:** Attendance time: 98 h Self-study time: 172 h

Courses:	
1. Inorganic Hydrogeochemistry (Exercise, Lecture)	3 WLH
2. Organic Hydrogeochemistry (Exercise, Lecture)	2 WLH
Examination: Written examination (90 minutes)	

Course: Isotope Hydrology (Exercise, Lecture)	2 WLH
Examination: Written examination (60 minutes)	9 C

Examination requirements: Knowledge about basic inorganic equilibrium water chemistry, water chemistry data interpretation, contaminant classes, basic organic chemistry, structure-properties relationships for organic compounds, distribution equilibria, isotope hydrology	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** PD Dr. rer. nat. Tobias Licha (Prof. Dr. Martin Sauter)
Course frequency: each winter semester	**Duration:** 1 Semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 25	

Georg-August-Universität Göttingen **Module M.HEG.04: Hydrology**	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
"Applied Stataistics in Hydrogeology" focuses on probability and statistics in hydrology. 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. "Appllied Operation Research" focuses on 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 second course gives an overview about the fundamentals of surface water hydrology. Main topics are: climate, hydrologic cycle, river basin characterisation, precipitation, surface runoff and river discharge, unsaturated zone assessment, evapotranspiration, river morphology, erosion and sediment transport, precipitationrunoff processes and modeling, water balance, surface water quality assessment, hydrometry, regionalization and hydrological mapping, open channel hydraulics and fundamentals of hydraulic modeling. The third course 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.	Attendance time: 56 h Self-study time: 124 h

Courses:	
1. Applied Statistics in Hydrology or Applied Operation Research (Exercise, Lecture)	1 WLH
2. Surface Water Hydrology (Exercise, Lecture)	1 WLH
3. Geographic Information Systems (Exercise, Lecture)	2 WLH
Examination: Written examination (120 minutes)	7 C

Examination requirements:	
Understanding of basic principles and application of state of the art methods in surface water hydrology and applied statistics.	

Admission requirements:	**Recommended previous knowledge:**
none	none
Language: English	**Person responsible for module:** Dr. -Ing. Bernd Rusteberg (Dr. rer. nat. Bianca Wagner)
Course frequency: each summer semester	**Duration:** 1 Semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 2

Maximum number of students: 25	

Georg-August-Universität Göttingen **Module M.HEG.05: Hydrogeology II**	8 C 6 WLH

Learning outcome, core skills: This module builds on the foundations of „Hydrogeology I“ and concentrates on specific relevant fields. The first and second course focus on the understanding and modeling of processes, their interaction and weighting on groundwater catchment scale. Mass balances for sub systems and their individual impact on the whole mass balance for groundwater catchments are addressed. The third course will convey principles of field testing techniques employed in hydrogeology such as pumping tests, slug tests, tracer experiments, sampling as well as direct push investigation methods.	**Workload:** Attendance time: 84 h Self-study time: 156 h

Courses:	
1. Catchment Hydrogeology (Exercise, Lecture)	2 WLH
2. Field Trip - Catchment Hydrogeology (Excursion)	1 WLH
Examination: Written examination (45 minutes)	5 C

Course: Hydrogeological Field Seminar (Excursion)	3 WLH
Examination: Term Paper (max. 10 pages) **Examination prerequisites:** Compulsory attendance in the Hydrogeological Field Seminar	3 C

Examination requirements: Theory of flow and transport processes on groundwater catchment scale, theory and practical application of hydrogeological characterisation techniques using field investigation methods.	

Admission requirements: M.HEG.02	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr.-Ing. habil. Thomas Ptak-Fix
Course frequency: each summer semester	**Duration:** 1 Semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 2
Maximum number of students: 25	

Georg-August-Universität Göttingen **Module M.HEG.06: Groundwater Modeling**	8 C 6 WLH

Learning outcome, core skills: 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 assembly 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 and second course focus 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 third course 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.	**Workload:** Attendance time: 84 h Self-study time: 156 h

Courses:	
1. Groundwater Flow Modeling (Exercise, Lecture)	3 WLH
2. Groundwater Transport Modeling (Exercise, Lecture)	2 WLH
3. Advanced Modeling Techniques (Exercise, Lecture)	1 WLH
Examination: Term Paper (max. 10 pages) **Examination prerequisites:** Compulsory attendance in all 3 exercises	8 C

Examination requirements: Knowledge about theoretic background and state of the art techniques in groundwater modelling, understanding of main concepts of integrated hydrosystem modelling and practical skills.	

