### Kontaktpersonen:

<table>
<thead>
<tr>
<th>Rollen</th>
<th>Name</th>
<th>Position</th>
<th>Telefon</th>
<th>E-Mail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Studiendekan/in</td>
<td>Univ.-Prof. Silke Wieprecht</td>
<td>Institut für Wasser- und Umweltsystemmodellierung</td>
<td>685-64461</td>
<td><a href="mailto:silke.wieprecht@iws.uni-stuttgart.de">silke.wieprecht@iws.uni-stuttgart.de</a></td>
</tr>
<tr>
<td>Studiengangsmanager/in</td>
<td>Anne Weiß</td>
<td>Water Resources Engineering and Management (WAREM)</td>
<td></td>
<td><a href="mailto:anne.weiss@iws.uni-stuttgart.de">anne.weiss@iws.uni-stuttgart.de</a></td>
</tr>
<tr>
<td>Prüfungsausschussvorsitzende/r</td>
<td>Univ.-Prof. Silke Wieprecht</td>
<td>Institut für Wasser- und Umweltsystemmodellierung</td>
<td>685-64461</td>
<td><a href="mailto:silke.wieprecht@iws.uni-stuttgart.de">silke.wieprecht@iws.uni-stuttgart.de</a></td>
</tr>
<tr>
<td>Fachstudienberater/in</td>
<td>Anne Weiß</td>
<td>Water Resources Engineering and Management (WAREM)</td>
<td></td>
<td><a href="mailto:anne.weiss@iws.uni-stuttgart.de">anne.weiss@iws.uni-stuttgart.de</a></td>
</tr>
<tr>
<td>Stundenplanverantwortliche/r</td>
<td>Anne Weiß</td>
<td>Water Resources Engineering and Management (WAREM)</td>
<td></td>
<td><a href="mailto:anne.weiss@iws.uni-stuttgart.de">anne.weiss@iws.uni-stuttgart.de</a></td>
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<td>50110 Requirements of Professional Life and Engineering in Practise</td>
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<td>50260 Measurements in the Watercycle</td>
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<td></td>
<td>50290 Numerical Methods for Differential Equations</td>
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<td></td>
<td>50280 Multiphase Modeling in Porous Media</td>
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<td>50210 Geohydrology and Geoengineering</td>
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#### 200 Spezialisierungsmodule

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<td>19130 Urban Drainage and Design of Wastewater Treatment Plants</td>
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<td>19360 Water Quality and Treatment</td>
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<td>25080 Structural Engineering of Hydraulic Structures</td>
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Stand: 02. April 2017
Präambel


Das Studium bei WAREM wird als konsekutiver Studiengang angeboten. Absolventen eines Bachelorstudiums können bei WAREM nach einem viersemestrigen Studium den Abschluss „Master of Science“ erhalten.
Qualifikationsziele

Die im Studiengang Water Resources Engineering and Management (WAREM) ausgebildeten Ingenieurinnen und Ingenieure erwerben alle für die Universität Stuttgart wichtigen und zugrundeliegenden Kompetenzen und Kenntnisse, die als Grundlage für ein erfolgreiches Berufsleben dienen.

Sie

- haben vertiefte Kenntnisse über Wasserwirtschaft, Wasserbau, Grundwasser, Geohydrologie, Siedlungswasserwirtschaft, Wasserqualität und verstehen die dabei grundlegenden natur- und ingenieurwissenschaftlichen Zusammenhänge,
- kennen die Methoden zur Entwicklung von wasserwirtschaftlichen Managementkonzepten, haben aber auch gleichzeitig die Fähigkeiten diese zu planen und durch geeignete technische Maßnahmen und Installationen umzusetzen,
- können die Probleme durch und im Umgang mit Wasser- und Wassersystemen vorhersehen, erkennen und bewerten, sowie analytische, modellhafte und experimentelle Untersuchungen planen und durchführen,
- verfügen über die ingenieurwissenschaftliche Fertigkeit zur Entwicklung, zur Planung und zum Betrieb von Anlagen und kennen dabei auch die nicht-technischen Auswirkungen ihrer Tätigkeit,
- verfügen über die Kompetenzen zur organisatorischen und verwaltungsmäßigen Umsetzung der Wassermanagementaufgaben
- können Aufgaben mit interdisziplinärem und internationalem Charakter vor dem Hintergrund kultureller, wirtschaftlicher und politischer Rahmenbedingungen im Team bearbeiten,
- verfügen über eine hohe wissenschaftliche Qualifikation.
### 100 Vertiefungsmodule

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<th>Zugeordnete Module</th>
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<th>Vertiefungsmodule Pflicht</th>
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<td></td>
<td>120</td>
<td>Vertiefungsmodule Wahlpflicht</td>
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# 110 Vertiefungsmodule Pflicht

Zugeordnete Module:  
- 19120 Sanitary Engineering  
- 50090 Environmental Fluid Mechanics I  
- 50110 Requirements of Professional Life and Engineering in Practise  
- 50620 Hydraulic Structures
## Modul: 19120 Sanitary Engineering

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<td>4. SWS:</td>
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<td>5. Modulduauer:</td>
<td>Einsemestrig</td>
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<td>6. Turnus:</td>
<td>Wintersemester</td>
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<td>7. Sprache:</td>
<td>Englisch</td>
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<tr>
<td>8. Modulverantwortlicher:</td>
<td>Dr.-Ing. Klaus Fischer</td>
</tr>
<tr>
<td>9. Dozenten:</td>
<td>Klaus Fischer, Harald Schönberger</td>
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</table>
-M.Sc. Water Resources Engineering and Management Mara Outgoing Double Degree, PO 913MaO2012, 1. Semester
-M.Sc. Water Resources Engineering and Management Chalmers Outgoing Double Degree, PO 913ChO2012, 1. Semester |
| 11. Empfohlene Voraussetzungen: | The students have detailed knowledge about waste avoidance procedures in household and industry. Waste avoidance includes the ecology-oriented daily shopping, the substitution of contaminated materials in the industrial production as well as the Zero Emission Society. In the case of unavoidable waste fractions, the students acquire the competence to establish collection and transportation systems for these wastes, within the logistic, economic and legal frame. Main emphasis is given to the collection of recyclables. The students know the relevant factors which influence the waste amount and waste composition in general and in particular within the separate collection of recyclables. The students are acquainted with the state of the art of recycling technologies for separate collected paper, glass, metal and plastic including the pretreatment process. They have knowledge of the aerobic and anaerobic treatment and utilization of separate collected biowaste. Not avoided and recycled waste has to be treated before disposing off e.g. in a landfill site. The students possess a general knowledge of the mechanical and biological treatment technology as well as of the thermal waste treatment. They are able to evaluate the different treatment and recycling processes from an ecological and economic point of view. The students have knowledge about the most important components of the urban drainage and the basic treatment processes of wastewater. Thus they are able to compare different systems in dependence of changing boundary conditions and assess the effectiveness and pros and cons of the systems, e.g. concerning impacts on the environment, economical and operational aspects. They obtain an understanding for system connections between the urban drainage system and the wastewater treatment system as well as between the urban water system and the environment. |
| 12. Lernziele: | Solid Waste Management: Waste generation and waste composition, National and international regulations for waste |
| 13. Inhalt: | |
Waste avoidance
Collection and transport of waste
Separate collection of recyclables
Sorting of recyclables
Recycling technologies for paper, glass, metal, plastic
Biological treatment of waste
Waste Disposal
Ecological indicator systems
Waste Water Technology:
Basics of urban drainage and municipal wastewater treatment
Quantity and Composition of Wastewater
Urban drainage systems
stormwater treatment
mechanical wastewater treatment
biological wastewater treatment
sludge treatment
natural close and ECOSAN systems

14. Literatur:
Lecture Manuscripts Solid Waste Management
Butler, D., Davies, J.W.: Urban drainage, Spon press London,
Henze, M., Harremoes, J., la Coour Jansen, J., Arvin, E: Wastewater treatment. Springer Verlag Berlin

15. Lehrveranstaltungen und -formen:
• 191201 Vorlesung Solid Waste Management
• 191202 Vorlesung Waste Water
• 191203 Exkursion Sanitary Engineering

16. Abschätzung Arbeitsaufwand:
Time of attendance:
I Solid Waste Management, lecture: 2.0 SWS = 28 hours
II Waste Water: 2 SWS = 28 hours
excursion: 12 hours
exam: 2 hours
sum of attendance: 70 hours
self-study: 110 hours
total: 180 hours

17. Prüfungsnummer/n und -name:
• 19121 Solid Waste Management and Waste Water Technology (PL), Schriftlich, 120 Min., Gewichtung: 1
• V Vorleistung (USL-V), Schriftlich oder Mündlich

18. Grundlage für ... :
Urban Drainage and Design of Wastewater Treatment Plants
Industrial Waste Water

19. Medienform:

20. Angeboten von:
Abfallwirtschaft und Abluft
Modul: 50090 Environmental Fluid Mechanics I

2. Modulkürzel: 021420012
5. Moduldauer: Einsemestrig

3. Leistungspunkte: 6 LP
6. Turnus: Wintersemester

4. SWS: 5
7. Sprache: Englisch

8. Modulverantwortlicher: apl. Prof. Dr.-Ing. Holger Class

9. Dozenten: Holger Class
Jürgen Braun
Sergey Oladyshkin

10. Zuordnung zum Curriculum in diesem Studiengang:
M.Sc. Water Resources Engineering and Management Mara
Outgoing Double Degree, PO 913MaO2012, 1. Semester
   → Pflichtmodule
M.Sc. Water Resources Engineering and Management Chalmers
Outgoing Double Degree, PO 913ChO2012, 1. Semester
   → Pflichtmodule
M.Sc. Water Resources Engineering and Management Mara
Incoming Double Degree, PO 913MaI2012, 3. Semester
   → Compulsory Modules
M.Sc. Water Resources Engineering and Management Chalmers
Incoming Double Degree, PO 913ChI2012, 3. Semester
   → Semi-Compulsory Modules
M.Sc. Water Resources Engineering and Management, PO 913-2012, 1. Semester
   → Vertiefungs module Pflicht --> Vertiefungs module

11. Empfohlene Voraussetzungen:
Technical Mechanics
• Introduction to the statics of rigid bodies
• Introduction to elastostatics
• Introduction to the mechanics of incompressible fluids

Higher Mathematics
• Partial differential equations
• Vector analysis
• Numerical integration

Fundamentals of Flow Mechanics
• Conservation equations for mass, momentum, energy
• Navier-Stokes, Euler, Reynolds, Bernoulli equation

12. Lernziele:
Students have fundamental knowledge of flow in various natural hydrosystems and its application in civil and environmental engineering.

13. Inhalt:
The lecture deals with flow in natural hydrosystems with particular emphasis on groundwater / seepage flow and on flow in surface water / open channels. Groundwater hydraulics includes flow in confined, semi-confined and unconfined groundwater aquifers, wells, pumping tests and other hydraulic investigation methods for exploring groundwater aquifers. In addition, questions concerning regional groundwater management (z.B. recharge, unsaturated zone, saltwater intrusion) are discussed. Using the example of groundwater flow, fundamentals of CFD (Computational Fluid Dynamics) are explained, particularly the numerical discretisation techniques finite volume und finite difference. The hydraulics of surface water deals with shallow water equations / Saint Venant equations, unstationary channel flow, turbulence und
layered systems. Calculation methods such as the methods of characteristics are explained. The contents are:
- Potential flow and groundwater flow
- Computational Fluid Dynamics
- Shallow water equations for surface water
- Characteristikenmethode
- Examples from civil and environmental engineering

14. Literatur:
Lecture notes: Hydromechanics, Helmig and Class
Lecture notes: Ausbreitungs-und Transportvorgänge in Strömungen, Cirpka

15. Lehrveranstaltungen und -formen:
- 500901 Lecture and Exercise Environmental Fluid Mechanics I

16. Abschätzung Arbeitsaufwand:
Sum 180 h

17. Prüfungsnummer/n und -name:
- 50091 Environmental Fluid Mechanics I (PL), Schriftlich, 120 Min., Gewichtung: 1
- V Vorleistung (USL-V), Schriftlich

18. Grundlage für ...:
Environmental Fluid Mechanics II

19. Medienform:
Fundamentals will be developed using the blackboard and presentation tools.

20. Angeboten von:
Hydromechanik und Hydrosystemmodellierung
# Modul: 50110 Requirements of Professional Life and Engineering in Practise

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<td>7. Sprache:</td>
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<tr>
<td>8. Modulverantwortlicher:</td>
<td>Anne Weiβ</td>
<td></td>
</tr>
<tr>
<td>9. Dozenten:</td>
<td>Anne Weiβ</td>
<td></td>
</tr>
</tbody>
</table>
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester → Vertiefungsmodułe Pflicht → Vertiefungsmodułe  
M.Sc. Water Resources Engineering and Management Chalmers Outgoing Double Degree, PO 913ChO2012, 1. Semester → Pflichtmodułe  
M.Sc. Water Resources Engineering and Management Mara Outgoing Double Degree, PO 913MaO2012, 1. Semester → Pflichtmodułe |
| 11. Empfohlene Voraussetzungen: | Capability to summarize a water-related topic or the investigations of a scientific, water related problem in terms of two 20 min presentations, discussion on the topic after presenting.  
Ability to participate in a scientific discussion, asking questions to presenters.  
Writing a summary of a visit at a technical site, condense information to a short report. |
| 12. Lernziele: | Treatment of a water related topic or a recent scientific problem in an international research environment.  
The successful treatment of the scientific problem requires the specialisation in the related field of research and the acquisition of the necessary knowledge.  
Workshop regarding presentation techniques. This course covers the basics of presentation structure, layout, voice and body language as it relates to presentation delivery. The aim is to provide students with means to give lively and effective presentations.  
Instructions for scientific work: Correct Citation in Scientific Papers, Visualizing of graphs, time management. The students will learn about scientific argumentation, the importance of correct citations, as well as formal ways to make citations visible and comprehensible |
| 13. Inhalt: | Recent literature on the water related topic/ scientific problem, |
| 14. Literatur: | 501101 Seminar Requirements of Professional Life and Engineering in Practise  
501102 Excursion Requirements of Professional Life and Engineering in Practise |
| 15. Lehrveranstaltungen und -formen: | 90 h |

Stand: 02. April 2017
<table>
<thead>
<tr>
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<tr>
<td></td>
<td>Attendance in seminars, workshop &quot;Presentation Techniques&quot;, and lecture &quot;scientific work&quot;, Excursion</td>
</tr>
<tr>
<td></td>
<td>Presentation of a water related topic (case study) and Master's Thesis (USL)</td>
</tr>
</tbody>
</table>

| 18. Grundlage für ... :       |                                                                                                   |
| 19. Medienform:               |                                                                                                   |
| 20. Angeboten von:            | Water Resources Engineering and Management (WAREM)                                                  |
Modul: 50620 Hydraulic Structures

2. Modulkürzel: 021410106  
5. Modulduauer: Zweisemestrig

3. Leistungspunkte: 6 LP  
6. Turnus: Wintersemester

4. SWS: 4  
7. Sprache: Englisch

8. Modulverantwortlicher: Univ.-Prof. Dr. Silke Wieprecht

9. Dozenten: Silke Wieprecht  
Daniel Stolz  
Kristina Terheiden

10. Zuordnung zum Curriculum in diesem Studiengang:  
M.Sc. Water Resources Engineering and Management Chalmers Incoming Double Degree, PO 913Chl2012, 2. Semester  
→ Semi-Compulsory Modules  
M.Sc. Water Resources Engineering and Management, PO 913-2012, 1. Semester  
→ Vertiefungsmodule Pflicht → Vertiefungsmodule  
M.Sc. Water Resources Engineering and Management Chalmers Outgoing Double Degree, PO 913ChO2012, 1. Semester  
→ Wahlmodule

11. Empfohlene Voraussetzungen:

12. Lernziele:

Advanced Studies in Hydraulic Structures: The students,

- Know about the basic features of hydraulic structures  
- have an overview what are the main components and know how to arrange them in order to ensure a satisfying operation  
- are able to dimension all parts of different hydraulic structures  
- are aware of implicating river works into an overall context of a fluvial system and know how to act and to evaluate in spatial and temporal interrelation  
- are able to realize the economic and ecologic significance of hydraulic structures as dams, reservoirs and hydro power plants

Case Study in Hydraulic Structures: The students,

- are able to use of the gained theoretical knowledge with the help of a practical example  
- are aware of the technical relations and their effects on non-technical areas of interest  
- can give a well-founded argumentation of chosen estimations and are able to present their own results  
- can give a convincing presentation  
- are able to assess objectively different planning alternatives

13. Inhalt:

Advanced Studies in Hydraulic Structures: The course deals with main structural components of hydraulic engineering schemes such as weirs, dams, hydro power plants, pipelines and ancillary works. The main features as hydraulic and structural dimensioning are treated. The application of structural power plants, reservoirs and river development works is discussed. Conventional engineering methods as well as approaches with improved environmental compatibility are taken into consideration.

Case Study in Hydraulic Structures: The case study uses the content of the lecture "Advanced Studies in Hydraulic Structures".
In working groups of 3 to five students a real hydraulic structures will be planned and completely dimensioned. There are hydraulic calculations to be carried out as hydraulic capacity of spillway, dimensioning of stilling basin, hydrological and sedimentological calculations. As well the stabilities of the structures itself has to be checked. Additionally an analysis of the demand of potentially provided electricity, drinking water or irrigation water, resp. is required. The intermediate results will be presented by the groups. Every student has to deliver at least one presentation. Finally a poster for the final presentation and assessment has to be designed. This is the basis for the development of the assessment criteria for the different alternatives.

14. Literatur:
Lecture notes can be downloaded from the internet. Additional detailed information for the case study will be provided during the lectures.

15. Lehrveranstaltungen und -formen:
• 506201 Lecture and Practice Advanced Studies in Hydraulic Structures
• 506202 Lecture and Presentation Case Study in Hydraulic Structures

16. Abschätzung Arbeitsaufwand:
Sum 180h

17. Prüfungsnummer/n und -name:
50621 Hydraulic Structures (LBP), Schriftlich oder Mündlich, 90 Min., Gewichtung: 1

18. Grundlage für ...

19. Medienform:

20. Angeboten von:
Wasserbau und Wassermengenwirtschaft
### 120 Vertiefungsmodul Wahlpflicht

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<th>Zugeordnete Module</th>
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<tr>
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<td>Integrated River Management and Engineering</td>
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<td>15160</td>
<td>Water and Power Supply</td>
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<td>19100</td>
<td>Chemistry and Biology for Environmental Engineers</td>
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<td>19310</td>
<td>Urban Drainage and Design of Wastewater Treatment Plants</td>
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<td>Structural Engineering of Hydraulic Structures</td>
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Modul: 15010 Integrated River Management and Engineering

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<tr>
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<td>M.Sc. Water Resources Engineering and Management, PO 913-2012, Sommersemester</td>
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<tr>
<td>→ SpezialisierungsmoduleName</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>11. Empfohlene Voraussetzungen:</th>
</tr>
</thead>
<tbody>
<tr>
<td>none (BAU), advisable LWW_Wabau</td>
</tr>
<tr>
<td>none (UMW), advisable LWW_Gew</td>
</tr>
<tr>
<td>Hydraulic Structures (WAREM)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>12. Lernziele:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>River Engineering and Sediment Management</strong></td>
</tr>
<tr>
<td>The students,</td>
</tr>
<tr>
<td>• are aware of rivers must be regarded and managed based on an integrated approach</td>
</tr>
<tr>
<td>• know the basic concept of the European Water Framework Directive (WFD) and the German legal framework for river basin management</td>
</tr>
<tr>
<td>• are able to analyze and estimate the consequences of the WFD based inventory for future management</td>
</tr>
<tr>
<td>• are aware of sediment transport processes and of the complexity of the interactions and relations</td>
</tr>
<tr>
<td>• recognize the possibilities and limitations of sediment managements strategies</td>
</tr>
</tbody>
</table>

| **Integrated Flood Protection Measures** |
| The students, |
| • are aware of the fact that flood protection is an integral process, based on different components (e.g. technical flood protection measures, prevention) |
| • know the basic physical processes: dynamics of flood events, calculation of discharges and water depths, flood wave propagation, functionality of retention and protection structures: reservoirs, dams and dikes |
| • know 1-D and 2-D numerical hydro-dynamic models |
| • are able to apply their knowledge on practical engineering problems related to flood protection |

<table>
<thead>
<tr>
<th>13. Inhalt:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The module consists of two lectures:</td>
</tr>
<tr>
<td><strong>River Engineering and Sediment Management</strong></td>
</tr>
<tr>
<td>• Basic approaches of river basin management (legal framework)</td>
</tr>
</tbody>
</table>
• Systematics and results of basic inventory due to the WFD
• Anthropogenic impacts on river basins
• Origin of sediments and fundamental principles of transport
• Sediment management measures on different scales

**Integrated Flood Protection Measures**
• Socio-economic aspects of flood damage
• Calculation of water depths
• Hydro-dynamic flood wave calculation, Saint Venant-equation
• Technical flood protection measures
• Design and operation of retention basins
• Set-up of damage and risk maps, design of overtopping earthen dams and dikes
• Probability of failure, reliability calculation, flood risk management

14. **Literatur:**
Lecture notes and exercise material can be downloaded from the internet.
Hints are given for additional literature from the internet as well as libraries.

15. **Lehrveranstaltungen und -formen:**
• 150101 Vorlesung River Engineering and Sediment Management
• 150102 Vorlesung Integrated Flood Protection

16. **Abschätzung Arbeitsaufwand:**
Time of attendance: 55 h
Private study: 125 h

17. **Prüfungsnummer/n und -name:**
15011 Integrated River Management and Engineering (PL),
Schriftlich oder Mündlich, 120 Min., Gewichtung: 1

18. **Grundlage für ... :**

19. **Medienform:**

20. **Angeboten von:**
Wasserbau und Wassermengenwirtschaft
## Modul: 15160 Water and Power Supply

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>4. SWS:</td>
<td>0</td>
<td>7. Sprache:</td>
<td>Englisch</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>8. Modulverantwortlicher:</th>
<th>Dr. Sabine-Ulrike Gerbersdorf</th>
</tr>
</thead>
</table>
| 9. Dozenten: | Ralf Minke  
Sabine-Ulrike Gerbersdorf |

<table>
<thead>
<tr>
<th>10. Zuordnung zum Curriculum in diesem Studiengang:</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.Sc. Water Resources Engineering and Management, PO 913-2012, 1. Semester</td>
</tr>
<tr>
<td>→ Vertiefungsmodule Wahlpflicht -- Vertiefungsmodule</td>
</tr>
<tr>
<td>M.Sc. Water Resources Engineering and Management Mara Outgoing Double Degree, PO 913MaO2012, 1. Semester</td>
</tr>
<tr>
<td>→ Wahlmodule</td>
</tr>
<tr>
<td>M.Sc. Water Resources Engineering and Management, PO 913-2012, 1. Semester</td>
</tr>
<tr>
<td>→ Spezialisierungsmodul</td>
</tr>
<tr>
<td>M.Sc. Water Resources Engineering and Management, PO 913-2012, 1. Semester</td>
</tr>
<tr>
<td>→ Zusatzmodule</td>
</tr>
<tr>
<td>M.Sc. Water Resources Engineering and Management Chalmers Outgoing Double Degree, PO 913ChO2012, 1. Semester</td>
</tr>
<tr>
<td>→ Wahlmodule</td>
</tr>
</tbody>
</table>

| 11. Empfohlene Voraussetzungen: | None |

<table>
<thead>
<tr>
<th>12. Lernziele:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power Demand, Supply and Distribution:</strong> The students,</td>
</tr>
<tr>
<td>• know the German, European and worldwide energy markets related to demand, supply and its distribution capabilities</td>
</tr>
<tr>
<td>• are aware of that non-renewable energy sources are strictly limited and time-scales for conversion of energy markets long</td>
</tr>
<tr>
<td>• have an idea about the relations between energy, politics, social changes and influences on environment</td>
</tr>
<tr>
<td>• have a basic knowledge about present energy conversion systems, theoretical limits of efficiencies, and the potential to enhance applied technology</td>
</tr>
<tr>
<td>• have a basic understanding about where and how energy is provided and distributed</td>
</tr>
<tr>
<td>• comprehend the balance between load and supply in electrical grids and the resulting necessity for control energy</td>
</tr>
</tbody>
</table>

| **Water Demand, Supply and Distribution:** The students, |
| • know the German and worldwide water systems related to demand, supply and its distribution capabilities |
| • have an overview on the water supply situation all over the world |
| • recognize the different possibilities and levels of water supply |
| • have an idea of the relations between water, politics, social changes and influences on environment |

<table>
<thead>
<tr>
<th>13. Inhalt:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power Demand, Supply and Distribution:</strong></td>
</tr>
<tr>
<td>• Energy demand, energy supply</td>
</tr>
<tr>
<td>• Energy generation</td>
</tr>
</tbody>
</table>
- overview of different types of power plants
- renewable energy
- thermal power plants (conventional and nuclear)
• Areas of application of different power plants
• Emission control techniques
• Cooling of thermal power plants
  - methods
  - water resources aspects
• Energy transport and energy storage
• Net techniques
• Energy market
  - trade
  - politics
  - law
• social changes due to energy supply

**Water Demand, Supply and Distribution:**
• Water supply and water distribution: necessity, basic requirements, elements, hydrological cycle
• Water demand calculation: water consumption, water demand, consumer groups, losses, forecasting, design periods
• Water collection: Selection of source, groundwater withdrawal, springwater tapping, surface water intakes, rainwater harvesting, seawater desalination, recycling of treated sewage, drinking water protection areas
• Water transmission and distribution: necessity, hydraulic basics, dimensioning and calculation of branched and closed loop systems.
• Pumps and pumping stations: necessity, types, hydraulics for pumping design, pumping stations and pressure boosters
• Water storage: necessity, types and functions of tanks and reservoirs
• Case study: planning and design of a water supply system for a small town

14. Literatur: Lecture notes can be downloaded from the internet. Hints are given for additional literature from the internet as well as libraries.

15. Lehrveranstaltungen und -formen:
• 151602 Vorlesung Water Demand, Supply and Distribution
• 151601 Vorlesung Energy Demand, Supply and Distribution

16. Abschätzung Arbeitsaufwand:
| Time of attendance: | 45 h |
| Private Study:      | 135 h |

17. Prüfungsnummer/n und -name:
15161 Water and Power Supply (PL), Schriftlich, 120 Min., Gewichtung: 1

18. Grundlage für ...

19. Medienform:

20. Angeboten von: Wasserbau und Wassermengenwirtschaft
Modul: 19100 Chemistry and Biology for Environmental Engineers

2. Modulkürzel: 021230502
5. Moduldauer: Einsemestrig

3. Leistungspunkte: 6 LP
6. Turnus: Wintersemester

4. SWS: 6
7. Sprache: Weitere Sprachen

8. Modulverantwortlicher: Univ.-Prof. Dr. Jörg Metzger

9. Dozenten: Karl Heinrich Engesser
Brigitte Schwederski
Jörg Metzger
Bertram Kuch
Daniel Dobslaw

10. Zuordnung zum Curriculum in diesem Studiengang:
M.Sc. Water Resources Engineering and Management, PO 913-2012,
→ Zusatzmodule
M.Sc. Water Resources Engineering and Management Mara Outgoing Double Degree, PO 913MaO2012, 1. Semester
→ Pflichtmodule
M.Sc. Water Resources Engineering and Management, PO 913-2012, 1. Semester
→ Vertiefungsmodul Wahlpflicht --> Vertiefungsmodul
M.Sc. Water Resources Engineering and Management, PO 913-2012, 1. Semester
→ Spezialisierungsmodul
M.Sc. Water Resources Engineering and Management Chalmers Incoming Double Degree, PO 913ChI2012, 3. Semester
→ Semi-Compulsory Modules
M.Sc. Water Resources Engineering and Management Chalmers Outgoing Double Degree, PO 913ChO2012, 1. Semester
→ Pflichtmodul
→ Elective Modules

11. Empfohlene Voraussetzungen:

12. Lernziele:

**Lecture: Inorganic chemistry**

The students

• know the fundamental concepts of chemistry (atomic structure, periodic system, chemical formulae, stoichiometry, molecular structures) and are able to use them,
• know the principle types of chemical substances and chemical reactions and can apply their knowledge to synthetic problems,
• know about the most important industrial compounds, their preparation and environmental aspects in their application.

**Lecture: Organic chemistry**

The students
- can identify important functional groups in organic molecules

- know the main compound classes in organic chemistry and the common rules for their nomenclature

- know the most important representatives thereof and are able to draw their structural formulae

- know the structure and properties of important bio-molecules such as fats, carbohydrates, proteins, nucleic acids, ATP, lignin and humic acids

- know the most important reactions involved in chemical and microbial degradation of organic matter

- know summary parameters used to characterize water quality

- know the properties of bio-molecules and can explain their general function with respect to cell structures, enzymatic and immune reactions

- knows selected environmental organic contaminants (PAH, dioxins, pesticides etc.) and their properties

Lecture: Biology and ecology of water, soil and air systems

The students

- know about the relation between water, soil and air compartments and many diseases, happening especially in developing countries

- know about the reasons for break out of diseases, the structure and function of prokaryotic and eucaryotic cells as well as the methods for identification and determination of growth conditions and possible growth limitations

- comprehend microbial metabolism, energy production, release and conservation, enzyme syntheses and their regulation.

- know important events and scientists in the history of biology

- know basics in ecology of natural and artificial ("technical") ecosystems as well as selected methods to detect distorted equilibria in technical ecosystems influenced by mankind

Lecture: Technical and medical microbiology for engineers

The students

- know the most important microorganisms being active in plants treating waste water, air and contaminated soil
- know the kind of participation in purification and thus the procedures used to make them feel happy as well as the problems associated with excess biomass

- are aware of a detailed overview of the kind of medically important microorganisms and of the most relevant agents of illness met in these plants, this holds also for the compartments 'drinking water' and 'sewage sludge'.

13. Inhalt:

Lecture: **Inorganic chemistry**
- atomic structure: stable nuclear particles, atomic nuclei, isotopes and radioactivity, atomic spectra and the hydrogen atom, heavier atoms
- the periodic system of the elements: the sequence of elements, the electronic configuration of some elements, the periodicity of some properties
- chemical bonding: the ionic bond, the metallic bond, the covalent bond, hydrogen bonding, van der Waals forces
- quantitative Relationships and Stoichiometric Equations
- characterizing chemical reactions: the chemical equilibrium, water: the solvent, acid/base reactions, redox reactions
- descriptive part: selected chemical compounds and their preparation and properties

Lecture: **Organic chemistry**
- functional groups and compound classes
- classification of chemical reactions in organic chemistry
- organic bio-molecules (e.g. proteins, carbohydrates, nucleic acids, fats, humic acids, lignin): structure and function
- chemical and microbial degradation of organic matter in the environment
- summary parameters
- organic environmental contaminants

Lecture: **Biology and ecology of water, soil and air systems**
The following topics are presented within the lecture:
- Introduction in history of microbiology
- Important waterbased/water related diseases
- Function of microscopy of staining techniques
- Structure and function of prokaryotic cells
- Structure and function of eucaryotic cells
- Necessity and effects of microbial nutrition
- Microbial growth relations and possible limitations
- Microbial metabolism: Energy production, conservation and release
- Microbial metabolism: Enzymes syntheses and regulation.

Lecture: **Technical and medical microbiology for engineers**
- Important (sewage) water based /water related diseases/ detection and possible countermeasures
- Important soil and air connected diseases
- (micro)biological principles in application of engineering techniques
- Implication of engineer work on ecosystems/environment protection problems

Some test systems for estimation of (bio)degradability of chemicals will be evaluated

### 14. Literatur:
- Lecture notes
- Pdf download of powerpoint slides for lectures
- Exercises as hand-out or download (pdf)

### 15. Lehrveranstaltungen und -formen:
- 191001 Lecture Inorganic chemistry
- 191002 Lecture Organic chemistry
- 191003 Lecture Biology and ecology of water, soil and air systems
- 191004 Lecture Technical and medical microbiology for engineers

### 16. Abschätzung Arbeitsaufwand:

<table>
<thead>
<tr>
<th>Time of attendance:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inorganic chemistry (Schwederski): Lecture, 1 SWS = 14 hours</td>
</tr>
<tr>
<td>Organic chemistry (Metzger/Kuch): Lecture, 1 SWS = 14 hours</td>
</tr>
<tr>
<td>Biology and ecology of water, soil and air systems (Engesser): Lecture, 1 SWS = 14 hours</td>
</tr>
<tr>
<td>Technical and medical microbiology for engineers (Engesser): Lecture, 1 SWS = 14 hours</td>
</tr>
<tr>
<td>Exercises for Chemistry and Biology for environmental engineers, 2 SWS = 28 hours</td>
</tr>
<tr>
<td>Exam: 2 hours</td>
</tr>
<tr>
<td>Sum of attendance: 86 hours</td>
</tr>
<tr>
<td>Exercises (group work with presentations): 28 hours</td>
</tr>
<tr>
<td>Self-study: 94 hours</td>
</tr>
</tbody>
</table>

### 17. Prüfungsnummer/n und -name:
- 19101 Chemistry and Biology for Environmental Engineers (PL), Schriftlich oder Mündlich, 120 Min., Gewichtung: 1

### 18. Grundlage für ... :

### 19. Medienform:
- Video projector (powerpoint) presentation
- Explanations on blackboard, group work with presentations

### 20. Angeboten von:
- Hydrochemie und Hydrobiologie in der Siedlungswasserwirtschaft
Modul: 19310 Urban Drainage and Design of Wastewater Treatment Plants

2. Modulkürzel: 02120251
5. Moduldauer: Einsemestrig

3. Leistungspunkte: 6 LP
6. Turnus: Sommersemester

4. SWS: 5
7. Sprache: Englisch

8. Modulverantwortlicher: Dr.-Ing. Ulrich Dittmer

9. Dozenten: Harald Schönberger Ulrich Dittmer

    M.Sc. Water Resources Engineering and Management Chalmers Outgoing Double Degree, PO 913ChO2012, 2. Semester
    Pflichtmodule
    M.Sc. Water Resources Engineering and Management Mara Outgoing Double Degree, PO 913MaO2012, 2. Semester
    Pflichtmodule
    M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
    Vertiefungsmodule Wahlpflicht --> Vertiefungsmodule
    M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
    Spezialisierungsmodule

11. Empfohlene Voraussetzungen: Chemistry and Biology for Environmental Engineers
    Sanitary Engineering

12. Lernziele:
    Advanced knowledge of processes and concepts for urban drainage and municipal wastewater treatment systems
    Basics of construction and dimensioning of different urban drainage systems, stormwater treatment facilities and wastewater treatment plants as a base for dimensioning and discussion of proved and innovative technologies
    Deeper understanding for system connections as base for a decisions during the planning process

13. Inhalt:
    Design of sewer systems and stormwater treatment (Dr.-Ing. Ulrich Dittmer)
    principles of collection and disposal
    design of combined and separate sewer systems
    Sustainable urban drainage systems (SUDS) and low impact design(LID)
    Application of rainfall runoff models (computer exercise using U.S. EPA Stormwater Management Model)
    different techniques for treatment and retention
    design of treatment facilities
    Design of wastewater treatment plants (Prof. Dr.-Ing. Heidrun Steinmetz)
    Municipal wastewater treatment
    different techniques for advanced biological wastewater treatment (nitrogen and phosphorous removal)
    principles of process engineering
design of biological wastewater treatment plants and the main important aggregates

- design of sludge treatment plants
- Seminar: feasibility studies
  (Prof. Dr.- Ing. Heidrun Steinmetz and external consultants)
- special examples for sanitation concepts for world wide application
- Ecological sanitation and resource orientated systems case studies

14. Literatur:
- Different German standards (DWA, Hennef)
- Lecture notes

15. Lehrveranstaltungen und -formen:
- 193101 Vorlesung und Übung Design of Sewer System and Stormwater Treatment
- 193104 Exkursion
- 193102 Vorlesung und Übung Design of Wastewater Treatment Plants
- 193103 Seminar Case Study

16. Abschätzung Arbeitsaufwand:
- Time of attendance: approx. 70 hours (including 4*4hours for excursion) 1,5 SWS
- Private Study: approx. 110 hours
- Lecture 1 Presence time: 28 hours, self study 30 hours, project 0, Sum: 58 hours
- Lecture 2: Presence time: 28 hours, self study 30 hours, project 40, Sum: 58 hours
- Case study: Presence time: 14 hours, self study 10 hours, project 0, Sum: 25 hours

17. Prüfungsnummer/n und -name:
- 19311 Urban Drainage and Design of Wastewater Treatment Plants (PL), Schriftlich, 120 Min., Gewichtung: 1

18. Grundlage für ...

19. Medienform:

20. Angeboten von:

Siedlungswasserbau und Wassergütewirtschaft
Modul: 19360 Water Quality and Treatment

2. Modulkürzel: 021210051
5. Modulldauer: Einsemestrig

3. Leistungspunkte: 6 LP
6. Turnus: Sommersemester

4. SWS: 4
7. Sprache: Englisch

8. Modulverantwortlicher: Carsten Meyer

9. Dozenten: Harald Schönberger
Carsten Meyer

10. Zuordnung zum Curriculum in diesem Studiengang:
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
→ Spezialisierungsmodule
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
→ Vertiefungsmodul Wahlplicht → Vertiefungsmodul
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
→ Zusatzmodule

11. Empfohlene Voraussetzungen:
Knowledge in Sanitary Engineering, Water Supply and Hydraulics
Contents of Water and Power Supply

12. Lernziele:
• The students learn how to characterize and protect water bodies as well as to improve the water quality
• Students understand the contribution of wastewater treatment to the preventive protection of receiving waters and they learn the basic methods of water quality management instruments
• Students understand the necessity of water treatment as essential element of drinking water supply
• Students learn the chemical, physical and biological background of water treatment technologies, their possibilities and boundaries and they are able to develop, design and dimension treatment schemes for different raw water qualities

13. Inhalt:
Water Quality Management:
• Terms and introduction: environmental data from Germany
• Characterisation and assessment of flowing waters, stagnant waters and groundwater
• Water quality parameters, WHO drinking water guidelines, targets for drinking water and sanitation, description of water quality in relation to use
• Improvement of water quality, reduction of pollution load, point pollutants and diffuse loads, improving the self-purification capacity of waters, technical helps, assessment of progress
• Water quality management, the European Union Framework Directive, quality planning and maintenance, monitoring networks

Water Treatment:
• Water supply and water treatment: basic requirements, drinking water standards
• Mechanical treatment: Screening, Sieving, Sedimentation, (Membrane)Filtration, Gas-Exchange, Flotation
• Carbondioxide-Carbonate-Balance: relevance, chemical background
• Deacidification: mechanical and chemical methods
• Removal of iron, manganese and arsenic: methods
• Decarbonization: chemical methods
• Flocculation
• Adsorption
• Disinfection: chemical and physical methods

14. Literatur: Lecture notes and material for exercises will be provided during the lecture. Hints are given for additional literature from the internet as well as libraries, e.g.
• American Water Works Assoc.: Water Quality and Treatment, McGraw-Hill Inc., 1999
• Nicholas P. Cheremisinoff: Handbook of Water and Wastewater Treatment Technologies, Bitterworth und Heinemann, Boston Oxford Auckland Johannesburg Melbourne New Delhi, 2002
• WHO Guidelines, 2006
• Mutschmann, J, Stimmelmayr, F.: Taschenbuch der Wasserversorgung, Vieweg-Verlag

15. Lehrveranstaltungen und -formen:
• 193601 Lecture Water Treatment
• 193602 Lecture Water Quality Management

16. Abschätzung Arbeitsaufwand:
Time of attendance: ca. 42 h
Private study: ca. 138 h
1) Lecture: presence time = 34,0, self study = 106,0, Sum = 140,0
2) Exercise: presence time = 8,0, self study = 32,0, Sum = 40,0
Sum Lecture (140) + Sum Exercise (40) = 180,0