Admission requirements: M.HEG.02, M.HEG.03	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr.-Ing. habil. Thomas Ptak-Fix (Prof. Dr. Martin Sauter)
Course frequency: each summer semester	**Duration:** 1 Semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 2
Maximum number of students:	

25	

Georg-August-Universität Göttingen **Module M.HEG.07: Geophysics**	6 C 4 WLH

Learning outcome, core skills: 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.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Applied Geophysics and Hydrogeophysics (Exercise, Lecture)	2 WLH
Examination: Written examination (90 minutes)	6 C

Course: Geophysical Field Seminar (Excursion)	2 WLH
Examination: Term Paper (max. 5 pages), not graded	

Examination requirements: Theory and practical application of applied geophysical methods in the solution of hydrogeological problems.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Andreas Weller (Prof. Dr. Martin Sauter)
Course frequency: each summer semester	**Duration:** 1 Semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 2
Maximum number of students: 25	

Georg-August-Universität Göttingen **Module M.HEG.31: Systems Modeling**	6 C 4 WLH

Learning outcome, core skills: The first course 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 second course deals with surface water modeling methods 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. The third course deals with non-Darcian flow processes and transport phenomena which can be observed in strongly heterogeneous media.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Courses:	
1. Modeling of unsaturated Zone Processes (Exercise, Lecture)	2 WLH
2. Surface Water Modeling (Exercise, Lecture)	1 WLH
3. Simulation of Flow and Transport in Fractured and Karstified Aquifers (Exercise, Lecture)	1 WLH
Examination: Written examination (90 minutes)	6 C

Examination requirements: Understanding of main concepts of unsaturated zone processes, river catchment modelling, theory of simulation of flow and transport processes in fractured/karstified media.	

Admission requirements: M.HEG.02, M.HEG.04	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. -Ing. Bernd Rusteberg
Course frequency: each winter semester	**Duration:** 1 Semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 25	

Georg-August-Universität Göttingen **Module M.HEG.32: Integrated Water Resources Management**	6 C 4 WLH

Learning outcome, core skills: The first course 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. The second course 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. The third course deals with 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.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Courses:	
1. Water Resources Planning and Management (Exercise, Lecture)	2 WLH
2. Urban Hydrology and Groundwater Management (Lecture)	1 WLH
3. Environmental Impact Assessment (EIA) (Lecture)	1 WLH
Examination: Written examination (120 minutes)	6 C

Examination requirements: Understanding of basic principles and state of the art methods for integrated and sustainable water resources planning and management and EIA.	

Admission requirements: M.HEG.02, M.HEG.04	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. -Ing. Bernd Rusteberg (Prof. Dr.-Ing. habil. Thomas Ptak-Fix)
Course frequency: each winter semester	**Duration:** 1 Semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 3
Maximum number of students: 25	

Georg-August-Universität Göttingen **Module M.HEG.33: Georeservoirs I**	6 C 5 WLH

Learning outcome, core skills: 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.	**Workload:** Attendance time: 70 h Self-study time: 110 h

Courses:	
1. Deep Geothermics (Exercise, Lecture)	2 WLH
2. Shallow Geothermics (Exercise, Lecture)	1 WLH
3. Fluidtransport in Reservoirs (Exercise, Lecture)	2 WLH
Examination: Written examination (120 minutes)	6 C

Examination requirements: Prerequisites for the economical exploitation of shallow and deep geothermal energy, design of geothermal plants.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. Iulia Ghergut
Course frequency: each winter semester	**Duration:** 1 Semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 3
Maximum number of students: 25	