17. Prüfungsnummer/n und -name:
• 19361 Water Quality Management (PL), Schriftlich, 60 Min., Gewichtung: 1
• 19362 Water Treatment (PL), Schriftlich, 60 Min., Gewichtung: 1

18. Grundlage für ...

19. Medienform:

20. Angeboten von: Siedlungswasserbau und Wassergütewirtschaft
## Modul: 25080 Structural Engineering of Hydraulic Structures

<table>
<thead>
<tr>
<th>2. Modulkürzel:</th>
<th>LWW_01</th>
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</thead>
<tbody>
<tr>
<td>3. Leistungspunkte:</td>
<td>6 LP</td>
</tr>
<tr>
<td>4. SWS:</td>
<td>5</td>
</tr>
<tr>
<td>5. Moduldauer:</td>
<td>Einsemestrig</td>
</tr>
<tr>
<td>6. Turnus:</td>
<td>Wintersemester</td>
</tr>
<tr>
<td>7. Sprache:</td>
<td>Englisch</td>
</tr>
<tr>
<td>8. Modulverantwortlicher:</td>
<td>Dr.-Ing. Kristina Terheiden</td>
</tr>
<tr>
<td>9. Dozenten:</td>
<td>Kristina Terheiden, Hans-Peter Koschitzky</td>
</tr>
<tr>
<td>11. Empfohlene Voraussetzungen:</td>
<td>Basic Knowledge of Structural Engineering</td>
</tr>
<tr>
<td>12. Lernziele:</td>
<td>Students know basics of structural design, restoration and monitoring of hydraulic structures e.g. (reinforced) concrete or block masonry structures in theory and for practical applications. Furthermore they are able to select and design hydraulic gates and for several purposes.</td>
</tr>
<tr>
<td>14. Literatur:</td>
<td></td>
</tr>
<tr>
<td>15. Lehrveranstaltungen und -formen:</td>
<td>• 250802 Übung Talsperrenbemessung, -sanierung, -überwachung • 250803 Vorlesung Stahlwasserbau • 250804 Übung Stahlwasserbau • 250801 Vorlesung Talsperrenbemessung, -sanierung, -überwachung</td>
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<tr>
<td>17. Prüfungsnummer/n und -name:</td>
<td>25081 Structural Engineering of Hydraulic Structures (PL), Schriftlich, 150 Min., Gewichtung: 1</td>
</tr>
<tr>
<td>18. Grundlage für ... :</td>
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<td>19. Medienform:</td>
<td></td>
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20. Angeboten von: Wasserbau und Wassermengenwirtschaft
Modul: 50120 Environmental Informatics

2. Modulkürzel: 021430002
5. Modulduer: Einsemestrig

3. Leistungspunkte: 6 LP
6. Turnus: Wintersemester

4. SWS: 4
7. Sprache: Englisch

8. Modulverantwortlicher: Univ.-Prof. Dr.-Ing. Dr. Andras Bardossy

9. Dozenten: Johannes Riegger

10. Zuordnung zum Curriculum in diesem Studiengang:
M.Sc. Water Resources Engineering and Management, PO 913-2012, 1. Semester
→ Vertiefungsmodule Wahlpflicht --> Vertiefungsmodule
M.Sc. Water Resources Engineering and Management Chalmers Incoming Double Degree, PO 913Chl2012, 3. Semester
→ Semi-Compulsory Modules
M.Sc. Water Resources Engineering and Management, PO 913-2012, 1. Semester
→ Spezialisierungsmodul
→ Compulsory Modules
M.Sc. Water Resources Engineering and Management Chalmers Outgoing Double Degree, PO 913ChO2012, 1. Semester
→ Wahlmodule
M.Sc. Water Resources Engineering and Management Mara Outgoing Double Degree, PO 913MaO2012, 1. Semester
→ Wahlmodule
M.Sc. Water Resources Engineering and Management, PO 913-2012, 1. Semester
→ Zusatzmodule

11. Empfohlene Voraussetzungen:
Skills in Spreadsheet Calculations for Data Processing, Design, Creation, Handling and Application of Relational Database Management Systems for Environmental Issues, Creation and display of Environmental GIS data sets. Use of GIS functionalities to investigate spatial and attribute relationships

12. Lernziele:
Information Processing und Environmental Data Management (Excel und Access):
Environmental Database Design, Relational Database Management, Data Normalization, Data Security
GIS Tools in Environmental Engineering (ArcGIS):
Basics of GIS, Data implementation, Spatial Structures and Attributes, Display of Environmental Information, Charts and Diagrams, Digitization, Spatial and Logical Queries, Data Links, Geo-Referencing, Field Calculations

13. Inhalt:

14. Literatur:
Script: J. Riegger 'Environmental Informatics'
User Handbooks for Excel, Access, ArcGIS
Getting to know ArcGIS Desktop ISBN: 9781589482609

15. Lehrveranstaltungen und -formen:
• 501201 Lecture Environmental Data Management
• 501202 Lecture GIS Tools in Environmental Engineering

16. Abschätzung Arbeitsaufwand:
Time of attendance: approx. 56 hours
Private Study: approx. 124 hours during semester
Sum: 180h
17. Prüfungsnummer/n und -name:

• 50121 Environmental Informatics (PL), Schriftlich, 120 Min., Gewichtung: 1
• V Vorleistung (USL-V), Schriftlich

18. Grundlage für ...

19. Medienform:

20. Angeboten von: Hydrologie und Geohydrologie
Modul: 50130 Integrated Watershed Modeling

2. Modulkürzel: 021430009
5. Moduldauer: Einsemestrig

3. Leistungspunkte: 6 LP
6. Turnus: Sommersemester

4. SWS: 4
7. Sprache: Deutsch

8. Modulverantwortlicher: Univ.-Prof. Dr.-Ing. Dr. Andras Bardossy

9. Dozenten: Andras Bardossy
Johannes Riegger

10. Zuordnung zum Curriculum in diesem Studiengang:
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
➞ Spezialisierungsmodule
M.Sc. Water Resources Engineering and Management Chalmers Outgoing Double Degree, PO 913ChO2012, 2. Semester
➞ Wahlmodule
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
➞ Zusatzmodule
M.Sc. Water Resources Engineering and Management Mara Outgoing Double Degree, PO 913MaO2012, 2. Semester
➞ Wahlmodule
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
➞ Vertiefungsmodule Wahlpflicht --> Vertiefungsmodule

11. Empfohlene Voraussetzungen:
Recommended background knowledge: Basic knowledge of hydrology and geohydrology
Prerequisite module: none

12. Lernziele:
Hydrological Modeling:
Construction of models for each part in the runoff process and how these models are used and integrated in different environment management systems.

Integrated model systems for the groundwater management:
Design of hydrogeological databases, visualization of data, GIS-Operations for the groundwater and hydrological modeling, Geostatistic, stochastic modeling, Monte Carlo Methods.

13. Inhalt:
Hydrological Modeling:
What happens to the rain? This is the basic question that needs to be addressed in order to predict the amount of discharge at a certain location in a river system at a given time. Which parts of the fate of rainfall can be determined on a physical basis, and which are still left to empirical searching? Beside the qualitative determination of e.g. the processes of evapotranspiration, infiltration, interflow etc. we also need to describe the quantities of these processes to be able to forecast e.g. flood events.

Hydrological watershed modelling is fundamental to integrated water management. There are complex interactions between the elements of the environmental continuum. In order to predict future behaviour and to quantify effects of management changes, quantitative mathematical descriptions are needed. A number of advanced hydrological watershed models have been developed in the last 30 years. A few of them will be reviewed in terms of their data needs and their predictive power. The participants are encouraged to form groups and to use their selected models
for the same catchment so that the different approaches are compared.

**Integrated model systems for the groundwater management:**
Modern integrated model systems require techniques for the efficient construction of ground water models and their integration in "Decision Support Systems" as well as strategies for the handling of uncertainties. The course will discuss the specific "GIS-Methods" that are important for the integrations of databases, the visualization of data and the calculation of spatial data like ground water recharge. Special focus is laid on GIS supported hydrological modeling of the ground water recharge and the runoff parameters as well as adequate choice of the hydrological model concepts for the calculation of the local water balance in different data situations. To handle the model uncertainties, geostatistic methods and associated stochastic modeling attempts like the "Monte Carlo Simulation" will be mentioned.

14. Literatur: Hydrological Modeling:

15. Lehrveranstaltungen und -formen: • 501301 Lecture and exercise Hydrological Modeling
• 501302 Lecture and exercise Integrated model systems for the groundwater management

16. Abschätzung Arbeitsaufwand: Sum: 180h

17. Prüfungsnummer/n und -name: 50131 Integrated Watershed Modeling (PL), Schriftlich, 150 Min., Gewichtung: 1

18. Grundlage für ... :

19. Medienform:

20. Angeboten von: Hydrologie und Geohydrologie
Modul: 50140 Modeling of Hydrosystems

2. Modulkürzel: 021420011
3. Leistungspunkte: 6 LP
4. SWS: 5
5. Modulduauer: Einsemestrig
6. Turnus: Sommersemester
7. Sprache: Englisch

8. Modulverantwortlicher: Univ.-Prof. Dr.-Ing. Rainer Helmig
9. Dozenten: Bernd Flemisch, Rainer Helmig

10. Zuordnung zum Curriculum in diesem Studiengang:
M.Sc. Water Resources Engineering and Management Chalmers Outgoing Double Degree, PO 913ChO2012, → Wahlmodule
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester → Spezialisierungsmodul
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester → Zusatzmodule
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester → Vertiefungsmodul

Empfohlene Voraussetzungen:
Recommended background knowledge:
Higher Mathematics:
• Partial differential equations
• Numerical integration

Fundamentals of fluid mechanics:
• Conservation equations for mass, momentum, energy
• Mathematical descr

Lernziele:
Students can select suitable numerical methods for solving problems from fluid mechanics and have basic knowledge of implementing a numerical model in C.

Inhalt:
Discretisation methods:
• Knowledge of the common methods (finite differences, finite elements, finite volume) and the differences between them
• Advantages and disadvantages and of the methods and thus of their applicability
• Derivation of the various methods
• Use and choice of the correct boundary conditions for the various methods

Time discretisation:
• Knowledge of the various possibilities
• Assessment of stability, computational effort, precision
• Courant number, CFL criterion

Transport equation:
• Various discretisation possibilities
• Physical background
• Stability criteria of the methods (Peclet number)

Clarification of concepts: model, simulation
Application of the finite element method to the stationary groundwater equation Setting-up of a simulation programme for modeling groundwater:

- Programme requirements
- Programming individual routines

Fundamentals of programming in C:

- Control structures
- Functions
- Arrays
- Debugging

Visualisation of the simulation results

14. Literatur:
Lecture notes: Modeling of Hydrosystems, Helmig

15. Lehrveranstaltungen und -formen:
- 501403 Lecture and Exercise Modeling of Hydrosystems 2, Applications
- 501401 Lecture and Exercise Modeling of Hydrosystems 1, Fundamentals

16. Abschätzung Arbeitsaufwand:
Sum: 180h

17. Prüfungsnummer/n und -name:
50141 Modeling of Hydrosystems (PL), Schriftlich, 120 Min., Gewichtung: 1

18. Grundlage für ... :

19. Medienform:
Fundamentals will be developed using the blackboard and presentation tools. Group exercises help in understanding the obtained theoretical basis.

20. Angeboten von:
Hydromechanik und Hydrosystemmodellierung
Modul: 50150 Stochastical Modeling and Geostatistics

2. Modulkürzel: 021430003
5. Moduldauer: Einsemestrig

3. Leistungspunkte: 6 LP
6. Turnus: Sommersemester

4. SWS: 4
7. Sprache: Deutsch

8. Modulverantwortlicher: Univ.-Prof. Dr.-Ing. Dr. Andras Bardossy

9. Dozenten: Andras Bardossy

10. Zuordnung zum Curriculum in diesem Studiengang:
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
→ Spezialisierungsmodule
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
→ Vertiefungsmodul Wahlpflicht ---> Vertiefungsmodul
M.Sc. Water Resources Engineering and Management Chalmers Outgoing Double Degree, PO 913ChO2012, 2. Semester
→ Wahlmodule
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
→ Zusatzmodule

11. Empfohlene Voraussetzungen: Recommended background knowledge: Basic knowledge of statistics
Prerequisite module: none

12. Lernziele:
Concepts of Geostatistics:
Knowledge of the basic geostatistical concepts, difference between Kriging and simulation, advantages and disadvantages of the discussed methods, application of Kriging and simulation
Stochastical Modeling:
The participants have skills in basic statistical methods used in hydrology, like time series analysis, extreme value statistics, parameter estimation methods and statistical tests.

13. Inhalt:
Concepts of Geostatistics:
Geostatistical procedures for the interpolation of measured values, assessment of model parameters and planning of Measuring networks are dealt with.
Contents:
• Introduction
• Statistical hypotheses: Basic concepts, Regionalized variables, Second order stationarity, Intrinsic hypothesis, Comparison of the two hypotheses, Selection of the regionalized variable
• The variogram: The experimental variogram, The theoretical variogram, Variogram models, Variogram fitting, Isotropy -, anisotropy
• Ordinary Kriging: Point kriging, Block kriging, Properties of ordinary kr., Kr. as an interpolator, Kr. and the variogram, Practice of kr., Selection of the neighbourhood, Kr. with a "false" variogram, Cross validation, Kr. with uncertain data, Simple Kr.
• Non stationary methods: Universal kr., Intrinsic random functions of order k, External-Drift-Kr.
• Indicator Kriging: Indicator Kriging, Applications
• Kriging with arbitrary additional information: Markov-Bayes-Kriging, Simple Updating (SU)
• Time dependent variables

• Exercises

**Stochastic Modeling:**
The lecture part stochastic modeling is primarily concerned with the stochastic analysis of temporal and areal arrays, their generation and their use in the hydrological modeling. Calculation and analysis of hydrological data, descriptive statistic and their parameters, possibility analysis, correlation and regression, time series analysis and simulation.

Content:
• Univariate Statistics and multivariate Statistics (e.g. regression analysis)
• theory of probabilities
• random variables and probability functions (e.g. Poission distribution)
• estimation of parameters (e.g. Maximum Likelihood Method)
• statistical tests (e.g. Kolmogorov-Smirnov test)
• extreme value statistics (analysis of the frequency of occurrence of floods)
• time series analysis (e.g., ARMA Models)
• stochastic simulations (Monte-Carlo Methods)

14. Literatur:

**Geostatistics:**
Introduction to Geostatistics (Lecture notes, English)
Kitanidis, P. K (1997): Introduction to geostatistics: applications to hydrogeology
Armstrong, Margaret (1998): Basic linear geostatistics

**Stochastic Modeling:**

15. Lehrveranstaltungen und -formen:
• 501501 Lecture Concepts of Geostatistics
• 501502 Lecture and Exercise Stochastic Modeling

16. Abschätzung Arbeitsaufwand:
Sum:180h

17. Prüfungsnummer/n und -name:
50151    Stochastic Modeling and Geostatistics (PL), Schriftlich, 90 Min., Gewichtung: 1

18. Grundlage für ...

19. Medienform:

20. Angeboten von:
Hydrologie und Geohydrologie
200 Spezialisierungsmodule

Zugeordnete Module:

15010 Integrated River Management and Engineering
15150 Fuzzy Logic and Operation Research
15160 Water and Power Supply
19100 Chemistry and Biology for Environmental Engineers
19310 Urban Drainage and Design of Wastewater Treatment Plants
19330 Industrial Waste Water
19360 Water Quality and Treatment
19390 Sanitary Engineering - Practical Class
25080 Structural Engineering of Hydraulic Structures
34420 Regional and Urban Planning II
36400 Limnic Ecology
36450 Special Aspects of Urban Water Management
50120 Environmental Informatics
50130 Integrated Watershed Modeling
50140 Modeling of Hydrosystems
50150 Stochastical Modeling and Geostatistics
50160 Applied GIS
50170 Environmental Fluid Mechanics II
50180 Flood Control: Evaluation and Case Studies
50190 Geohydrological Modelling I and II
50200 Geohydrological Modelling III
50210 Geohydrology and Geoengineering
50220 Groundwater and Resources Management
50230 Hydrogeological Investigations
50240 Independent Study
50260 Measurements in the Watercycle
50280 Multiphase Modeling in Porous Media
50290 Numerical Methods for Differential Equations
50300 Planning and Design of Water Supply Facilities
50320 Project Preparation, Management and Finance
50330 Regional and Urban Planning I
50340 Regional and Urban Planning III
50350 Water Resources and Irrigation - Planning Methods and Tools
50520 Environmental Aspects
50560 Project Planning and Financing
50580 Methodological Aspects of Infrastructure Planning
55860 Contaminated site remediation and investigation technologies
55950 Hydropower: Environmental Impacts, Mitigation measures and Ecohydraulic Investigations
58100 Constructed wetlands for wastewater treatment
68060 Advanced Methods in Biofilm Research
Modul: 15010 Integrated River Management and Engineering

2. Modulkürzel: 021410102

3. Leistungspunkte: 6 LP

4. SWS: 0

5. Modulduauer: Einsemestrig

6. Turnus: Sommersemester

7. Sprache: Englisch

8. Modulverantwortlicher: Dr.-Ing. Markus Noack

9. Dozenten: Markus Noack

10. Zuordnung zum Curriculum in diesem Studiengang:
M.Sc. Water Resources Engineering and Management, PO 913-2012, Sommersemester
  ➔ Zusatzmodule
M.Sc. Water Resources Engineering and Management Chalmers Outgoing Double Degree, PO 913ChO2012, Sommersemester
  ➔ Wahlmodule
M.Sc. Water Resources Engineering and Management, PO 913-2012, Sommersemester
  ➔ Vertiefungsmodule Wahlpflicht --> Vertiefungsmodule
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
  ➔ Spezialisierungsmodul

11. Empfohlene Voraussetzungen:
none (BAU), advisable LWW_Wabau
none (UMW), advisable LWW_Gew
Hydraulic Structures (WAREM)

12. Lernziele:
River Engineering and Sediment Management
The students,
• are aware of rivers must be regarded and managed based on an integrated approach
• know the basic concept of the European Water Framework Directive (WFD) and the German legal framework for river basin management
• are able to analyze and estimate the consequences of the WFD based inventory for future management
• are aware of sediment transport processes and of the complexity of the interactions and relations
• recognize the possibilities and limitations of sediment managements strategies

Integrated Flood Protection Measures
The students,
• are aware of the fact that flood protection is an integral process, based on different components (e.g. technical flood protection measures, prevention)
• know the basic physical processes: dynamics of flood events, calculation of discharges and water depths, flood wave propagation, functionality of retention and protection structures: reservoirs, dams and dikes
• know 1-D and 2-D numerical hydro-dynamic models
• are able to apply their knowledge on practical engineering problems related to flood protection

13. Inhalt:
The module consists of two lectures:
River Engineering and Sediment Management
• Basic approaches of river basin management (legal framework)
• Systematics and results of basic inventory due to the WFD
• Anthropogenic impacts on river basins
• Origin of sediments and fundamental principles of transport
• Sediment management measures on different scales

**Integrated Flood Protection Measures**
• Socio-economic aspects of flood damage
• Calculation of water depths
• Hydro-dynamic flood wave calculation, Saint Venant-equation
• Technical flood protection measures
• Design and operation of retention basins
• Set-up of damage and risk maps, design of overtopping earthen dams and dikes
• Probability of failure, reliability calculation, flood risk management

14. Literatur:
Lecture notes and exercise material can be downloaded from the internet. Hints are given for additional literature from the internet as well as libraries.

15. Lehrveranstaltungen und -formen:
• 150101 Vorlesung River Engineering and Sediment Management
• 150102 Vorlesung Integrated Flood Protection

16. Abschätzung Arbeitsaufwand:
Time of attendance: 55 h
Private study: 125 h

17. Prüfungsnummer/n und -name:
15011 Integrated River Management and Engineering (PL), Schriftlich oder Mündlich, 120 Min., Gewichtung: 1

18. Grundlage für ...

19. Medienform:

20. Angeboten von: Wasserbau und Wassermengenwirtschaft
Modul: 15150 Fuzzy Logic and Operation Research

2. Modulkürzel: 021430004
5. Modulsdauer: Einsemestrig
3. Leistungspunkte: 6 LP
6. Turnus: Sommersemester
4. SWS: 4
7. Sprache: Deutsch
8. Modulverantwortlicher: Univ.-Prof. Dr.-Ing. Dr. Andras Bardossy
9. Dozenten: Andras Bardossy

10. Zuordnung zum Curriculum in diesem Studiengang:
M.Sc. Water Resources Engineering and Management, PO 913-2012, ➞ Zusatzmodule
M.Sc. Water Resources Engineering and Management Chalmers Incoming Double Degree, PO 913ChI2012, 1. Semester ➞ Semi-Compulsory Modules

11. Empfohlene Voraussetzungen:
Modul Statistik und Informatik

12. Lernziele:

13. Inhalt:
**Fuzzy-Logic:**
Um komplexe Prozesse und Zusammenhänge unserer Umwelt zu beschreiben und mögliche Folgen von Eingriffen abschätzen zu können, ist es notwendig, diese in mathematischen Modellen abzubilden. Fuzzy-Logik (oder Unscharfe-Logik) bietet einfache Werkzeuge, um derartige Modelle zu erstellen: Fuzzy-Sets, Membership Funktionen, Fuzzy Zahlen, Fuzzy Regeln

**Operation Research:**

14. Literatur:
Fuzzy rule based modeling with applications to geophysical, biological and engineering systems / Andras Bardossy, Lucien Duckstein. - Boca Raton [u.a.] : CRC Press, 1995

15. Lehrveranstaltungen und -formen:
- 151501 Vorlesung Fuzzy Logic
- 151502 Vorlesung Operation Research
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<td>Selbststudium:</td>
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| 17. Prüfungsnummer/n und -name:| 15151 | Fuzzy Logic and Operation Research (PL), Schriftlich, 90 Min., Gewichtung: 1 |

| 18. Grundlage für ...:         |                |      |

| 19. Medienform:                |                |      |

| 20. Angeboten von:             | Hydrologie und Geohydrologie |      |
Modul: 15160 Water and Power Supply

2. Modulkürzel: 021410105
3. Leistungspunkte: 6 LP
4. SWS: 0
8. Modulverantwortlicher: Dr. Sabine-Ulrike Gerbersdorf
9. Dozenten: Ralf Minke
Sabine-Ulrike Gerbersdorf
10. Zuordnung zum Curriculum in diesem Studiengang:
M.Sc. Water Resources Engineering and Management, PO 913-2012, 1. Semester
→ Vertiefungsmodul Wahlpflicht --> Vertiefungsmodul
M.Sc. Water Resources Engineering and Management Mara Outgoing Double Degree, PO 913MaO2012, 1. Semester
→ Wahlmodule
M.Sc. Water Resources Engineering and Management, PO 913-2012, 1. Semester
→ Spezialisierungsmodul
M.Sc. Water Resources Engineering and Management, PO 913-2012, 1. Semester
→ Zusatzmodule
M.Sc. Water Resources Engineering and Management Chalmers Outgoing Double Degree, PO 913ChO2012, 1. Semester
→ Wahlmodule

11. Empfohlene Voraussetzungen: None
12. Lernziele:

**Power Demand, Supply and Distribution:**
The students,
- know the German, European and worldwide energy markets related to demand, supply and its distribution capabilities
- are aware of that non-renewable energy sources are strictly limited and time-scales for conversion of energy markets long
- have an idea about the relations between energy, politics, social changes and influences on environment
- have a basic knowledge about present energy conversion systems, theoretical limits of efficiencies, and the potential to enhance applied technology
- have a basic understanding about where and how energy is provided and distributed
- comprehend the balance between load and supply in electrical grids and the resulting necessity for control energy.

**Water Demand, Supply and Distribution:**
The students,
- know the German and worldwide water systems related to demand, supply and its distribution capabilities
- have an overview on the water supply situation all over the world.
- recognize the different possibilities and levels of water supply
- have an idea of the relations between water, politics, social changes and influences on environment.

13. Inhalt:

**Power Demand, Supply and Distribution:**
- Energy demand, energy supply
- Energy generation
- overview of different types of power plants
- renewable energy
- thermal power plants (conventional and nuclear)
- Areas of application of different power plants
- Emission control techniques
- Cooling of thermal power plants
- methods
- water resources aspects
- Energy transport and energy storage
- Net techniques
- Energy market
- trade
- politics
- law
- social changes due to energy supply

**Water Demand, Supply and Distribution:**
- Water supply and water distribution: necessity, basic requirements, elements, hydrological cycle
- Water demand calculation: water consumption, water demand, consumer groups, losses, forecasting, design periods
- Water collection: Selection of source, groundwater withdrawal, springwater tapping, surface water intakes, rainwater harvesting, seawater desalination, recycling of treated sewage, drinking water protection areas
- Water transmission and distribution: necessity, hydraulic basics, dimensioning and calculation of branched and closed loop systems.
- Pumps and pumping stations: necessity, types, hydraulics for pumping design, pumping stations and pressure boosters
- Water storage: necessity, types and functions of tanks and reservoirs
- Case study: planning and design of a water supply system for a small town

14. Literatur: Lecture notes can be downloaded from the internet. Hints are given for additional literature from the internet as well as libraries.

15. Lehrveranstaltungen und -formen: • 151602 Vorlesung Water Demand, Supply and Distribution • 151601 Vorlesung Energy Demand, Supply and Distribution

16. Abschätzung Arbeitsaufwand: Time of attendance: 45 h Private Study: 135 h

17. Prüfungsnummer/n und -name: 15161 Water and Power Supply (PL), Schriftlich, 120 Min., Gewichtung: 1

18. Grundlage für ... :

19. Medienform:

20. Angeboten von: Wasserbau und Wassermengenwirtschaft
Modul: 19100 Chemistry and Biology for Environmental Engineers

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<td>8. Modulverantwortlicher:</td>
<td>Univ.-Prof. Dr. Jörg Metzger</td>
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<td>9. Dozenten:</td>
<td>Karl Heinrich Engesser, Brigitte Schwederski, Jörg Metzger, Bertram Kuch, Daniel Dobslaw</td>
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11. Empfohlene Voraussetzungen:

12. Lernziele:

**Lecture: Inorganic chemistry**

The students

- know the fundamental concepts of chemistry (atomic structure, periodic system, chemical formulae, stoichiometry, molecular structures) and are able to use them,
- know the principle types of chemical substances and chemical reactions and can apply their knowledge to synthetic problems,
- know about the most important industrial compounds, their preparation and environmental aspects in their application.

**Lecture: Organic chemistry**

The students
- can identify important functional groups in organic molecules

- know the main compound classes in organic chemistry and the common rules for their nomenclature

- know the most important representatives thereof and are able to draw their structural formulae

- know the structure and properties of important bio-molecules such as fats, carbohydrates, proteins, nucleic acids, ATP, lignin and humic acids

- know the most important reactions involved in chemical and microbial degradation of organic matter

- know summary parameters used to characterize water quality

- know the properties of bio-molecules and can explain their general function with respect to cell structures, enzymatic and immune reactions

- knows selected environmental organic contaminants (PAH, dioxins, pesticides etc.) and their properties

**Lecture: Biology and ecology of water, soil and air systems**

The students

- know about the relation between water, soil and air compartments and many diseases, happening especially in developing countries

- know about the reasons for break out of diseases, the structure and function of prokaryotic and eucaryotic cells as well as the methods for identification and determination of growth conditions and possible growth limitations

- comprehend microbial metabolism, energy production, release and conservation, enzyme syntheses and their regulation.

- know important events and scientists in the history of biology

- know basics in ecology of natural and artificial ("technical") ecosystems as well as selected methods to detect distorted equilibria in technical ecosystems influenced by mankind

**Lecture: Technical and medical microbiology for engineers**

The students

- know the most important microorganisms being active in plants treating waste water, air and contaminated soil
- know the kind of participation in purification and thus the procedures used to make them feel happy as well as the problems associated with excess biomass

- are aware of a detailed overview of the kind of medically important microorganisms and of the most relevant agents of illness met in these plants, this holds also for the compartments 'drinking water' and 'sewage sludge'.

13. Inhalt:

**Lecture: Inorganic chemistry**
- atomic structure: stable nuclear particles, atomic nuclei, isotopes and radioactivity, atomic spectra and the hydrogen atom, heavier atoms
- the periodic system of the elements: the sequence of elements, the electronic configuration of some elements, the periodicity of some properties
- chemical bonding: the ionic bond, the metallic bond, the covalent bond, hydrogen bonding, van der Waals forces
- quantitative Relationships and Stoichiometric Equations
- characterizing chemical reactions: the chemical equilibrium, water: the solvent, acid/base reactions, redox reactions
- descriptive part: selected chemical compounds and their preparation and properties

**Lecture: Organic chemistry**
- functional groups and compound classes
- classification of chemical reactions in organic chemistry
- organic bio-molecules (e.g. proteins, carbohydrates, nucleic acids, fats, humic acids, lignin): structure and function
- chemical and microbial degradation of organic matter in the environment
- summary parameters
- organic environmental contaminants

**Lecture: Biology and ecology of water, soil and air systems**
The following topics are presented within the lecture:
- Introduction in history of microbiology
- Important waterbased/water related diseases
- Function of microscopy of staining techniques
- Structure and function of prokaryotic cells
- Structure and function of eucaryotic cells
- Necessity and effects of microbial nutrition
- Microbial growth relations and possible limitations
- Microbial metabolism: Energy production, conservation and release
- Microbial metabolism: Enzymes syntheses and regulation.

**Lecture: Technical and medical microbiology for engineers**
- Important (sewage) water based /water related diseases/ detection and possible countermeasures
- Important soil and air connected diseases
- (micro)biological principles in application of engineering techniques
• Implication of engineer work on ecosystems/environment protection problems

Some test systems for estimation of (bio)degradability of chemicals will be evaluated

14. Literatur:
Lecture notes
pdf download of powerpoint slides for lectures
Exercises as hand-out or download (pdf)

15. Lehrveranstaltungen und -formen:
• 191001 Lecture Inorganic chemistry
• 191002 Lecture Organic chemistry
• 191003 Lecture Biology and ecology of water, soil and air systems
• 191004 Lecture Technical and medical microbiology for engineers

16. Abschätzung Arbeitsaufwand:
Time of attendance:
Inorganic chemistry (Schwederski): Lecture, 1 SWS = 14 hours
Organic chemistry (Metzger/Kuch): Lecture, 1 SWS = 14 hours
Biology and ecology of water, soil and air systems (Engesser):
Lecture,
1 SWS = 14 hours
Technical and medical microbiology for engineers (Engesser):
Lecture,
1 SWS = 14 hours
Exercises for Chemistry and Biology for environmental engineers,
2 SWS = 28 hours
Exam: 2 hours
Sum of attendance: 86 hours
Exercises (group work with presentations): 28 hours
Self-study: 94 hours:

17. Prüfungsnummer/n und -name: 19101 Chemistry and Biology for Environmental Engineers (PL), Schriftlich oder Mündlich, 120 Min., Gewichtung: 1

18. Grundlage für ... :

19. Medienform: Video projector (powerpoint) presentation explanations on blackboard, group work with presentations

20. Angeboten von: Hydrochemie und Hydrobiologie in der Siedlungswasserwirtschaft
Modul: 19310 Urban Drainage and Design of Wastewater Treatment Plants

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<td>7. Sprache:</td>
<td>Englisch</td>
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<tr>
<td>8. Modulverantwortlicher:</td>
<td>Dr.-Ing. Ulrich Dittmer</td>
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<td>9. Dozenten:</td>
<td>Harald Schönberger, Ulrich Dittmer</td>
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<tr>
<td>11. Empfohlene Voraussetzungen:</td>
<td>Chemistry and Biology for Environmental Engineers Sanitary Engineering</td>
</tr>
<tr>
<td>12. Lernziele:</td>
<td>Advanced knowledge of processes and concepts for urban drainage and municipal wastewater treatment systems Basics of construction and dimensioning of different urban drainage systems, stormwater treatment facilities and wastewater treatment plants as a base for dimensioning and discussion of proved and innovative technologies Deeper understanding for system connections as base for a decisions during the planning process</td>
</tr>
<tr>
<td>13. Inhalt:</td>
<td>Design of sewer systems and stormwater treatment (Dr.-Ing. Ulrich Dittmer) principles of collection and disposal design of combined and separate sewer systems Sustainable urban drainage systems (SUDS) and low impact design(LID) Application of rainfall runoff models (computer exercise using U.S. EPA Stormwater Management Model) different techniques for treatment and retention design of treatment facilities Design of wastewater treatment plants (Prof. Dr.-Ing. Heidrun Steinmetz) Municipal wastewater treatment different techniques for advanced biological wastewater treatment (nitrogen and phosphorous removal) principles of process engineering</td>
</tr>
</tbody>
</table>
design of biological wastewater treatment plants and the main
important aggregates
design of sludge treatment plants
Seminar: feasibility studies
(Prof. Dr.-Ing. Heidrun Steinmetz and external consultants)
special examples for sanitation concepts for world wide application
Ecological sanitation and resource orientated systems
  case studies

14. Literatur:
• Butler, D., Davies, J.W). Urban drainage, Spon press London,
  US EPA: SWMM 5.0 users manual
• Henze, M., Harremoes, J. La Coour Jansen, J., Arvin, E:
  Wastewater treatment. Springer Verlag Berlin
• Lens, P, Zeeman, G., Lettinga, G.: Decentralised Sanitation and
  reuse. IWA publishing, London
• Different German standards (DWA, Hennef)
• Lecture notes

15. Lehrveranstaltungen und -formen:
• 193101 Vorlesung und Übung Design of Sewer System and
  Stormwater Treatment
• 193104 Exkursion
• 193102 Vorlesung und Übung Design of Wastewater Treatment
  Plants
• 193103 Seminar Case Study

16. Abschätzung Arbeitsaufwand:
   Time of attendance: approx. 70 hours (including 4*4 hours for
   excursion) 1,5 SWS
   Private Study: approx. 110 hours
   Lecture 1 Presence time: 28 hours, self study 30 hours, project 0,
   Sum: **58 hours**
   Lecture 2: Presence time: 28 hours, self study 30 hours, project 40,
   Sum: **58 hours**
   Case study: Presence time: 14 hours, self study 10 hours, project
   0, Sum: **25 hours**

17. Prüfungsnummer/n und -name:
   19311 Urban Drainage and Design of Wastewater Treatment Plants
   (PL), Schriftlich, 120 Min., Gewichtung: 1

18. Grundlage für ...:

19. Medienform:

20. Angeboten von:
   Siedlungswasserbau und Wassergütewirtschaft
**Modul: 19330 Industrial Waste Water**

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<td>4. SWS:</td>
<td>4</td>
<td>7. Sprache:</td>
<td>Englisch</td>
</tr>
</tbody>
</table>

8. Modulverantwortlicher: Prof. Uni. Reg. de Blumenau Uwe Menzel

9. Dozenten: Michael Koch, Uwe Menzel

10. Zuordnung zum Curriculum in diesem Studiengang:

  → Semi-Compulsory Modules
  → Compulsory Modules
  → Spezialisierungsmodul
  → Zusatzmodule

11. Empfohlene Voraussetzungen:

12. Lernziele: Students have:

- a basic understanding for the problems and requirements of industrial waste water treatment
- an overview of measures for production integrated environmental protection, relevant treatment methods for process water and its characterization
- an overview of water analysis including sampling, the main principles of different analytical techniques and the ways to assure the quality of chemical analysis

13. Inhalt: Fundamentals of industrial waste water treatment

- Determination of current situation possible process integrated measures, arrangements for reuse and recirculation of water mass and concentration balance
- Basic elements and examples for applications of advanced purification processes
- Biological waste water treatment
- Sampling and analytical techniques using on-site measurements, oxidation - reduction, acids and bases, sum parameters, photometry, spectrometry and chromatography
- Analytical quality assurance

14. Literatur:

- lecture notes (approx. 400 pages)
- exercises
- Deutsche Einheitsverfahren zur Wasser-, Abwasser und Schlammuntersuchung - Standard Methods for the Examination of Water and Wastewater

15. Lehrveranstaltungen und -formen:
- 193301 Lecture Treatment of Industrial Waste Water
- 193302 Lecture Water Analysis and Analytical Quality Control

16. Abschätzung Arbeitsaufwand:
Time of attendance:
I Treatment of Industrial Waste Water: 2 SWS = 24 hours
II Water Analysis and Analytical Quality Control: 2 SWS = 24 hours
Exam: 2 hours
sum of attendance: 50 hours
self-study: 130 hours
**total: 180 hours**

17. Prüfungsnummer/n und -name:
19331 Industrial Waste Water (PL), Schriftlich, 120 Min., Gewichtung: 1

18. Grundlage für ... :

19. Medienform:
   power-point-presentation, blackboard and over-head projector

20. Angeboten von:
   Siedlungswasserbau und Wassergüterwirtschaft
Modul: 19360 Water Quality and Treatment

2. Modulkürzel: 021210051
5. Modulduauer: Einsemestrig

3. Leistungspunkte: 6 LP
6. Turnus: Sommersemester

4. SWS: 4
7. Sprache: Englisch

8. Modulverantwortlicher: Carsten Meyer

9. Dozenten: Harald Schönberger
Carsten Meyer

10. Zuordnung zum Curriculum in diesem Studiengang:
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
➞ Spezialisierungsmodul
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
➞ Vertiefungsmodul Wahlpflicht → Vertiefungsmodul
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
➞ Zusatzmodule

11. Empfohlene Voraussetzungen:
Knowledge in Sanitary Engineering, Water Supply and Hydraulics
Contents of Water and Power Supply

12. Lernziele:
• The students learn how to characterize and protect water bodies as well as to improve the water quality
• Students understand the contribution of wastewater treatment to the preventive protection of receiving waters and they learn the basic methods of water quality management instruments
• Students understand the necessity of water treatment as essential element of drinking water supply
• Students learn the chemical, physical and biological background of water treatment technologies, their possibilities and boundaries and they are able to develop, design and dimension treatment schemes for different raw water qualities

13. Inhalt:
Water Quality Management:
• Terms and introduction: environmental data from Germany
• Characterisation and assessment of flowing waters, stagnant waters and groundwater
• Water quality parameters, WHO drinking water guidelines, targets for drinking water and sanitation, description of water quality in relation to use
• Improvement of water quality, reduction of pollution load, point pollutants and diffuse loads, improving the self-purification capacity of waters, technical helps, assessment of progress
• Water quality management, the European Union Framework Directive, quality planning and maintenance, monitoring networks

Water Treatment:
• Water supply and water treatment: basic requirements, drinking water standards
• Mechanical treatment: Screening, Sieving, Sedimentation, (Membrane)Filtration, Gas-Exchange, Flotation
• Carbondioxide-Carbonate-Balance: relevance, chemical background
• Deacidification: mechanical and chemical methods
• Removal of iron, manganese and arsenic: methods
• Decarbonization: chemical methods
• Flocculation
• Adsorption
• Disinfection: chemical and physical methods

14. Literatur:
Lecture notes and material for exercises will be provided during the lecture. Hints are given for additional literature from the internet as well as libraries, e.g.
• American Water Works Assoc.: Water Quality and Treatment, McGraw-Hill Inc., 1999
• Nicholas P. Cheremisinoff: Handbook of Water and Wastewater Treatment Technologies, Bitterworth and Heinemann, Boston Oxford Auckland Johannesburg Melbourne New Delhi, 2002
• WHO Guidelines, 2006
• Mutschmann, J, Stimmelmayr, F.: Taschenbuch der Wasserversorgung, Vieweg-Verlag

15. Lehrveranstaltungen und -formen:
• 193601 Lecture Water Treatment
• 193602 Lecture Water Quality Management

16. Abschätzung Arbeitsaufwand:
Time of attendance: ca. 42 h
Private study: ca. 138 h
1) Lecture: presence time = 34,0, self study = 106,0, Sum = 140,0
2) Exercise: presence time = 8,0, self study = 32,0, Sum = 40,0
Sum Lecture (140) + Sum Exercise (40) = 180,0

17. Prüfungsnummer/n und -name:
• 19361 Water Quality Management (PL), Schriftlich, 60 Min., Gewichtung: 1
• 19362 Water Treatment (PL), Schriftlich, 60 Min., Gewichtung: 1

18. Grundlage für ... :

19. Medienform:

20. Angeboten von: Siedlungswasserbau und Wassergütewirtschaft
Modul: 19390 Sanitary Engineering - Practical Class


4. SWS: 0 7. Sprache: Englisch

8. Modulverantwortlicher: Dr. Bertram Kuch

9. Dozenten: Bertram Kuch
Ralf Minke
Matthias Rapf
Detlef Clauß

10. Zuordnung zum Curriculum in diesem Studiengang:
  → Spezialisierungsmodule
  → Zusatzmodule

11. Empfohlene Voraussetzungen:
Prerequisite Modules:
Sanitary Engineering
Urban drainage and design of Wastewater treatment plants
Chemistry and Biology for Environmental Engineers

12. Lernziele:
The student knows and understands in theory and practice
  - the most important parameters to characterize water and waste
    water and the analytical methods to determine them (e.g. pH,
    nitrate, ammonium, phosphorus, alkalinity, acidity, permanganate
    index, conductivity, oxygen, loss of ignition, filterable matter).
  - important techniques for removal of water contaminants (e.g.
    ion exchange, precipitation, coagulation, sorption, neutralization,
    aerobic, anoxic and anaerobic degradation)
  - how to take representative samples out of the different waste
    streams and the relevant sampling errors
The student is aware of the most important microbiological tools
to detect, handle and use microorganisms in environmental
engineering systems
The student
  - is capable of interpreting and evaluating analytical data and
    based on these data to draw conclusions in order to evaluate
    the quality of water and the efficiency of processes for treatment of
    water and solid waste.
  - is able to apply the relevant laboratory test procedures to analyze
    compost within the quality assurance system and to interpret the
    results.
  - has the competence to develop a sampling procedure for
    household waste and to determine the waste composition by a
    sorting analyses
  - is able to apply selected test procedures in the field of hazardous
    waste and the analyses of odor samples

13. Inhalt:
This course serves to the intensification of the theoretical
knowledge in sanitary engineering by practical work in the
laboratory and an accompanying student seminar. The
experiments offered belong thematically to the three main areas:
  - water and waste water
  - solid waste
The experiments are mainly performed directly by the students in groups of 3 to max. 6 or offered as demonstration experiments.