Georg-August-Universität Göttingen **Module M.HEG.34: Georeservoirs II**	6 C 5 WLH

Learning outcome, core skills: The module “Georeservoirs II” deals with processes in georeservoirs (geothermal, energy storage, CO2-storage and hydrocarbons), their identification and quantification of process parameters. Processes in georeservoirs comprise hydraulic, thermal, mechanical and chemical processes as well as their coupling. The investigation of georeservoirs is one of the main research focuses in the Applied Geology and nowadays a highly relevant field in energy research issues. During the courses, the methods of the investigation, characterisation and modelling of georeservoirs shall be conveyed to the students, together with illustrations of practical examples of case studies. A field trip shall be conducted to geothermal plants and drilling sites.	**Workload:** Attendance time: 70 h Self-study time: 110 h

Courses:	
1. Processes in Georeservoirs (Exercise, Lecture)	2 WLH
2. Characterisation of Georeservoirs (Exercise, Lecture)	2 WLH
3. Exploration of Geothermal Energy (Excursion)	1 WLH
Examination: Written examination (60 minutes)	6 C

Examination requirements: Prerequisites of the understanding of reservoir functioning and prediction of their future dynamics.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. Iulia Ghergut
Course frequency: each winter semester	**Duration:** 1 Semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 3
Maximum number of students: 25	

Georg-August-Universität Göttingen **Module M.HEG.35: Water Pollution Control and Remdiation**	6 C 4 WLH

Learning outcome, core skills: The first course 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 course introduces sampling strategies and basic chemical analytical methods as applied for the analysis of organic compounds. It further familiarises the student with data quality evaluation and data interpretation to identify subsurface processes. The third course 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.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Courses:	
1. Environmental Geochemistry (Exercise, Lecture)	2 WLH
2. Sampling, Chemical Analysis and Data Evaluation (Exercise, Lecture)	1 WLH
3. Innovative Remediation Techniques and Waste Deposal (Exercise, Lecture)	1 WLH
Examination: Written examination (120 minutes)	6 C

Examination requirements: Understanding of water chemistry relevant processes in natural systems and innovative remediation techniques, skills related to state-of-the-art environmental risk assessment	

Admission requirements: M.HEG.02, M.HEG.03	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** PD Dr. rer. nat. Tobias Licha (Prof. Dr.-Ing. habil. Thomas Ptak-Fix)
Course frequency: each winter semester	**Duration:** 1 Semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 3
Maximum number of students: 25	

Georg-August-Universität Göttingen **Module M.HEG.36: Environmental Monitoring**	6 C 5 WLH

Learning outcome, core skills: The first course 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 second course 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. The third course provides knowledge about remote sensing techniques (e.g. remote sensing scanning techniques, image processing, interpretation) applied in hydrologic and environmental studies. Finally the module is supplemented with the basics of well construction and completion.	**Workload:** Attendance time: 70 h Self-study time: 110 h

Courses:	
1. Investigation Techniques and Monitoring (Exercise, Lecture)	2 WLH
2. Saline Groundwater (Exercise, Lecture)	1 WLH
3. Applied Remote Sensing Techniques (Exercise, Lecture)	1 WLH
4. Well Design and Construction (Lecture)	1 WLH
Examination: Written examination (120 minutes)	6 C

Examination requirements: Investigation and monitoring techniques, seawater intrusion control, remote sensing techniques, basic principles of well construction.	

Admission requirements: M.HEG.02, M.HEG.04, M.HEG.07	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr.-Ing. habil. Thomas Ptak-Fix (PD Dr. rer. nat. Tobias Licha)
Course frequency: each winter semester	**Duration:** 1 Semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 3
Maximum number of students: 25	

Georg-August-Universität Göttingen **Module M.HEG.370: Project: Remote Sensing and GIS**	6 C 4 WLH

Learning outcome, core skills: In the first sub module the students will be able to choose between the compilation of a literature review report and the preparation of a computer program. In the second and third sub module the students will be assigned to an integrated project. The three submodules should be related to the area of Remote Sensing and GIS. The presentation of the Assigned Project and the Master Thesis conveys knowledge to the students how to formulate scientific problems and define science based methodological procedure and how to present the study and corresponding results in a clear and structured way. The students will participate in the weekly research colloquium of the Department of Applied Geology as a preparation for their presentations. The presentation of the Assigned Project and the Master Thesis will be held in a seminar organized by the students themselves.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Courses:	
1. Literature Review (Exercise) The exercise is carried out in the project groups. *Course frequency:* each winter semester	1 WLH
2. Master Thesis (Seminar) The Master's Thesis Seminar is organized by the students across projects. It is performed as a block course. *Course frequency:* each semester	0,5 WLH
Examination: Oral Presentation (approx. 20 minutes), not graded **Examination prerequisites:** Written report in course 1 (max. 15 pages) or computer program **Examination requirements:** Introduction to the conception of the master's thesis	3 C

Courses:	
1. Assigned Project (Exercise, Seminar) The exercise is carried out in the project groups. *Course frequency:* each winter semester	1,5 WLH
2. Applied Geology (Colloquium) *Course frequency:* each semester	1 WLH
Examination: Report (max. 15 pages) or presentation (approx. 20 minutes) **Examination prerequisites:** 14 participations on the weekly colloquium of Applied Geology	3 C

Examination requirements:	

Literature review (report) and assigned project (report and presentation) in the area of Remote Sensing and/or GIS. Presentation of the Master Thesis related to a topic of the research area of the department of Applied Geology. The literature review has to cover publications who deal with GIS- or Remote Sensing related methods in Hydrology, Hydrogeology, Geology or Soil Sciences. If the assigned project or master thesis focus on GIS, the student should create, import, correct and analyze spatial data to solve a scientific question in the above mentioned fields. A Remote Sensing project or thesis should comprise data query, preprocessing, correction and processing of multispectral satellite images of various sensors and their geological or hydrological analysis and interpretation.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. rer. nat. Bianca Wagner
Course frequency: once a year	**Duration:** 2 Semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** from 3
Maximum number of students: 6	

Georg-August-Universität Göttingen **Module M.HEG.371: Project: Mathematical Modeling**	6 C 4 WLH

Learning outcome, core skills: In the 'Mathematics' sub module the students will be reminded or introduced in the basic mathematical skills necessary for mathematical analytical understanding and work. The chapters include: Linear Algebra, Basic Statistics, Differentiation, Integration, ODEs and PDEs. The final examination includes tests from all of these topics. The 'Scientific Programming' sub module is an introduction into programming for non-programmers. Basic programming techniques are presented: variables, conditions, branches, loops, scripts, functions, etc. The techniques will be taught in MATLAB, which is also introduced in the course. The final test consists in writing one or two programs, in order to show the ability to handle MATLAB and use the taught programming skills.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Courses:	
1. Literature Review (Exercise) The exercise is carried out in the project groups. *Course frequency:* each semester	1 WLH
2. Master Thesis (Seminar) The Master's Thesis Seminar is organized by the students across projects. It is performed as a block course. *Course frequency:* each semester	0,5 WLH
Examination: Oral Presentation (approx. 20 minutes), not graded **Examination prerequisites:** Report in course 1 (max. 15 pages) or computer program **Examination requirements:** Introduction to the conception of the master's thesis	3 C

Courses:	
1. Assigned Project (Exercise, Seminar) The exercise is carried out in the project groups. *Course frequency:* each winter semester	1,5 WLH
2. Applied Geology (Colloquium) *Course frequency:* each semester	1 WLH
Examination: Term Paper (max. 30 pages) **Examination prerequisites:** 14 participations on the weekly colloquium of Applied Geology	3 C

Examination requirements: Participitation on the seminar of Applied Geology. Literature review (report) and assigned project (report) in the area of Mathematical Modeling.	