14. Literatur:
- Description of Experiments (available as download, pdf)
- Handouts for seminar work

15. Lehrveranstaltungen und -formen:
- 193901 Praktikum Sanitary Engineering - Practical Class
- 193903 Practical Work and Seminar Solid Waste

16. Abschätzung Arbeitsaufwand:
- Time of attendance (incl. seminar work): 90 h
- Preparation time (before/after practical work): 90 h
- Total: 180 hours

17. Prüfungsnummer/n und -name:
- 19391 Sanitary Engineering - Practical Class (PL), Schriftlich, 90 Min., Gewichtung: 1
- written records of practical experiments

18. Grundlage für ...

19. Medienform:
- Explanation of experiments and presentation of the results of the practical work by the students (flip chart, blackboard)
- Practical Work in chemical and microbiological laboratories

20. Angeboten von:
- Hydrochemie und Hydrobiologie in der Siedlungswasserwirtschaft
Modul: 25080 Structural Engineering of Hydraulic Structures

2. Modulkürzel: LWW_01
5. Moduldauer: Einsemestrig
3. Leistungspunkte: 6 LP
6. Turnus: Wintersemester
4. SWS: 5
7. Sprache: Englisch

8. Modulverantwortlicher: Dr.-Ing. Kristina Terheiden

9. Dozenten: Kristina Terheiden
Hans-Peter Koschitzky

10. Zuordnung zum Curriculum in diesem Studiengang:
→ Vertiefungsmodule Wahlpflicht --> Vertiefungsmodul
→ Spezialisierungsmodule

11. Empfohlene Voraussetzungen:
Basic Knowledge of Structural Engineering

12. Lernziele:
Students know basics of structural design, restoration and monitoring of hydraulic structures e.g. (reinforced) concrete or block masonry structures in theory and for practical applications. Furthermore they are able to select and design hydraulic gates and for several purposes.

13. Inhalt:
The module contains two parts:
**Structural Design, Restoration and Monitoring of Dams**
Determination of internal forces of tanks, silos, arched dams using membrane and bending theory
FEM for structural hydraulic engineering as large dams (Theory and Practical Application)
Damage and failure of dams
Monitoring of dams
Restoration of dams
**Hydraulic Gates**
Mechanics and Operation of Hydraulic Gates
Design and operating windows
Hydraulics and special problems caused by high speed flows
Maintenance of hydraulic gates

14. Literatur:

15. Lehrveranstaltungen und -formen:
• 250802 Übung Talsperrenbemessung, -sanierung, -überwachung
• 250803 Vorlesung Stahlwasserbau
• 250804 Übung Stahlwasserbau
• 250801 Vorlesung Talsperrenbemessung, -sanierung, -überwachung

16. Abschätzung Arbeitsaufwand:
Time of attendance: 55 h
Private study: 125 h
Total: 180 h

17. Prüfungsnummer/n und -name:
25081 Structural Engineering of Hydraulic Structures (PL), Schriftlich, 150 Min., Gewichtung: 1

18. Grundlage für ... :

19. Medienform:
20. Angeboten von: Wasserbau und Wassermengenwirtschaft
**Modul: 34420 Regional and Urban Planning II**

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<td>Englisch</td>
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8. Modulverantwortlicher:  
Univ.-Prof. Dr.-Ing. Jörn Birkmann

9. Dozenten:  
Astrid Ley  
Jörn Birkmann

10. Zuordnung zum Curriculum in diesem Studiengang:  
M.Sc. Water Resources Engineering and Management Mara Outgoing Double Degree, PO 913MaO2012, 2. Semester  
➞ Wahlmodule  
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester  
➞ Zusatzmodule  
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester  
➞ Spezialisierungsmodulen  
M.Sc. Water Resources Engineering and Management Chalmers Outgoing Double Degree, PO 913ChO2012, 2. Semester  
➞ Wahlmodule

11. Empfohlene Voraussetzungen:  
prerequisite modules: Regional and Urban Planning I

12. Lernziele:  
The students are acquainted with basic methods of analysis and assessment in spatial planning. The students are able to cope with function, prerequisites and methodical problems of the methods presented. The lectures demonstrate the usage of planning instruments and methods based on planning cases from Germany and other countries.

13. Inhalt:  
The course Regional Planning II deals with the following planning methods:  
- Indicator-based monitoring and evaluation methods  
- Multi-criteria decision analysis (e.g. cost-benefit analysis, utility value analysis, analytic hierarchy process)  
- Methods of impact assessment  
- Techniques of demand forecast and land suitability analysis  
- Hazard and vulnerability analysis (climate change adaptation)

The course Urban Planning II gives an overview on:  
- Levels of spatial planning in urban areas  
- Urban development planning  
- Urban analysis  
- Urban renewal  
- Urban planning instruments  
- Land use planning and implementation planning  
- Legal framework

14. Literatur:  
Skript Regional and Urban Planning II

15. Lehrveranstaltungen und -formen:  
- 344201 Vorlesung Regional Planning II  
- 344202 Vorlesung Urban Planning II

16. Abschätzung Arbeitsaufwand:  
Time of attendance: approx. 45 hours  
Private Study: approx. 120 hours

17. Prüfungsnummer/n und -name:  
- 34421 Regional Planning II (LBP), Gewichtung: 1
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<th>Nummer</th>
<th>Fragestellung</th>
<th>Antwort</th>
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<td>18.</td>
<td>Grundlage für ...</td>
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<tr>
<td>19.</td>
<td>Medienform:</td>
<td>Optional</td>
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<tr>
<td>20.</td>
<td>Angeboten von:</td>
<td>Raumentwicklungs- und Umweltplanung</td>
</tr>
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</table>
Modul: 36400 Limnic Ecology

2. Modulkürzel: 021410205
5. Moduldauer: Einsemestrig
3. Leistungspunkte: 6 LP
6. Turnus: Wintersemester
4. SWS: 0
7. Sprache: Englisch

8. Modulverantwortlicher: Dr. Sabine-Ulrike Gerbersdorf
9. Dozenten: Sabine-Ulrike Gerbersdorf

10. Zuordnung zum Curriculum in diesem Studiengang:
M.Sc. Water Resources Engineering and Management, PO 913-2012, ➔ Spezialisierungsmodule
M.Sc. Water Resources Engineering and Management, PO 913-2012, ➔ Zusatzmodule

11. Empfohlene Voraussetzungen: Biologie Grundkenntnisse / basic knowledge in biology

12. Lernziele:
Knowledge on Limnology, Hydrobiology and Limnic Ecology is essential for solving problems concerned with water protection.

Lecture Limnic Ecology
The student knows about abiotic factors (e.g. light, nutrients, flow regime) to impact biocoenosis and thus to structure habitats/biotopes. He/She understands the organisms and their metabolic activities in detail, ranging from primary producers (microalgae, macrophytes) to secondary producers and consumers up to trophic relationships (from microbial loop to higher food webs). The student is familiar with challenges for health and safety of water bodies / drinking water as well as self-purification within aquatic systems with regard to eutrophication, human impacts in a wider sense as well as natural toxic algae blooms. The student knows about the important question on the ecological balance of water bodies and strategies of biomanipulation, decontamination up to restoration in order to support the natural regeneration potential of aquatic systems. He/She understands both habitats, water column and sediment, as both compartments are strongly linked to each other and determine the overall health status.

Seminar Selected topics in Limnic Ecology
The student knows how to present research to an audience by practising and improving important presentation skills (soft skills) in response to appropriate feedback. At the same time he/she deepened his/her knowledge in selected topics by choosing a topic of his/her special interest from Limnic Ecology. The students learned about external lecturer and their special fields of interest and how to participate in a lively discussion.

13. Inhalt:
Lecture "Limnic Ecology
This lecture gives insights into morphology and ecological principles of different water bodies (natural / artificial, groundwater, streams, lakes, drinking reservoirs etc).
• Basic definitions and classifications schemes for a range of aquatic habitats, differences in lotic and stagnant water bodies
• Abiotic factors and their impact on organisms and habitat: light, temperature, flow regime/turbulence, wind, water level, chemical factors, pH, conductivity, oxygen and nutrients
• Biotic factors such as competition, prey-predator relations, biological engineering as well as primary and secondary production and decomposition
• Ecosystem functions such as nutrient recycling, food webs or engineering / sediment stabilisation
• Challenges for health and safety of water bodies: natural (toxic algae) to human (eutrophication) impacts
• Strategies to re-establish or support ecological balance, is there an ecological balance?
• Important methods investigating single abiotic (e.g. oxygen, nutrients) and biotic (e.g. chlorophyll) factors as well as complex interactions on ecological level (e.g. community composition) with implications for water purity will be presented

Seminar Selected topics in Limnic Ecology
A range of possible topics (front of research or actual/political interest) will serve as a choice, but also the students can come up with own ideas


15. Lehrveranstaltungen und -formen: • 364001 Lecture Limnic Ecology • 364002 Seminar Limnic Ecology

16. Abschätzung Arbeitsaufwand:
Lecture: Präsenzzeit/Presence: ca. 22,5 h Selbststudium/post-preparation: ca. 67,5 h
Seminar: Präsenzzeit/Presence: ca. 22,5 h Selbststudium/post-preparation: ca. 67,5 h

17. Prüfungsnummer/n und -name: 36401 Limnic Ecology (PL), Schriftlich oder Mündlich, 90 Min., Gewichtung: 1

18. Grundlage für ...:

19. Medienform: Powerpoint, Tafel

20. Angeboten von: Wasser- und Umweltsystemmodellierung
Modul: 36450 Special Aspects of Urban Water Management

2. Modulkürzel: 021210006  
5. Modulduauer: Einsemestrig

3. Leistungspunkte: 6 LP  
6. Turnus: Wintersemester

4. SWS: 4  
7. Sprache: Englisch

8. Modulverantwortlicher: Ralf Minke

9. Dozenten: Ralf Minke  
Ulrich Dittmer  
Klaus Werner König

10. Zuordnung zum Curriculum in diesem Studiengang: 
M.Sc. Water Resources Engineering and Management Chalmers  
Incoming Double Degree, PO 913ChI2012, 3. Semester  
➞ Semi-Compulsory Modules  
➞ Zusatzmodule  
➞ Spezialisierungsmodule

11. Empfohlene Voraussetzungen: 
Inhaltlich:  
Grundlegende Kenntnisse der Gesamtsysteme der Siedlungswasser- und Wasserwirtschaft.  
Vertiefte Kenntnisse der Abwassertechnik, der Wassergüteentscheidungen, der Wasserversorgung oder des allgemeinen Managements von Wasserressourcen.  
Formal:  
Wasserversorgungstechnik I oder  
Abwassertechnik I oder  
Waste Water Technology oder Water Quality and Treatment

12. Lernziele: 
Fachlich:  
Die Studierenden entwickeln ein Verständnis für Zusammenhänge über ihre Teildisziplin hinaus. Sie können bei Entscheidungsfindungen und Planungen zwischen konkurrierenden Belangen der Siedlungswasserwirtschaft, Wasserwirtschaft und anderer Infrastrukturbereiche fachlich fundiert abwägen.  
Methodisch:  
Die Studierenden können selbständig mit internationaler wissenschaftlicher Literatur zu ihrem jeweiligen Fachgebiet umgehen, Ergebnisse kritisch bewerten und so ein eigenes Bild des Standes der Wissenschaft erarbeiten und präsentieren.

13. Inhalt:  
- Wechselwirkungen zwischen Teilbereichen der Siedlungswasserwirtschaft am Beispiel des Umgangs mit Regenwasser  
- Jährlich wechselnde Spezialthemen entsprechend dem wissenschaftlichen und technischen Fortschritt

14. Literatur:  
Gujer, W. Siedlungswasserwirtschaft, Springer Verlag GmbH  
Mutschmann, J., Stimmelmayr, F.: Taschenbuch der Wasserversorgung, Vieweg-Verlag  
Jeweils die aktuellen Auflagen  

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15. Lehrveranstaltungen und -formen:

- 364503 Excursions
- 364501 Scientific Seminar
- 364502 Lecture Rainwater Harvesting and Management

16. Abschätzung Arbeitsaufwand:

17. Prüfungsnummer/n und -name: 36451  Special Aspects of Urban Water Management (Seminar presentation) (LBP), Schriftlich oder Mündlich, Gewichtung: 1

18. Grundlage für ... :

19. Medienform:

20. Angeboten von: Siedlungswasserbau und Wassergügewirtschaft
Modul: 50120 Environmental Informatics

2. Modulkürzel: 021430002  
3. Leistungspunkte: 6 LP  
4. SWS: 4  
5. Modulpauze: Einsemestrig  
6. Turnus: Wintersemester  
7. Sprache: Englisch

8. Modulverantwortlicher: Univ.-Prof. Dr.-Ing. Dr. Andras Bardossy  
9. Dozenten: Johannes Riegger

10. Zuordnung zum Curriculum in diesem Studiengang:  
    M.Sc. Water Resources Engineering and Management, PO 913-2012, 1. Semester  
    → Vertiefungsmodule Wahlpflicht → Vertiefungsmodule  
    M.Sc. Water Resources Engineering and Management Chalmers Incoming Double Degree, PO 913ChI2012, 3. Semester  
    → Semi-Compulsory Modules  
    M.Sc. Water Resources Engineering and Management, PO 913-2012, 1. Semester  
    → Spezialisierungsmodul  
    M.Sc. Water Resources Engineering and Management Mara Incoming Double Degree, PO 913MaI2012, 3. Semester  
    → Compulsory Modules  
    M.Sc. Water Resources Engineering and Management Chalmers Outgoing Double Degree, PO 913ChO2012, 1. Semester  
    → Wahlmodule  
    M.Sc. Water Resources Engineering and Management Mara Outgoing Double Degree, PO 913MaO2012, 1. Semester  
    → Wahlmodule  
    M.Sc. Water Resources Engineering and Management, PO 913-2012, 1. Semester  
    → Zusatzmodule

11. Empfohlene Voraussetzungen:

12. Lernziele:  
    Skills in Spreadsheet Calculations for Data Processing, Design, Creation, Handling and Application of Relational Database Management Systems for Environmental Issues, Creation and display of Environmental GIS data sets. Use of GIS functionalities to investigate spatial and attribute relationships

13. Inhalt:  
    Information Processing und Environmental Data Management (Excel und Access):  
    Environmental Database Design, Relational Database Management, Data Normalization, Data Security  
    GIS Tools in Environmental Engineering (ArcGIS):  
    Basics of GIS, Data implementation, Spatial Structures and Attributes, Display of Environmental Information, Charts und Diagrams, Digitization, Spatial and Logical Queries, Data Links, Geo-Referencing, Field Calculations

14. Literatur:  
    Script: J. Riegger 'Environmental Informatics'  
    User Handbooks for Excel, Access, ArcGIS  
    Getting to know ArcGIS Desktop ISBN: 9781589482609

15. Lehrveranstaltungen und -formen:  
    • 501201 Lecture Environmental Data Management  
    • 501202 Lecture GIS Tools in Environmental Engineering

16. Abschätzung Arbeitsaufwand:  
    Time of attendance: approx. 56 hours  
    Private Study: approx. 124 hours during semester  
    Sum: 180h
17. Prüfungsnummer/n und -name: 

- 50121 Environmental Informatics (PL), Schriftlich, 120 Min., Gewichtung: 1
- V Vorleistung (USL-V), Schriftlich

18. Grundlage für ... :

19. Medienform:

20. Angeboten von: Hydrologie und Geohydrologie
Modul: 50130 Integrated Watershed Modeling

2. Modulkürzel: 021430009
5. Modulsdauer: Einsemestrig

3. Leistungspunkte: 6 LP
6. Turnus: Sommersemester

4. SWS: 4
7. Sprache: Deutsch

8. Modulverantwortlicher: Univ.-Prof. Dr.-Ing. Dr. Andras Bardossy
9. Dozenten: Andras Bardossy
Johannes Riegger

10. Zuordnung zum Curriculum in diesem Studiengang:
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
→ Spezialisierungsmodule
M.Sc. Water Resources Engineering and Management Chalmers Outgoing Double Degree, PO 913ChO2012, 2. Semester
→ Wahlmodule
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
→ Zusatzmodule
M.Sc. Water Resources Engineering and Management Mara Outgoing Double Degree, PO 913MaO2012, 2. Semester
→ Wahlmodule
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
→ Vertiefungsmodule
Wahlpflicht --> Vertiefungsmodule

11. Empfohlene Voraussetzungen:
Recommended background knowledge: Basic knowledge of hydrology and geohydrology
Prerequisite module: none

12. Lernziele:
Hydrological Modeling:
Construction of models for each part in the runoff process and how these models are used and integrated in different environment management systems.

Integrated model systems for the groundwater management:
Design of hydrogeological databases, visualization of data, GIS-Operations for the groundwater and hydrological modeling, Geostatistic, stochastic modeling, Monte Carlo Methods.

13. Inhalt:
Hydrological Modeling:
What happens to the rain? This is the basic question that needs to be addressed in order to predict the amount of discharge at a certain location in a river system at a given time. Which parts of the fate of rainfall can be determined on a physical basis, and which are still left to empirical searching? Beside the qualitative determination of e.g. the processes of evapotranspiration, infiltration, interflow etc. we also need to describe the quantities of these processes to be able to forecast e.g. flood events.

Hydrological watershed modelling is fundamental to integrated water management. There are complex interactions between the elements of the environmental continuum. In order to predict future behaviour and to quantify effects of management changes, quantitative mathematical descriptions are needed. A number of advanced hydrological watershed models have been developed in the last 30 years. A few of them will be reviewed in terms of their data needs and there predictive power. The participants are encouraged to form groups and to use their selected models...
for the same catchment so that the different approaches are compared.

**Integrated model systems for the groundwater management:**
Modern integrated model systems require techniques for the efficient construction of ground water models and their integration in "Decision Support Systems" as well as strategies for the handling of uncertainties. The course will discuss the specific "GIS-Methods" that are important for the integrations of databases, the visualization of data and the calculation of spatial data like ground water recharge. Special focus is laid on GIS supported hydrological modeling of the ground water recharge and the runoff parameters as well as adequate choice of the hydrological model concepts for the calculation of the local water balance in different data situations. To handle the model uncertainties, geostatistic methods and associated stochastic modeling attempts like the "Monte Carlo Simulation" will be mentioned.

14. Literature:
   - Hydrological Modeling:

15. Lehrveranstaltungen und -formen:
   - 501301 Lecture and exercise Hydrological Modeling
   - 501302 Lecture and exercise Integrated model systems for the groundwater management

16. Abschätzung Arbeitsaufwand: Sum: 180h

17. Prüfungsnummer/n und -name:
   - 50131 Integrated Watershed Modeling (PL), Schriftlich, 150 Min., Gewichtung: 1

18. Grundlage für ...

19. Medienform:

20. Angeboten von: Hydrologie und Geohydrologie
Modul: 50140 Modeling of Hydrosystems

2. Modulkürzel: 021420011
5. Moduldauer: Einsemestrig

3. Leistungspunkte: 6 LP
6. Turnus: Sommersemester

4. SWS: 5
7. Sprache: Englisch

8. Modulverantwortlicher: Univ.-Prof. Dr.-Ing. Rainer Helmig

9. Dozenten: Bernd Flemisch
Rainer Helmig

10. Zuordnung zum Curriculum in diesem Studiengang:
M.Sc. Water Resources Engineering and Management Chalmers Outgoing Double Degree, PO 913ChO2012,
➞ Wahlmodule
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
➞ Spezialisierungsmodule
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
➞ Zusatzmodule
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
➞ Vertiefungsmodule Wahlpflicht --> Vertiefungsmodule

11. Empfohlene Voraussetzungen:
Recommended background knowledge:
Higher Mathematics:
• Partial differential equations
• Numerical integration

Fundamentals of fluid mechanics:
• Conservation equations for mass, momentum, energy
• Mathematical descr

12. Lernziele:
Students can select suitable numerical methods for solving problems from fluid mechanics and have basic knowledge of implementing a numerical model in C.

13. Inhalt:
Discretisation methods:
• Knowledge of the common methods (finite differences, finite elements, finite volume) and the differences between them
• Advantages and disadvantages and of the methods and thus of their applicability
• Derivation of the various methods
• Use and choice of the correct boundary conditions for the various methods

Time discretisation:
• Knowledge of the various possibilities
• Assessment of stability, computational effort, precision
• Courant number, CFL criterion

Transport equation:
• Various discretisation possibilities
• Physical background
• Stability criteria of the methods (Peclet number)

Clarification of concepts: model, simulation
Application of the finite element method to the stationary groundwater equation Setting-up of a simulation programme for modeling groundwater:
• Programme requirements
• Programming individual routines

Fundamentals of programming in C:
• Control structures
• Functions
• Arrays
• Debugging

Visualisation of the simulation results

14. Literatur: Lecture notes: Modeling of Hydrosystems, Helmig

15. Lehrveranstaltungen und -formen: 501403 Lecture and Exercise Modeling of Hydrosystems 2, Applications
• 501401 Lecture and Exercise Modeling of Hydrosystems 1, Fundamentals

16. Abschätzung Arbeitsaufwand: Sum: 180h

17. Prüfungsnummer/n und -name: 50141 Modeling of Hydrosystems (PL), Schriftlich, 120 Min., Gewichtung: 1

18. Grundlage für ...

19. Medienform: Fundamentals will be developed using the blackboard and presentation tools. Group exercises help in understanding the obtained theoretical basis.

20. Angeboten von: Hydromechanik und Hydrosystemmodellierung
# Modul: 50150 Stochastical Modeling and Geostatistics

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<td>4. SWS:</td>
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<td>7. Sprache:</td>
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## 8. Modulverantwortlicher:
Univ.-Prof. Dr.-Ing. Dr. Andras Bardossy

## 9. Dozenten:
Andras Bardossy

## 10. Zuordnung zum Curriculum in diesem Studiengang:
- M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
  → Spezialisierungsmodul
- M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
  → Vertiefungsmodule Wahlpflicht --> Vertiefungsmodule
- M.Sc. Water Resources Engineering and Management Chalmers Outgoing Double Degree, PO 913ChO2012, 2. Semester
  → Wahlmodule
- M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
  → Zusatzmodule

## 11. Empfohlene Voraussetzungen:
Recommended background knowledge: Basic knowledge of statistics
Prerequisite module: none

## 12. Lernziele:
- **Concepts of Geostatistics:**
  Knowledge of the basic geostatistical concepts, difference between Kriging and simulation, advantages and disadvantages of the discussed methods, application of Kriging and simulation
- **Stochastical Modeling:**
  The participants have skills in basic statistical methods used in hydrology, like time series analysis, extreme value statistics, parameter estimation methods and statistical tests.

## 13. Inhalt:
- **Concepts of Geostatistics:**
  Geostatistical procedures for the interpolation of measured values, assessment of model parameters and planning of Measuring networks are dealt with.
  Contents:
  - Introduction
  - Statistical hypotheses: Basic concepts, Regionalized variables, Second order stationarity. Intrinsic hypothesis, Comparison of the two hypotheses, Selection of the regionalized variable
  - The variogram: The experimental variogram, The theoretical variogram, Variogram models, Variogram fitting, Isotropy -, anisotropy
  - Ordinary Kriging: Point kriging, Block kriging, Properties of ordinary kr., Kr.as an interpolator, Kr. and the variogram, Practice of kr.,Selection of the neighbourhood, Kr. with a "false" variogram, Cross validation, Kr. with uncertain data, Simple Kr.
  - Non stationary methods: Universal kr., Intrinsic random functions of order k, External-Drift-Kr.
  - Indicator Kriging: Indicator Kriging, Applications
  - Kriging with arbitrary additional information: Markov-Bayes-Kriging, Simple Updating (SU)
  - Time dependent variables

• Exercises

Stochastical Modeling:
The lecture part stochastic modeling is primarily concerned with the stochastic analysis of temporal and areal arrays, their generation and their use in the hydrological modeling. Calculation and analysis of hydrological data, descriptive statistic and their parameters, possibility analysis, correlation and regression, time series analysis and simulation.

Content:
• Univariate Statistics and multivariate Statistics (e.g. regression analysis)
• theory of probabilities
• random variables and probability functions (e.g. Poission distribution)
• estimation of parameters (e.g. Maximum Likelihood Method)
• statistical tests (e.g. Kolmogorov-Smirnov test)
• extreme value statistics (analysis of the frequency of occurrence of floods)
• time series analysis (e.g., ARMA Models)
• stochastic simulations (Monte-Carlo Methods)

14. Literatur:

Geostatistics:
Introduction to Geostatistics (Lecture notes, English)
Kitanidis, P. K (1997): Introduction to geostatistics: applications to hydrogeology
Armstrong, Margaret (1998): Basic linear geostatistics

Stochastical Modeling:

15. Lehrveranstaltungen und -formen:
• 501501 Lecture Concepts of Geostatistics
• 501502 Lecture and Exercise Stochastical Modeling

16. Abschätzung Arbeitsaufwand:
Sum:180h

17. Prüfungsnummer/n und -name:
50151 Stochastical Modeling and Geostatistics (PL), Schriftlich, 90 Min., Gewichtung: 1

18. Grundlage für ... :

19. Medienform:

20. Angeboten von:
Hydrologie und Geohydrologie
Modul: 50160 Applied GIS

2. Modulkürzel: 062300071
3. Leistungspunkte: 6 LP
4. SWS: 4
5. Modulduer: Einsemestrig
6. Turnus: Sommersemester
7. Sprache: Englisch
8. Modulverantwortlicher: Dr.-Ing. Li Zhang
10. Zuordnung zum Curriculum in diesem Studiengang:
    M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
    ➞ Spezialisierungsmodul
    M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
    ➞ Zusatzmodule
11. Empfohlene Voraussetzungen: Modul "Statistics and GIS"
12. Lernziele:
    The students are able to evaluate different data sources, to carry through basic data acquisition and integrate different data into field and office GIS. They are able to apply spatial analysis techniques to real world GIS problems in environmental and regional planning (GIS-based modeling, network-, raster- and 3D-analysis). The students have the expertise and ability to manage small-scale GIS projects (data mining, analysis design, output delivery) within the planning workflow, from project definition to product delivery.
13. Inhalt:
    GIS-based Data Acquisition
    Lecture:
    • introduction
    • GIS hard- and software for primary data acquisition
    • coordinate systems, geodetic datum and projections
    • coordinate transformations and conversions
    • terrestrial positioning and laser scanning
    • satellite-based positioning (GNSS)
    • overview of other acquisition methods
    • additional topics of mapping
    • data import from various sources (e.g. Web)
    • Web-GIS (e.g. Open Street Map)integration of data into GIS
    Exercises:
    • terrestrial and satellite-based data acquisition (field project)
    • integration of measured data into GIS (computer lab)
    • integration of web-data into GIS (computer lab)
    GIS in Environmental and Regional Planning
    Application cases:
    • land suitability analysis for urban development
    • accessibility of infrastructure facilities
    • Evaluation of soil functions
    • Urban Heat Island modelling
    • Biotope Networks and animal movement
    • Flood risk
    • Development capacity studies

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• Site analysis for wind power
• GIS-based E-government and community participation

Tools and methods:
• Model builder
• Spatial Analyst
• Network Analyst
• Map Algebra
• Neighbourhood Analysis
• Regression Modelling
• Multi Criteria Evaluation
• analysis design
• project management

Workflow:
• Geoprocessing,
• remote sensing data integration,
• advanced visual communication

14. Literatur:
GIS in Environmental and Regional Planning: ILIAS-Material, Exercise sheets, onlines-tutorial

15. Lehrveranstaltungen und -formen:
• 501604 Practical Training GIS in Environmental and Regional Planning
• 501601 Lecture GIS-based Data Acquisition
• 501602 Laboratory and Practical Training GIS-based Data Acquisition
• 501603 Lecture GIS in Environmental and Regional Planning

16. Abschätzung Arbeitsaufwand:
Summe: 180 h

17. Prüfungsnummer/n und -name:
50161 Applied GIS (PL), Schriftlich, 120 Min., Gewichtung: 1

18. Grundlage für ...

19. Medienform:

20. Angeboten von:
Ingenieurgeodäsie und Geodätische Messtechnik
### Modul: 50170 Environmental Fluid Mechanics II

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<td>5. Moduldauer:</td>
<td>Einsemestrig</td>
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<td>6. Turnus:</td>
<td>Sommersemester</td>
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<td>7. Sprache:</td>
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<tr>
<td>8. Modulverantwortlicher:</td>
<td>Univ.-Prof. Dr.-Ing. Rainer Helmig</td>
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<tr>
<td>9. Dozenten:</td>
<td>Wolfgang Nowak</td>
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<td></td>
<td>Rainer Helmig</td>
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<td>M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester Spezialisierungsmodul</td>
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<tr>
<td>11. Empfohlene Voraussetzungen:</td>
<td>Recommended background knowledge:</td>
</tr>
<tr>
<td></td>
<td>Mechanics of incompressible and compressible fluids, fundamentals of numerical methods in fluid mechanics, fundamentals of exchange and transport processes in technical and natural systems (e.g. groundwater and surface water, pipelines).</td>
</tr>
<tr>
<td></td>
<td>Contents of Environmental Fluid Mechanics I</td>
</tr>
<tr>
<td>12. Lernziele:</td>
<td>Students have the necessary grasp of hydrodynamic, physical and chemical processes and systems to be able to answer environmentally relevant questions concerning water and air quality in natural and technical systems.</td>
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<tr>
<td>13. Inhalt:</td>
<td>The lecture deals with the heat and mass budget of natural and technical systems. This includes transport processes in lakes, rivers and groundwater, heat and mass transfer processes between compartments as well as between various phases (sorption, dissolution), conversion of matter in aquatic systems and the quantitative description of these processes. In addition to classical single fluid phase systems, multiphase flow and transport processes in porous media will be considered. On the basis of a comparison of single- and multiphase flow systems, the various model concepts will be discussed and assessed. In the accompanying exercises, example problems present applications, extend the lecture material and help prepare for the exam. Computer exercises improve the grasp of the problems and give insight into the practical application of what has been learned.</td>
</tr>
<tr>
<td>14. Literatur:</td>
<td>Lecture notes: Fluidmechanics II, Helmig</td>
</tr>
<tr>
<td>15. Lehrveranstaltungen und -formen:</td>
<td>• 501701 Lecture and Excercise Environmental Fluid Mechanics II</td>
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<td>16. Abschätzung Arbeitsaufwand:</td>
<td>Sum: 180h</td>
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<td>17. Prüfungsnummer/n und -name:</td>
<td>50171 Environmental Fluid Mechanics II (PL), Schriftlich, 120 Min., Gewichtung: 1</td>
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<td>18. Grundlage für ... :</td>
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</table>
19. Medienform: Fundamentals will be developed using the blackboard and presentation tools. Process understanding will be improved using movies and experiments. Small exercises will help to deepen the knowledge.

20. Angeboten von: Hydromechanik und Hydrosystemmodellierung
# Modul: 50180 Flood Control: Evaluation and Case Studies

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<td>3. Leistungspunkte:</td>
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<td>Sommersemester</td>
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<td>4. SWS:</td>
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<tr>
<td>8. Modulverantwortlicher:</td>
<td>Anne Weiß</td>
<td></td>
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<tr>
<td>11. Empfohlene Voraussetzungen:</td>
<td>none (BAU), advisable LWW_Wabau none (UMW), advisable LWW_Gew Recommended background: Hydraulic Structures (WAREM)</td>
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<td>12. Lernziele:</td>
<td>The students,</td>
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<td>• are aware of the fact that flood protection is an integral process, based on different components (e.g. technical flood protection measures, prevention)</td>
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<td></td>
<td>• know different strategies and examples of implementation for flood protection</td>
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<td>• know about different procedure used worldwide in flood protection management</td>
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<td>• know about the functionality of retention and protection structures: reservoirs, dams and dikesmodels</td>
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<td>• are able to apply their knowledge on strategical planning and first design of engineering problems related to flood protection</td>
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<td>13. Inhalt:</td>
<td>The module comprises the following topics:</td>
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<td></td>
<td>• Introduction to flood control and flood control projects around the world</td>
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<td>• Details on flood control projects and its evaluation based on world bank procedures.</td>
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<td></td>
<td>• Flood control hydrological and hydraulic procedures.</td>
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<td></td>
<td>• Procedures by US Army Corps of Engineers.</td>
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<td>• Flood control economics</td>
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<td>• World bank procedures and practice.</td>
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<td></td>
<td>• Tsunami</td>
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<td></td>
<td>• Occurrence, geophysics, different types of Tsunami. Case study on Aceh, Indonesia.</td>
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<td>• Three Gorges dam flood control project in China</td>
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<td>• The biggest flood control dam project explained in detail.</td>
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<td>• The SMART Tunnel, Malaysia</td>
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<td>• The biggest flood control tunnel and road way underground built for flood reduction and roadway. This mega project is fully operational.</td>
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<td></td>
<td>• Flood Control Projects in UK and Netherlands</td>
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<td></td>
<td>• Special Topics: Rainfall Harvesting, Invisible flood walls, Floating Breakwaters</td>
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- Hydrological Application in Flood Control
- HEC Models exercises for river surface profiles
- MIKE computer Modelling application.

<table>
<thead>
<tr>
<th>14. Literatur:</th>
<th>Lecture notes and exercise material can be downloaded from the internet. Hints are given for additional literature from the internet as well as libraries. Tucci, Carlos E. M.: Urban Flood Management, Peter Van Oosterom, Siyka Zlatanova, Elfriede M. Fendel: Geo-Information for Disaster Management</th>
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<tr>
<td>15. Lehrveranstaltungen und -formen:</td>
<td>• 501801 Lecture Flood Control: Evaluation and Case Studies</td>
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<td>16. Abschätzung Arbeitsaufwand:</td>
<td>90h</td>
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<td>17. Prüfungsnr/n und -name:</td>
<td>• 50181 Flood Control: Evaluation and Case Studies (BSL), Schriftlich, Gewichtung: 1</td>
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<td>• Vorleistung (USL-V), Schriftlich</td>
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<td>written exam</td>
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## Modul: 50190 Geohydrological Modelling I and II

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<td>Modulverantwortlicher:</td>
<td>Univ.-Prof. Dr.-Ing. Dr. Andras Bardossy</td>
</tr>
<tr>
<td>Dozenten:</td>
<td>Johannes Riegger</td>
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| Zuordnung zum Curriculum: | M.Sc. Water Resources Engineering and Management, PO 913-2012, Zusatzmodule → Wahlmodule  
M.Sc. Water Resources Engineering and Management Chalmers Outgoing Double Degree, PO 913ChO2012, 2. Semester → Wahlmodule  
M.Sc. Water Resources Engineering and Management Mara Outgoing Double Degree, PO 913MaO2012, 2. Semester → Wahlmodule |
| Empfohlene Voraussetzungen: | Contents of Geohydrology and Geoengineering |
| Lernziele:  | • Setup of a Geohydrological Model  
• Spatial and temporal Discretization (Stability Criteria)  
• Adequate Transfer of Nature into a Model  
• Simplification of complex Geohydrological Systems  
• Choice of adequate Numerical Scheme  
• Unique Calibration of Flow and Transport  
• Assessment of Geohydrological Model Approaches and Model Realizations |
| Literatur:  | Script: J. Riegger 'Geohydrological Modelling'  
Anderson und Woessner 'Applied Groundwater Modelling'  
Spitz und Moreno: 'A Practical Guide to Groundwater and Solute Transport Modeling'  
Freeze und Cherry: 'Groundwater' |
| Lehrveranstaltungen und -formen: | • 501901 Lecture Geohydrological Modelling 1  
• 501902 Lecture Geohydrological Modelling 2 |
| Abschätzung Arbeitsaufwand: | Sum: 180h |
| Prüfungsnummer/n und -name: | • 50191 Geohydrological Modelling I and II (PL), Schriftlich, 120 Min., Gewichtung: 1  
• 50192 Geohydrological Modelling I and II (USL), Gewichtung: 1 |

Stand: 02. April 2017
19. Medienform:

20. Angeboten von: Hydrologie und Geohydrologie
# Modul: 50200 Geohydrological Modelling III

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<td>4. SWS:</td>
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<td>7. Sprache:</td>
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| 8. Modulverantwortlicher: | Dr. Johannes Riegger |
| 9. Dozenten: | Johannes Riegger |


| 11. Empfohlene Voraussetzungen: | recommended background knowledge: Contents of Geohydrological Modelling I+II |


| 13. Inhalt: | Geohydrological Modelling III: Theory of heat conductance and advective heat transport in porous media in thermal non- / equilibrium, Dual porosity approach, Adaption of heat parameters for calculation with modflow and mt3d, Calculation of non equilibrium heat conductance and transport with dual porosity approach, Application examples: ground heat collector, geothermal energy probes, geothermal tests, hydrothermal configurations (monopol, dipole, multipol) and their application for heat extraction or storage |

| 14. Literatur: | Script: J. Riegger 'Geohydrological Modelling III' |

| 15. Lehrveranstaltungen und -formen: | • 502001 Lecture Geohydrological Modelling 3 |

| 16. Abschätzung Arbeitsaufwand: | Time of attendance: approx. 21 hours Private Study: approx. 69 hours during semester |

| 17. Prüfungsnummer/n und -name: | 50201 Geohydrological Modelling III (BSL), Schriftlich, Gewichtung: 1 |

| 18. Grundlage für ... : | |

| 19. Medienform: | |

| 20. Angeboten von: | Hydrologie und Geohydrologie |
Modul: 50210 Geohydrology and Geoengineering

2. Modulkürzel: 021430004
3. Leistungspunkte: 6 LP
4. SWS: 4
5. Moduldauer: Einsemestrig
6. Turnus: Sommersemester
8. Modulverantwortlicher: Univ.-Prof. Dr.-Ing. Christian Moormann
9. Dozenten: Christian Moormann

11. Empfohlene Voraussetzungen:
Recommended background knowledge:
Geoengineering: Basic knowledge of mechanics and groundwater flow
Geohydrology: Basic knowledge of groundwater hydraulics
Prerequisite module: none

12. Lernziele:
Geoengineering:
The students have the required skills to treat fundamental soil mechanics problems such as: groundwater flow, consolidation, slope stability, settlement and soil strength calculations.