Admission requirements:	**Recommended previous knowledge:**
none	none

Language: English	**Person responsible for module:** PD Dr. Ekkehard Holzbecher
Course frequency: once a year	**Duration:** 2 Semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** from 3
Maximum number of students: 6	

Georg-August-Universität Göttingen **Module M.HEG.372: Project: Hydrogeochemistry**	6 C 4 WLH

Learning outcome, core skills: In the first sub module the students will learn how to search, evaluate, digest and summarise relevant literature on a hydrochemistry related subject. In the second sub module the student will conduct a small laboratory project to improve their experimental and/or chemical analytical skills and learn about the critical assessment of data together with their interpretation. The module is complemented with the discussion of case studies for the illustration of real world problems.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Courses:	
1. Literature Review (Exercise) The exercise is carried out in the project groups. *Course frequency:* each winter semester	1 WLH
2. Master Thesis (Seminar) The Master's Thesis Seminar is organized by the students across projects. It is performed as a block course. *Course frequency:* each semester	0,5 WLH
Examination: Oral Presentation (approx. 20 minutes), not graded **Examination prerequisites:** Report in course 1 (max. 15 pages) **Examination requirements:** Introduction to the conception of the master's thesis	3 C

Courses:	
1. Assigned Project (Exercise, Seminar) The exercise is carried out in the project groups. *Course frequency:* each winter semester	1,5 WLH
2. Applied Geology (Colloquium) *Course frequency:* each semester	1 WLH
Examination: Term Paper (max. 15 pages) **Examination prerequisites:** 14 participations on the weekly colloquium of Applied Geology	3 C

Examination requirements: Deeper understanding of chemical processes in the aquatic environment, process based interpretation of hydrochemical data, knowledge on development and application of new tracers and indicators in geosystems, chemical analytical skills, experimental lab work, sampling strategies	

Admission requirements: M.HEG.03	**Recommended previous knowledge:** none
Language:	**Person responsible for module:**

English	PD Dr. rer. nat. Tobias Licha
Course frequency: once a year	**Duration:** 2 Semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** from 3
Maximum number of students: 6	

Georg-August-Universität Göttingen **Module M.HEG.373: Project: Field Investigation and Modeling**	6 C 4 WLH

Learning outcome, core skills: The focus of this module is (i) on innovative subsurface investigation and monitoring techniques to characterize subsurface properties, groundwater flow and transport behavior etc., and (ii) on mathematical tools as well as state of-the-art high level process oriented numerical groundwater flow and transport modeling techniques, including geostatistical approaches and parameter optimization tools. Aspects of basin scale integrated hydrosystem modeling, climate change effects, saturated and unsaturated zones, surface water - groundwater interaction, saltwater intrusion, surface water modeling, hillslope hydrology, reactive contaminant transport, contamination backtracking, data fusion, parameter uncertainty and parameter inversion etc. will be covered. In the first sub module the students will have to compile a literature review report on one of the above topics. In the second sub module the students will have to accomplish assigned project work on one of the above topics, and to prepare a professional report summarizing the given assignment and the achieved outcome. Project work may cover lab and/or field work, as well as numerical modeling, dealing with real world problems. The skills acquired should be then invested in the preparation of the M.Sc. thesis.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Courses:	
1. Literature Review (Exercise) The exercise is carried out in the project groups. *Course frequency:* each winter semester	1 WLH
2. Master Thesis (Seminar) The Master's Thesis Seminar is organized by the students across projects. It is performed as a block course. *Course frequency:* each semester	0,5 WLH
Examination: Oral Presentation (approx. 20 minutes), not graded **Examination prerequisites:** Written report in course 1 (max. 10 pages) **Examination requirements:** Introduction to the conception of the master's thesis	3 C

Courses:	
1. Assigned Project (Exercise, Seminar) The exercise is carried out in the project groups. *Course frequency:* each winter semester	1,5 WLH
2. Applied Geology (colloquium) *Course frequency:* each semester	1 WLH
Examination: Term Paper (max. 10 pages) **Examination prerequisites:**	3 C

14 Participations on the weekly colloquium of Applied Geology	

Examination requirements: Participation in the seminar of the Applied Geology department. Literature review (report) and assigned project (report) in the area of field investigation and modeling, showing the competence of the student (i) to independently find, understand, interpret and summarize existing and especially recent literature relevant with respect to one of the above topics, and (ii) to independently and successfully deal with an assigned high level project aiming at real world problems of field investigation and modeling.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr.-Ing. habil. Thomas Ptak-Fix
Course frequency: once a year	**Duration:** 2 Semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** from 3
Maximum number of students: 6	

Georg-August-Universität Göttingen **Module M.HEG.374: Project: Integrated Water Resources Management**	6 C 4 WLH

Learning outcome, core skills: The focus of this module is on the application of modern techniques for the integrated planning and management of water resources as well as the assessment of social, environmental and economic performance and impacts of water development projects. Students will learn about the planning of hydro-infrastructure and water development projects, applying multi-criteria-decision techniques, simulation and optimization tools and how to use advanced techniques for the management of water resources systems. In the first sub module the students have to write a literature review report on a specific topic related to the planning and management of water resources. In the second sub module the student will work on an assigned project that allows her/him to put the gained knowledge into practice.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Courses:	
1. Literature Review (Exercise) The exercise is carried out in the project groups. *Course frequency:* each winter semester	1 WLH
2. Master Thesis (Seminar) The Master's Thesis Seminar is organized by the students across projects. It is performed as a block course. *Course frequency:* each semester	0,5 WLH
Examination: Oral Presentation (approx. 20 minutes) **Examination prerequisites:** Written report in course 1 (max. 15 pages) **Examination requirements:** Introduction to the conception of the master's thesis	3 C

Courses:	
1. Assigned Project (Exercise, Seminar) The exercise is carried out in the project groups. *Course frequency:* each winter semester	1,5 WLH
2. Applied Geology (Colloquium) *Course frequency:* each semester	1 WLH
Examination: Term Paper (max. 15 pages) **Examination prerequisites:** 14 participations on the weekly colloquium of Applied Geology	3 C

Examination requirements: The student needs to demonstrate that she/he has a profound understanding of IWRM and is able to conduct her/his own research by applying state-of-the-art planning,	

management and analysis methods in the area of sustainable water resources development.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. -Ing. Bernd Rusteberg
Course frequency: once a year	**Duration:** 2 Semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** from 3
Maximum number of students: 6	

Georg-August-Universität Göttingen **Module M.HEG.375: Project: Fractured and Karstified Aquifers**	6 C 4 WLH

Learning outcome, core skills: In the first sub module the students will be able to chose between the compilation of a literature review report and the preparation of a computer program. In the second sub module the student will be assigned to an integrated project. The two sub modules should be related to the area of fractured and karstified aquifers. The module is complemented with the discussion of case studies for the illustration of real world problems. The topics, assigned to the field of "Fractured and Karstified Rocks" are concerned with the investigation, characterisation and modelling of groundwater flow and transport in these highly heterogeneous aquifers. Emphasis is mainly placed on water resources aspects and contaminant transport issues.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Courses:	
1. Literature Review (Exercise) The exercise is carried out in the project groups. *Course frequency:* each winter semester	1 WLH
2. Master Thesis (Seminar) The Master's Thesis Seminar is organized by the students across projects. It is performed as a block course. *Course frequency:* each semester	0,5 WLH
Examination: Oral Presentation (approx. 20 minutes), not graded **Examination prerequisites:** Written report in course 1 (max. 15 pages) **Examination requirements:** Introduction to the conception of the master's thesis	3 C

Courses:	
1. Assigned Project (Seminar) The exercise is carried out in the project groups. *Course frequency:* each winter semester	1,5 WLH
2. Applied Geology (Colloquium) *Course frequency:* each semester	1 WLH
Examination: Term Paper (max. 15 pages) **Examination prerequisites:** 14 participations on the weekly colloquium of Applied Geology	3 C