Geohydrology:
The students have a strong foundation in the applied skills required to locate, analyse, assess, develop, and protect groundwater resources.

13. Inhalt:
Geoengineering:
This course includes information about the origin of soils and soil classification methods. It also includes the basics of groundwater flow as used in soil mechanics. Common geotechnical problems such as slope stability and soil consolidation are discussed and clarified. The stresses in soil, stiffness of soils and strength of soils are explained in details.

Geohydrology:
Covers the most important concepts of geology and hydrogeology, the interpretation of hydrogeological information from maps, aerial photographs, geophysical measurements and field data, the principles of groundwater development and the understanding of hydrogeological systems through case studies. A brief overview is given on the analysis of hydrochemical data and isotopes.

14. Literatur:
Geoengineering
Lecture notes can be downloaded from the Internet, PowerPoint presentations

Geohydrology:
Lecture notes can be downloaded from the Internet via the ILIAS system, PowerPoint presentations
Wichtig: mindestens ein konkreter Titel (Monographie, Artikel o.ä.) ist anzugeben

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<tr>
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<tbody>
<tr>
<td>• 502102 Lecture Geohydrology</td>
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<tr>
<td>• 502101 Lecture Geoengineering</td>
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<th>20. Angeboten von:</th>
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<tr>
<td>Geotechnik</td>
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</table>
Modul: 50220 Groundwater and Resources Management

2. Modulkürzel: 021420016
3. Leistungspunkte: 6 LP
4. SWS: 4
5. Moduldauer: Zweisemestrig
6. Turnus: Sommersemester
7. Sprache: Englisch
8. Modulverantwortlicher: Frieder Haakh
9. Dozenten: Frieder Haakh
10. Zuordnung zum Curriculum in diesem Studiengang:
    - M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
      ➞ Spezialisierungsmodule
    - M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
      ➞ Zusatzmodule
11. Empfohlene Voraussetzungen: Recommended background knowledge:
    - Technical Mechanics
    - Introduction to the mechanics of incompressible fluids
    - Higher Mathematics
    - Partial differential equations
    - Fluid Mechanics
    - Groundwater flow, alllication of type-curves (Theis,...)
12. Lernziele: Students know how groundwater resources are monitored and made accessible and how they should be protected to ensure sustainability with regard to other stakeholders within the catchment area.
    Qualification to start working in a water supply company or in the administration (dep. Water resources management) or consulting engineers.
13. Inhalt: Methods commonly used in practice for monitoring and exploring groundwater as well as making it accessible are presented. The contents are:
    - Function and operation of monitoring wells
    - Examples of bore hole geophysics
    - Monitoring networks, operation and optimisation
    - Building and operation of extraction wells (or well systems)
    - Vertical wells
    - Syphoning systems for water abstraction
    - Pumping tests (design, interpretation)
    - Conservation of evidence of impacts in environment (case study)
    - Practical application of numerical models for solving water management questions (case studies)
    - Environmental impact assessment for a groundwater extraction (case study)
    - Groundwater protection
    - Protection goals
    - Threats to groundwater
    - Water protection zones (purpose and demarcation)
    - Water pollution control and agriculture in water-supply areas
    - System analysis concerning groundwater management
    - Extraction optimisation taking the interests of the various stakeholders into account

14. Literatur: Lecture notes by F. Haakh
Script (compendium) "Grundwassererschließung und Grundwasserschutz" (about 375 pages)  
"Practical aspects of groundwater resources management" (about 275 pages)  
Exercises (via Mail)

15. Lehrveranstaltungen und -formen:
• 502202 Seminar practical aspects of groundwater resources management for drinking water supply  
• 502201 Lecture Grundwassererschließung und Grundwasserschutz

16. Abschätzung Arbeitsaufwand:
Sum: 180h

17. Prüfungsnummer/n und -name:
• 50221 Grundwassererschließung und Grundwasserschutz (BSL), Schriftlich, 120 Min., Gewichtung: 1  
• 50222 Practical Aspects of Groundwater Resources Management (BSL), Schriftlich, 120 Min., Gewichtung: 1

18. Grundlage für ... :

19. Medienform:

20. Angeboten von: Bau- und Umweltingenieurwissenschaften
Modul: 50230 Hydrogeological Investigations

2. Modulkürzel: 021430008
3. Leistungspunkte: 6 LP
4. SWS: 4
5. Modulsdauer: Einsemestrig
6. Turnus: Sommersemester
7. Sprache: Deutsch
8. Modulverantwortlicher: Univ.-Prof. Dr.-Ing. Dr. Andras Bardossy
9. Dozenten: Johannes Riegger, Jochen Seidel
10. Zuordnung zum Curriculum in diesem Studiengang:
   M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
   ➞ Spezialisierungsmodule
   M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
   ➞ Zusatzmodule
   M.Sc. Water Resources Engineering and Management Chalmers Outgoing Double Degree, PO 913ChO2012, 2. Semester
   ➞ Wahlmodule
11. Empfohlene Voraussetzungen:
    Recommended background knowledge:
    Hydrology, Hydrogeology, Fluid Mechanics
12. Lernziele:
    Field Course Hydrogeology:
    The students know the most common field investigations used in groundwater. This includes the relevant theoretical basics on groundwater hydraulics, hydrogeology and field methods. When applying theoretical knowledge on practical problems, the participants are able to recognise critical points and develop appropriate solutions.

    Pumping Test Analysis
    The participants know the basic theories to analyse pumping tests and are able to use computer based methods like Spreadsheet Calculations for Analysis like Theis, Cooper-Jacob, Diagnostic Plots, Inverse Normalized Diagnostics, Recognition of Inner / Outer Boundaries, Heterogeneity, Well Effects and Handling of noise and trends.

13. Inhalt:
    Field Course Hydrogeology:
    In the field:
    • Soil Sampling / Drilling
    • Surveying / Levelling
    • Piezometric Heads / Potentiometric Surfaces
    • Pumping Test - Recovery Test
    • Piezometer test / Slug test
    • Tracer Test
    • Geophysical Borehole measurements / Natural groundwater velocity
    • Groundwater Chemistry
    • Hydrogeological Site Assessment

    In the lab:
    • Column Experiments to Determine the Hydrodynamic Dispersion Coefficient and the Hydraulic Conductivity
    • Particle-Size Distribution and Soil Characterisation
• Rocks: Definitions, Characterisation, Classification, Genesis, Hydraulic Properties

In the classroom:
• Theoretical background of the methods applied in the field and in the laboratory (see above)

**Pumping Test Analysis**:
Basic theory and computer exercises to evaluate and analyse the pumping tests.
Analytical techniques, Diagnostic Plots, stationary / transient conditions, interior / outer boundary conditions, step-drawdown tests and Well Performance Tests, spatial distribution of parameters, regional parameters, effective parameters

14. Literatur:

**Field Course Hydrogeology:**
Lecture Notes: Barthel/Seidel Field Course Hydrogeology

**Pumping Test Analysis**
Script: J. Riegger 'Pumping Test Analysis'
Kruseman und de Ridder: 'Analysis and Evaluation of Pumping Test Data'

15. Lehrveranstaltungen und -formen:
• 502301 Lecture Field Course Hydrology
• 502302 Lecture Pumping Test Analysis

16. Abschätzung Arbeitsaufwand:
Sum 180h

17. Prüfungsnummer/n und -name:
50231 Hydrogeological Investigations (PL), Schriftlich, 120 Min., Gewichtung: 1

18. Grundlage für ...

19. Medienform:

20. Angeboten von:
Hydrologie und Geohydrologie
### Modul: 50240 Independent Study

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<td>Anne Weiß</td>
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<td>11. Empfohlene Voraussetzungen:</td>
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<tr>
<td>12. Lernziele:</td>
<td>The student is able to independently solve a problem in a specific discipline of study. The project involves solving a broader range of interdisciplinary tasks for a given problem. The student is able to present his work in a condensed way within a scientific presentation.</td>
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<td>13. Inhalt:</td>
<td>Literature or web research on a water-related topic or task Independent scientific work to gain results for the given task Analysis, Interpretation and report writing Preperation of a presentation Giving presentation and defending results in discussion</td>
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<td>14. Literatur:</td>
<td>depends on chosen subject</td>
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<td>15. Lehrveranstaltungen und -formen:</td>
<td>• 502401 Lecture Independent Study</td>
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<td>• 50241 Independent Study (PL), Schriftlich, Gewichtung: 1</td>
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<td>Water Resources Engineering and Management (WAREM)</td>
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Modul: 50260 Measurements in the Watercycle

2. Modulkürzel: 040401001
5. Moduldauer: Einsemestrig

3. Leistungspunkte: 6 LP
6. Turnus: Sommersemester

4. SWS: 4
7. Sprache: Englisch

8. Modulverantwortlicher: Univ.-Prof. Dr. Johan Alexander Huisman

9. Dozenten: Jochen Seidel
Johan Alexander Huisman
Rudolf Widmer-Schnidrig

10. Zuordnung zum Curriculum in diesem Studiengang:
M.Sc. Water Resources Engineering and Management Chalmers
Outgoing Double Degree, PO 913ChO2012,
→ Wahlmodule
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
→ Spezialisierungsmodule
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
→ Zusatzmodule

11. Empfohlene Voraussetzungen:
Recommended background knowledge:
(I) Basic knowledge in Hydromechanics/Hydraulics corresponding to a lecture with approx. 6-8 ECTS
(II) Basic physics of electricity and wave propagation

12. Lernziele:
The relevant principles of key measurement methodologies used to characterize the water cycle will be introduced and discussed so that the students can assess the advantages and disadvantages of the available measurements methodologies. In addition, the students will be sensitized for potential sources of error and uncertainty of measurements.

13. Inhalt:
(I) Measuring surface hydrological fluxes
• Precipitation measurements
• Evaporation and evapotranspiration measurements
• Discharge measurements
• Water quality measurements

(II) Measuring subsurface hydrological fluxes
• Infiltration measurements
• Water potential measurements
• Physical principles of water content measurements
• Electromagnetic methods (TDR, GPR, Remote sensing)
• Electrical methods (ERT, SP, SIP)

14. Literatur:

15. Lehrveranstaltungen und -formen:
• 502601 Lecture Hydrometry and Remote Sensing
• 502602 Lecture Hydrogeophysics

16. Abschätzung Arbeitsaufwand:
Sum 180h
<table>
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<th>17. Prüfungsnummer/n und -name:</th>
<th>50261 Measurements in the Watercycle (BSL), Schriftlich oder Mündlich, 120 Min., Gewichtung: 1</th>
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<td>20. Angeboten von:</td>
<td>Hydrogeophysik</td>
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Modul: 50280 Multiphase Modeling in Porous Media

2. Modulkürzel: 021420014
5. Moduldauer: Einsemestrig
3. Leistungspunkte: 6 LP
6. Turnus: Sommersemester
4. SWS: 5
7. Sprache: Englisch

8. Modulverantwortlicher: apl. Prof. Dr.-Ing. Holger Class
9. Dozenten: Holger Class
Rainer Helmig

10. Zuordnung zum Curriculum in diesem Studiengang:
➞ Spezialisierungsmodul
➞ Zusatzmodule

11. Empfohlene Voraussetzungen:
Theory of multiphase systems in porous media:
• Phases / components
• Capillary pressure
• Relative permeability

Contents of Environmental Fluid Mechanics I

12. Lernziele:
Students have the basic theoretical and numerical knowledge to model multiphase systems in porous media. Furthermore, they have basic skills to practically work with numerical software, programming languages, etc.

13. Inhalt:
Using complex models in engineering practice requires well-founded knowledge of the characteristics of discretisation techniques as well as of the capabilities and limitations of numerical models, taking into account the respective concepts implemented and the underlying model assumptions. The contents are:
Theory of multiphase flow in porous media
• Derivation of the differential equations
• Constitutive relations

Numerical solution of the multiphase flow equation
• Box method
• Linearisation
• Time discretisation

Multicomponent systems
• Thermodynamic fundamentals and non-isothermal processes

Application examples:
• Thermal remediation techniques
• CO2 storage in geological formations
• Water / oxygen transport in gas diffusion layers of fuel cells
• Freshwater / saltwater interaction

14. Literatur:
Lecture notes: Multiphase Modeling, Class
15. Lehrveranstaltungen und -formen:
- 502801 Lecture Multiphase Modeling in Porous Media
- 502802 Excercise Multiphase Modeling in Porous Media

16. Abschätzung Arbeitsaufwand:
Lectures: 55 h
Self-study: 125 h
Total: 180 h

17. Prüfungsnummer/n und -name:
50281 Multiphase Modeling in Porous Media (PL), Schriftlich, 120 Min., Gewichtung: 1

19. Medienform:
Fundamentals will be developed using the blackboard and presentation tools. Group exercises help in understanding the obtained theoretical basis. Practical computer exercises for different problems are carried out with the help of an interactive multi-media system.

20. Angeboten von:
Hydromechanik und Hydrosystemmodellierung
Modul: 50290 Numerical Methods for Differential Equations

2. Modulkürzel: 080310506
5. Moduldauer: Einsemestrig

3. Leistungspunkte: 6 LP
6. Turnus: Sommersemester

4. SWS: 3
7. Sprache: Englisch

8. Modulverantwortlicher: Univ.-Prof. Dr. Kunibert Gregor Siebert

9. Dozenten: Claus-Justus Heine

10. Zuordnung zum Curriculum in diesem Studiengang:
M.Sc. Water Resources Engineering and Management, PO 913-2012, → Zusatzmodule
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester → Spezialisierungsmodul

11. Empfohlene Voraussetzungen:

12. Lernziele:
• basic knowledge about the theory of ordinary and/or partial differential equations
• overview about numerical solution methods for these problems
• ability to link a given problem and the appropriate method
• ability to program solution methods in MATLAB

13. Inhalt:
In the first part of the semester, we will discuss algorithms for the numerical integration of ordinary differential equations (ODEs). In the second part, an introduction to partial differential equations (PDEs) and its solution by the use of the Finite Element (FE) method will be given. While the lecture focuses on the treatment of the required mathematical theory, the tutorial will place emphasis on the implementation of the developed schemes within the Matlab programming environment.

14. Literatur:
Stoer, Bulirsch: Introduction to numerical Analysis

15. Lehrveranstaltungen und -formen:
• 502901 Lecture Numerical Methods for Differential Equations
• 502902 Tutorial Numerical Methods for Differential Equations

16. Abschätzung Arbeitsaufwand:
Time of attendance: approx. 33=21(L)+12(T) hours
Private Study: approx. 70 hours
Preparation of exercises: 33 hours
Coding: approx 40 hours

17. Prüfungsnummer/n und -name:
50291 Numerical Methods for Differential Equations (PL), Schriftlich, Gewichtung: 1

18. Grundlage für ... :

19. Medienform:

20. Angeboten von: Angewandte Mathematik/Numerik für Höchstleistungsrechner
Modul: 50300 Planning and Design of Water Supply Facilities

2. Modulkürzel: 021210052
5. Modulduer: Einsemestrig

3. Leistungspunkte: 6 LP
6. Turnus: Sommersemester

4. SWS: 4
7. Sprache: Englisch

8. Modulverantwortlicher: Ralf Minke

9. Dozenten: Ralf Minke

10. Zuordnung zum Curriculum in diesem Studiengang:
M.Sc. Water Resources Engineering and Management, PO 913-2012,
➞ Zusatzmodule
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
➞ Spezialisierungsmodu

11. Empfohlene Voraussetzungen:
Knowledge in Sanitary Engineering, Water Supply and Hydraulics Contents of Water and Power Supply

12. Lernziele:
The students,

• Are able to plan and design centralised water supply systems as a part of rural and urban infrastructure.
• Are able to calculate dimensions of all elements of centralised water supply systems.
• Are able to calculate costs of all elements of centralised water supply systems.
• have an idea of the relations between water, politics, social changes and influences on environment and on planning process.
• Are able to design in detail all elements of centralised water supply systems.

13. Inhalt:

• Planning process as function of topographical, economical, social, environmental boundaries.
• Water demand calculation: water consumption, water demand, consumer groups, losses, forecasting, design periods.
• Water collection: Selection of source, groundwater withdrawal, springwater tapping, surface water intakes, rainwater harvesting, seawater desalination, recycling of treated sewage, drinking water protection areas, details of planning and design.
• Water transmission and distribution: necessity, hydraulic basics, dimensioning and calculation of branched and closed loop systems, details of planning and design.
• Pumps and pumping stations: necessity, types, hydraulics for pumping design, pumping stations and pressure boosters, details of planning and design.
• Water storage: necessity, types and functions of tanks, water towers and reservoirs, details of planning and design.
• Cost calculation: Cost functions for different facilities, Calculation process, calculation of water tariff.

14. Literatur:
Lecture notes can be downloaded from the internet.
Hints are given for additional literature from the internet as well as libraries.

### 15. Lehrveranstaltungen und -formen:
- 503001 Lecture Planning and design of water supply facilities
- 503003 Excursion to planning area and water supply company
- 503002 Case Study Planning and design of water supply facilities

### 16. Abschätzung Arbeitsaufwand:
Sum 180h

### 17. Prüfungsnummer/n und -name:
50301 Planning and Design of Water Supply Facilities (PL), Schriftlich, Gewichtung: 1

### 18. Grundlage für ...

### 19. Medienform:

### 20. Angeboten von:
Siedlungswasserbau und Wassergütestwirtschaft
### Modul: 50320 Project Preparation, Management and Finance

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<td>8. Modulverantwortlicher:</td>
<td>Anne Weiβ</td>
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<td>9. Dozenten:</td>
<td>Andreas Hutarew</td>
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<tr>
<td>11. Empfohlene Voraussetzungen:</td>
<td>Recommended background knowledge: Basics in environmental, engineering, hydraulic structures, finance and legal administration instruments</td>
</tr>
<tr>
<td>12. Lernziele:</td>
<td>Student is able to follow up necessary legal and administrative procedures. He understands the relation and communication necessities between the concerned faculties, parties and interest in a project. Student is able to rule the process of carrying out the project during the stages approval, financing execution and final operation</td>
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<tr>
<td>13. Inhalt:</td>
<td>PROJECT PREPARATION, MANAGEMENT AND FINANCE: Design criteria techno-financial - Legal procedures and clearances. Influencing aspects and basic needs and techniques in project preparation Civil - Steel structures - Mechanical - Electrical - Communication Feasibility - Detailed Project report - Execution design Interaction - Management - Start up - Acceptance approvals Onsite performance - Environmental management - Groundwater relevance Relationship Authorities - Owner - Suppliers - consultant - Financing institutions Operation - Lab diagnostics - Applied computing Conflict and dispute management techniques DEALING WITH WATER ENDANGERING SUBSTANCES: Why do we need a principle of concern? Legal background procedures and clearances. Influencing aspects and basic needs and techniques in environmental hazard Preventive civil and communication solutions Interaction - Management - Documentation - Acceptance approvals Onsite performance - Environmental, groundwater, soil and air relevance Relationship Authorities - operator - advisor - authorization principles Conflict and dispute management sequences PRACTICAL WORK, Dr. Andreas Hutarew PPaM und VAws Selection of ongoing project sites, used for teaching Project locations PPaM und VAws: Hydro power stations Rottenburg / Neckar Nuclear power station Phillipsburg / Rhein Pumping station</td>
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</table>
HEP Kostheim / Main
Hydro power stations Altenburg / Neckar
Lectures take partly place on projects sites and will last till early evening

14. Literatur: Script, e-learning Programs

15. Lehrveranstaltungen und -formen:
- 503201 Lecture PPaM
- 503202 Lecture VAwS
- 503203 Excursion

16. Abschätzung Arbeitsaufwand: Sum 180 h

17. Prüfungsnummer/n und -name: 50321 Project Preparation, Management and Finance (PL), Schriftlich, 120 Min., Gewichtung: 1

18. Grundlage für ... :

19. Medienform:

20. Angeboten von: Wasser- und Umweltsystemmodellierung
## Modul: 50330 Regional and Urban Planning I

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<td>Einsemestrig</td>
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<td>Wintersemester</td>
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<td>7. Sprache:</td>
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| 8. Modulverantwortlicher: | Univ.-Prof. Dr.-Ing. Jörn Birkmann |
| 9. Dozenten: | Jörn Birkmann, Astrid Ley |

### 10. Zuordnung zum Curriculum in diesem Studiengang:
- M.Sc. Water Resources Engineering and Management Chalmers Outgoing Double Degree, PO 913ChO2012, 1. Semester
  - Wahlmodule
- M.Sc. Water Resources Engineering and Management, PO 913-2012, 1. Semester
  - Zusatzmodule
- M.Sc. Water Resources Engineering and Management, PO 913-2012, 1. Semester
  - Spezialisierungsmodule
- M.Sc. Water Resources Engineering and Management Mara Outgoing Double Degree, PO 913MaO2012, 1. Semester
  - Wahlmodule

### 11. Empfohlene Voraussetzungen:

### 12. Lernziele:
The students understand the major challenges, objectives, strategies and instruments in spatial planning and urban development in Europe as well as in developing and countries in transition. The students are acquainted with the legal framework of comprehensive and sector planning and know the capabilities and limits of public planning as "positive" and "negative" planning.