Examination requirements: Students are expected to have developed an understanding of the particular flow dynamics of fractured and karstified rocks as well as transport processes. Participitation on in the seminar of Applied Geology. Literature review (report) and assigned project (report) in the area of Fractured Karstified Aquifers.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Martin Sauter
Course frequency: once a year	**Duration:** 2 Semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** from 3
Maximum number of students: 6	

Georg-August-Universität Göttingen **Module M.HEG.376: Project: Geology**	6 C 4 WLH

Learning outcome, core skills: This module prepares for the MSc. thesis and trains the participant in doing independent scientific work as well as writing and orally presenting scientific data. In the first sub module the students are expected to prepare a literature review. In the second sub module the student will be assigned to an integrated project and will be trained to work independently in the lab and/or in the field. The results are presented in a report and as a 20 minutes presentation during the seminar "Applied geology". All sub modules must be related to the area of geology.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Courses:	
1. Literature Review (Exercise) The exercise is carried out in the project groups. *Course frequency:* each winter semester	1 WLH
2. Master Thesis (Seminar) The Master's Thesis Seminar is organized by the students across projects. It is performed as a block course. *Course frequency:* each semester	0,5 WLH
Examination: Oral Presentation (approx. 20 minutes), not graded **Examination prerequisites:** Written report in course 1 (max. 15 pages) **Examination requirements:** Introduction to the conception of the master's thesis	3 C

Courses:	
1. Assigned Project (Exercise, Seminar) The exercise is carried out in the project groups. *Course frequency:* each winter semester	1,5 WLH
2. Applied Geology (Colloquium) *Course frequency:* each semester	1 WLH
Examination: Term Paper (max. 15 pages) **Examination prerequisites:** 14 participations on the weekly colloquium of Applied Geology	3 C

Examination requirements: Participation on the seminar of Applied Geology. Literature review (report) and assigned project (report) in the area of Geology and mapping.	

Admission requirements: none	**Recommended previous knowledge:** none
Language:	**Person responsible for module:**

English	Dr. Alfons M. van den Kerkhof
Course frequency: once a year	**Duration:** 2 Semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** from 3
Maximum number of students: 6	

Georg-August-Universität Göttingen **Module M.HEG.377: Project: Isotope Geochemistry**	6 C 4 WLH

Learning outcome, core skills: The focus of this module is on the application of modern isotope techniques to hydro(geo)logical and environmental research questions. Students will learn about isotope geochemistry and apply isotope methods to better understand complex hydro-geochemical processes (e.g. solute generation, water-rock interaction, surface water/ groundwater interaction) in catchments and groundwater systems. In the first sub module the students have to write a literature review report on a specific topic related to the use of isotopes in hydrogeology or environmental science. In the second sub module the student will work on an assigned project that allows her/him to work experimentally by employing geochemical and isotope techniques. A report and oral presentation of the results from the assigned project complement this sub module. Both literature review and assigned project in isotope geochemistry/isotope hydrology are required for a M.Sc. thesis project in this module.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Courses:	
1. Literature Review (Exercise) The exercise is carried out in the project groups. *Course frequency:* each winter semester	1 WLH
2. Master Thesis (Seminar) The Master's Thesis Seminar is organized by the students across projects. It is performed as a block course. *Course frequency:* each semester	0,5 WLH
Examination: Oral Presentation (approx. 20 minutes), not graded **Examination prerequisites:** Written report in course 1 (max. 15 pages) **Examination requirements:** Introduction to the conception of the master's thesis	3 C

Courses:	
1. Assigned Project (Seminar) The exercise is carried out in the project groups. *Course frequency:* each winter semester	1,5 WLH
2. Applied Geology (Colloquium) *Course frequency:* each semester	1 WLH
Examination: Written report (max. 15 pages) or oral presentation (approx. 20 minutes) **Examination prerequisites:** 14 participations on the weekly colloquium of Applied Geology	3 C

Examination requirements:	

Literature review (report) and assigned project (report and oral presentation) related to isotope geochemistry/isotope hydrology. The student needs to demonstrate that she/ he has a profound understanding of isotope geochemistry and is able to conduct her/his own research by integrating isotope methods to interpret and model hydro(geo)chemical processes in an actual research project (M.Sc. thesis).	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. rer. nat. Bettina Wiegand
Course frequency: once a year	**Duration:** 2 Semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** from 3
Maximum number of students: 6	

Georg-August-Universität Göttingen **Module M.HEG.378: Project: Catchment Hydrogeology**	6 C 4 WLH

Learning outcome, core skills: In the first sub module the students will be able to chose between the compilation of a literature review report and the preparation of a computer program. In the second sub module the student will be assigned to an integrated project. The two sub modules should be related to the area of Catchment Hydrogeology. The module is complemented with the discussion of case studies for the illustration of real world problems.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Courses:	
1. Literature Review (Exercise) The exercise is carried out in the project groups. *Course frequency:* each winter semester	1 WLH
2. Master Thesis (Seminar) The Master's Thesis Seminar is organized by the students across projects. It is performed as a block course. *Course frequency:* each semester	0,5 WLH
Examination: Oral Presentation (approx. 20 minutes), not graded **Examination prerequisites:** In course 1: Written report (max. 15 pages) or computer program **Examination requirements:** Introduction to the conception of the master's thesis	3 C

Courses:	
1. Assigned Project (Exercise, Seminar) The exercise is carried out in the project groups. *Course frequency:* each winter semester	1,5 WLH
2. Applied Geology (Colloquium) *Course frequency:* each semester	1 WLH
Examination: Term Paper (max. 15 pages) **Examination prerequisites:** 14 Participations on the weekly colloquium of Applied Geology	3 C

Examination requirements: Development of catchment based hydrogeological investigation methods; understanding of discharge mechanism and quantification of mass flux at catchment scale; experimental approaches and monitoring techniques.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. Jannes Kordilla

Course frequency: once a year	**Duration:** 2 Semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** from 3
Maximum number of students: 6	

Georg-August-Universität Göttingen **Module M.HEG.379: Project: Geothermics and Georeservoirs**	6 C 4 WLH

Learning outcome, core skills: In the first sub module the students will be able to chose between the compilation of a literature review report and the preparation of a computer program. In the second sub module the student will be assigned to an integrated project. The two sub modules should be related to the area of geothermics and georeservoirs. The module is complemented with the discussion of case studies for the illustration of real world problems. The topics assigned to the field of "Georeservoirs and Geothermis" are concerned with the characterisation and modelling of georeservoirs using hydraulic testing, tracer experiments and novel investigation methods. Georeservoirs are of relevance in the context of hydrocarbon and energy storage reservoirs, as well as disposal formations for waste fluids and e.g. carbon dioxide.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Courses:	
1. Literature Review (Exercise) The exercise is carried out in the project groups. *Course frequency:* each winter semester	1 WLH
2. Master Thesis (Seminar) The Master's Thesis Seminar is organized by the students across projects. It is performed as a block course. *Course frequency:* each semester	0,5 WLH
Examination: Oral Presentation (approx. 20 minutes), not graded **Examination prerequisites:** In course 1: Written report (max. 15 pages) or Computerprogram **Examination requirements:** Introduction to the conception of the master's thesis	3 C

Courses:	
1. Assigned Project (Exercise, Seminar) The exercise is carried out in the project groups. *Course frequency:* each winter semester	1,5 WLH
2. Applied Geology (Colloquium) *Course frequency:* each semester	1 WLH
Examination: Term Paper (max. 15 pages) **Examination prerequisites:** 14 Participations on the weekly colloquium of Applied Geology	3 C

Examination requirements: Students are expected to have developed an understanding of flow and transport processes in georeservoirs, the respective characterization and modeling methods.	

Participitation on in the seminar of Applied Geology. Literature review (report) and assigned project (report) in the area of Geothermics and Georeservoirs.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. Iulia Ghergut
Course frequency: once a year	**Duration:** 2 Semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** from 3
Maximum number of students: 6	