### 13. Inhalt:
The course Regional Planning I covers the following topics:
- International Planning studies
- Overview on current planning issues
- Basic Terms of Spatial Planning
- Strategies in Spatial Planning
- Instruments of Spatial Planning
- Performance of Plans, Assessing Plans

The course Urban Planning I provides an overview on the origin of planned urban development, starting in Greece and the Roman Empire, passing through all important periods up to the 21st century. The second part introduces urbanisation processes in third world countries, planned and unplanned urban conglomerations, including Mega Cities and Global Cities.

### 14. Literatur:
- Birkmann et al. (2010): Adaptive urban governance: nes challenges for the second generation of urban adaptation studies to climate change In: Sustanability science 5

### 15. Lehrveranstaltungen und -formen:
- 503301 Lecture Regional Planning I
- 503302 Lecture Urban Planning I

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Stand: 02. April 2017
16. Abschätzung Arbeitsaufwand:  
Time of attendance: approx. 45 hours  
Private Study: approx. 135 hours

17. Prüfungsnummer/n und -name:  
50331  Regional and Urban Planning I (LBP), Schriftlich, 120 Min.,  
Gewichtung: 1

18. Grundlage für ... :  

19. Medienform:  

20. Angeboten von:  
Raumentwicklungs- und Umweltplanung
Modul: 50340 Regional and Urban Planning III

2. Modulkürzel: 021100012  
3. Leistungspunkte: 6 LP  
4. SWS: 4  
5. Moduldauer: Einsemestrig  
6. Turnus: Sommersemester  
7. Sprache: Englisch

8. Modulverantwortlicher: Univ.-Prof. Dr.-Ing. Jörn Birkmann
9. Dozenten: Anette Gangler, Jörn Birkmann

10. Zuordnung zum Curriculum in diesem Studiengang:
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
➞ Spezialisierungsmodul
M.Sc. Water Resources Engineering and Management, PO 913-2012, 2. Semester
➞ Zusatzmodule

11. Empfohlene Voraussetzungen:

12. Lernziele: The students are able to analyze and present the development situation and problems or some specific topics related to the development of their own countries in a systematic way and to discuss development situations and problems or specific topics of other countries. They receive experience in analyzing, summarizing and presenting the aspects mentioned above in English language. The students are able to investigate housing standards and typologies and the housing demand and supply.

13. Inhalt: The course "Development Policy and Planning: A Seminar Conference" will be conducted as a series of (a) lectures, (b) consultations and (c) seminar meetings.
   a) Lectures provide an overview of development history and current issues concerning development policy and planning. Students will choose a topic of interest within this context and propose an agenda and outline for the self-study of this topic.
   b) Additional lectures on academic writing and presentation techniques as well as consultation hours will provide assistance for the preparation of a scientific paper on this topic.
   c) A conference program for seminar meetings will be set up for authors to present their work in smaller groups (plenary sessions). Students participating in a plenary session peer-review papers of presenters and participate in the discussion.

The first part of the seminar Housing introduces housing typologies in Europe and Middle East. In the second part, participants portray the housing situation of their home countries with respect to typology, supply and demand, self-help models and spontaneous settlement patterns.


15. Lehrveranstaltungen und -formen: • 503402 Seminar Housing
• 503401 Lecture Development Policy and Planning

16. Abschätzung Arbeitsaufwand: Sum 180h
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<tr>
<td>17. Prüfungsnummer/n und -name:</td>
<td>50341 Regional and Urban Planning III (PL), Schriftlich und Mündlich, Gewichtung: 1</td>
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<td>18. Grundlage für ...:</td>
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<td>19. Medienform:</td>
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<tr>
<td>20. Angeboten von:</td>
<td>Raumentwicklungs- und Umweltplanung</td>
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Modul: 50350 Water Resources and Irrigation - Planning Methods and Tools

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<td>4. SWS:</td>
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<td>7. Sprache:</td>
<td>Englisch</td>
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<tr>
<td>8. Modulverantwortlicher:</td>
<td>Dr.-Ing. Kristina Terheiden</td>
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<td>12. Lernziele:</td>
<td>Students know about crop water demand and supply, conservation of soil quality and, in this context, about decision making as well as planning and design processes.</td>
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Irrigation Issues (Terheiden):
Students have theoretical and practical background knowledge of irrigation and soil conservation issues.

Computer Applications in Water Engineering (Terheiden):
Students know how to apply computer programs related to irrigation- and river basin-management.

Multi Objective Decision Making in Water Resources Management (Seidel):
Students are able to apply various decision making methods and are able to use them for the appraisal of large projects such as irrigation schemes and/or river training works.

13. Inhalt:

Water Management and Irrigation Facilities:
- Water demand, scarcity and availability
- Assessment of crop water demand
- Irrigation facilities
- Health hazards of irrigation facilities
- Soil erosion and salinization

Computer Applications in Water Engineering:
Theory and application of computer programs such as
- SimResSedim: Water and sediment balance of reservoirs
- Sahel: Interaction between socio-economic human activities and water- and land-resources of the used area
- Wasim: Water and salt balance in soils
- Wepp: Water Erosion of crop- and natural land
- Cropwat: Crop water requirements and irrigation scheduling
- Hec-Ras, Mike11, Hydro_As 2D: One- and two-dimensional hydrodynamic modeling of river systems

Multi Objective Decision Making in Water Resources Management:
The use of evaluation and decision making methods in order to determine long term effects on planned actions will be addressed. Registration, quantification and evaluation of project alternatives using different methods and techniques are focused:

- Cost comparison method
- Linear Programming
- Multi Objective Decision Making methods, e.g. Composite Programming, ELECTRE, MCQA
- Case study using Composite Programming
- Introduction to Game Theory and Conflict Analysis

14. Literatur: Lecture notes to

- ‘Irrigation Issues’ authored by W. Marx
- 'Multi Objective Decision Making in Water Resources Management', authored by A. Bardossy, J. Seidel

will be provided on the e-learning Ilias-platform for downloading. Specific material will be distributed during lectures/exercises.

15. Lehrveranstaltungen und -formen:

- 503501 Lecture Water Management and Irrigation Facilities
- 503502 Lecture Computer Applications in Water Engineering
- 503503 Lecture Multi Objective Decision Making in Water Resources Management

16. Abschätzung Arbeitsaufwand: Sum 180h

17. Prüfungsnummer/n und -name: 50351 Water Resources and Irrigation - Planning Methods and Tools (PL), Schriftlich, 180 Min., Gewichtung: 1

18. Grundlage für ... :

19. Medienform:

20. Angeboten von: Wasserbau und Wassermengenwirtschaft
## Modul: 50520 Environmental Aspects

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<td>7. Sprache:</td>
<td>Englisch</td>
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<td>8. Modulverantwortlicher:</td>
<td>Dr. Hans-Georg Schwarz-von Raumer</td>
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<td>11. Empfohlene Voraussetzungen:</td>
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<tr>
<td>12. Lernziele:</td>
<td>The students have basic knowledge about basic environmental aspects in infrastructure planning concerning soils, species and biotopes, air quality and hydro systems. They know how to include environmental aspects in spatial planning and to assess environmental impacts of strategies and projects. They are aware and have gained skills in</td>
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<td>• ecological evaluation methods (e.g. land suitability) and</td>
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<td></td>
<td>• Environmental Impact Assessment</td>
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<td>The students have first experiences in project exercises.</td>
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<td>13. Inhalt:</td>
<td>A: Lecture &quot;Ecological aspects of infrastructure planning&quot; Introduction to the environment factors and goods: geological resources, species and biotopes, ecosystem functioning, Air quality, hydrosystems, impact of land use systems (especially agriculture and urbanisation, ecological landscape design.</td>
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<td>B: Seminar &quot;Environmental impact assessment&quot; In the seminar students have the task to prepare a presentation and a paper about:</td>
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<td>• Structuring and evaluation of environmental impacts of strategies and projects</td>
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<td></td>
<td>• Legislative aspects</td>
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<td></td>
<td>• Modelling and evaluation methods</td>
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<td></td>
<td>• Tools for impact modelling</td>
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<td>• Case study examples</td>
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<td>Alternatively the students work on case study exercises covering strategic regional and urban planning as well as road, housing, industrial, water, sports, tourism and other infrastructure projects</td>
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<td>14. Literatur:</td>
<td>Information will be provided during the lectures Additional material can be downloaded from ILIAS</td>
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<td>15. Lehrveranstaltungen und -formen:</td>
<td>• 505201 Vorlesung Ecological aspects of infrastructure planning</td>
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<td>• 505202 Seminar Environmental impact assessment</td>
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<td>16. Abschätzung Arbeitsaufwand:</td>
<td>Sum 204 h</td>
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| 17. Prüfungsnummer/n und -name:  | • 50521 Environmental Aspects (PL), Schriftlich, 120 Min., Gewichtung: 1  
|                                  | • V Vorleistung (USL-V), Schriftlich |
| 18. Grundlage für ...:          |          |
| 19. Medienform:                 |          |
| 20. Angeboten von:              | Landschaftsplanung und Ökologie |
**Modul: 50560 Project Planning and Financing**

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<td>4</td>
<td>7. Sprache:</td>
<td>Englisch</td>
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<tr>
<td>8. Modulverantwortlicher:</td>
<td>Elke Schneider</td>
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<td>9. Dozenten:</td>
<td>Klaus-Peter Pischke</td>
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10. Zuordnung zum Curriculum in diesem Studiengang:
- M.Sc. Water Resources Engineering and Management, PO 913-2012, ➔ Spezialisierungsmodul
- M.Sc. Water Resources Engineering and Management, PO 913-2012, ➔ Zusatzmodule
- M.Sc. Water Resources Engineering and Management Chalmers Incoming Double Degree, PO 913ChI2012, ➔ Semi-Compulsory Modules

11. Empfohlene Voraussetzungen:

12. Lernziele:

Students know critical phases of a typical project cycle, they know how to plan, appraise, and evaluate infrastructure projects from the economic and financial point of view, they know different measures to calculate the return of a project in order to evaluate its worth, they know pros and cons of different ways to finance and operate infrastructure projects, solving problems based on real world case studies enhances their ability to evaluate projects themselves or to assess project proposals (e.g. feasibility studies) prepared by consultants.

13. Inhalt:

A: Project Planning and Appraisal (SS)
- Comprehensive introduction into planning and appraisal of infrastructure projects
- Subject description
- the project cycle: major aspects of the different phases
- project planning
- LogFrame analysis as a project planning tool
- project appraisal (financial and economic analysis)
- evaluation of project alternatives
- case studies B: Project Financing, Implementation and Advanced Issues of Economic Analysis (WS)
- Comprehensive introduction into financing, implementation, monitoring and ex-post evaluation of infrastructure projects, selected issues of advanced economic analysis of projects
- Subject Description:
- external and internal sources of financing
- private sector participation for project financing and operation (BOT models)
- selected issues in project implementation (implementation consultant, terms of reference, bidding procedures, contract of goods and services) project supervision, monitoring and ex-post evaluation
- advanced issues of economic analysis of projects including case studies

14. Literatur:
- Script,
- Damodaran, Aswath: Corporate Finance -Theory and Practice
15. Lehrveranstaltungen und -formen:
   - 505601 Lecture A: Project Planning and Appraisal
   - 505602 Lecture B: Project Financing, Implementation and Final Evaluation

16. Abschätzung Arbeitsaufwand:
   Sum 180h Time of attendance: 56 h Private Study: 124 h Pos unit presence time self study project Sum 1 Lecture A 28,0 62,0 0,0 90,0 2 Lecture B 28,0 62,0 0,0 90,0 Sum: 180,0

17. Prüfungsnummer/n und -name:
   50561 Project Planning and Financing (PL), Schriftlich, 120 Min., Gewichtung: 1

18. Grundlage für ...

19. Medienform:
   Power Point Presentations, Black Board, Case Studies, Group Discussions

20. Angeboten von:
   Infrastructure Planning (MIP)
Modul: 50580 Methodological Aspects of Infrastructure Planning

| 2. Modulkürzel: | 021100013 |
| 3. Leistungspunkte: | 6 LP |
| 4. SWS: | 4 |
| 5. Modul: | 021100013 |
| 5. Modul: | Methodological Aspects of Infrastructure Planning |
| 6. Turnus: | Sommersemester |
| 6. Turnus: | 5. Moduldauer: |
| 7. Sprache: | Englisch |
| 8. Modulverantwortlicher: | Dr.-Ing. Richard Junesch |
| 9. Dozenten: | Marion Aschmann |
| 9. Dozenten: | Richard Junesch |
| 11. Empfohlene Voraussetzungen: | Basic notions of infrastructure planning |
| 12. Lernziele: | The students understand techniques for dealing with complex decision situations and gain insights in the decision-analysis process for both public and private decision-making with all related steps. Social aspects that may influence planning process or outcome will also be discussed. The students are acquainted with fundamental notions of demography as far as urban and regional planning is concerned. The students are able to apply basic methods of demographic analysis and forecasting. |
| 13. Inhalt: | The module consists of two courses: The lecture "Decision Analysis" will cover the following subjects: |
| 13. Inhalt: | • Elements of Decision Problems |
| 13. Inhalt: | • Structuring Decisions |
| 13. Inhalt: | • Generating Objectives and Hierarchies |
| 13. Inhalt: | • Generating Alternatives |
| 13. Inhalt: | • Decision Making with Multiple Objectives |
| 13. Inhalt: | • Risk and Uncertainty in Decision Situations |
| 13. Inhalt: | • Collective Decision Making |
| 13. Inhalt: | • Application to Infrastructure Planning |
| 13. Inhalt: | The course Demographic Analysis and Forecasting will provide an overview of the most frequently appearing issues of demographic analysis and forecasting. It will consist of three main parts: Fundamental notions of (applied) demography and some of the methodical/conceptual problems linked with these notions. Selected fundamental approaches to analysing and forecasting natural growth (or decline) of population, will be presented and discussed critically. Examples of such analyses and forecasts will be calculated. Migration, as the most critical and most important aspect of population development under regional aspects, will constitute the main topic of the third part. Basic methods of analysing and forecasting migration will be presented and discussed with regard to their application on concrete cases. |
| 14. Literatur: | Lecture notes, see http://www.ivr.uni-tuttgart.de/vwl/studium_und_lehre/sommer/Decision_Analysis.html as well as the literature listed (see website) |
15. Lehrveranstaltungen und -formen:
   • 505801 Lecture Decision Analysis
   • 505802 Lecture Demographic Analysis and Forecasting
   • 505803 Exercise Demographic Analysis and Forecasting

16. Abschätzung Arbeitsaufwand:
   Time of attendance: approx. 45 hours
   Private Study: approx. 135 hours

17. Prüfungsnummer/n und -name:
   50581 Methodological Aspects of Infrastructure Planning (PL),
   Schriftlich, 120 Min., Gewichtung: 1

18. Grundlage für ... :

19. Medienform:
   Presentations, Exercises with spreadshed calculations

20. Angeboten von:
   Raumentwicklungs- und Umweltplanung
Modul: 55860 Contaminated site remediation and investigation technologies

2. Modulkürzel: 021410903
5. Moduldauer: Einsemestrig
3. Leistungspunkte: 6 LP
6. Turnus: Wintersemester
4. SWS: 4
7. Sprache: Englisch

8. Modulverantwortlicher: Univ.-Prof. Dr. Johan Alexander Huisman
9. Dozenten: Johan Alexander Huisman

Jürgen Braun

10. Zuordnung zum Curriculum in diesem Studiengang:
M.Sc. Water Resources Engineering and Management, PO 913-2012,
→ Zusatzmodule
→ Spezialisierungsmodule

11. Empfohlene Voraussetzungen:
Recommended background knowledge:
Basic knowledge in Hydromechanics/Hydraulics/Multiphase flow corresponding to a lecture with approx. 6-8 ECTS
Recommended module: Measurements in the water cycle

12. Lernziele:
The relevant physical principles of subsurface remediation will be reviewed and key remediation technologies will be introduced and discussed. Non-invasive technologies for characterization and monitoring of contaminated sites will also be introduced and discussed. The overall aim is that students will be able to assess the advantages and disadvantages of the available remediation and measurement technologies.

13. Inhalt:
(I) Contaminated site remediation technologies
• Multi-phase flow considerations
• On/off site treatment
• Remediation technologies

(II) Non-invasive contaminated site investigations
• Introduction to site investigation
• Electromagnetic methods (TDR, GPR)
• Electrical methods (ERT, EMI, SIP)
• Direct-push methods
• Time-lapse monitoring with geophysics

14. Literatur:
(I) Selection of learning material for a range of remediation technologies (will be provided).
(II) Selection of learning material for a range of site investigation methods (will be provided). P. V. Sharma, Environmental and engineering geophysics, Cambridge Univ. Press, 1997.

15. Lehrveranstaltungen und -formen:
• 558601 Contaminated site remediation technologies, Lecture
• 558602 Non-invasive contaminated site investigations, Lecture

16. Abschätzung Arbeitsaufwand:
Lecture (I) 24,0
Lecture (II) 24,0
Seminar 8,0

17. Prüfungsnummer/n und -name:
• 55861 Contaminated site remediation and investigation technologies (PL), Schriftlich, 120 Min., Gewichtung: 1
• V Vorleistung (USL-V), Schriftlich und Mündlich
18. Grundlage für ...:

19. Medienform:

20. Angeboten von: Hydrogeophysik
Modul: 55950 Hydropower: Environmental Impacts, Mitigation measures and Ecohydraulic Investigations

2. Modulkürzel: Warem dezentral
5. Moduldauer: Zweisemestrig

3. Leistungspunkte: 3 LP
6. Turnus: Wintersemester

4. SWS: 2
7. Sprache: Englisch

8. Modulverantwortlicher: Anne Weiß
9. Dozenten: Martin Schletterer
Matthias Schneider

10. Zuordnung zum Curriculum in diesem Studiengang:
M.Sc. Water Resources Engineering and Management, PO 913-2012,
➞ Zusatzmodule
➞ Spezialisierungsmodul

11. Empfohlene Voraussetzungen:

12. Lernziele:
Students will know how river ecosystems are functioning. Understanding natural processes is the basis for the assessment of changes in riverine ecosystems and for the development of mitigation measures. They get the basic knowledge about macrozoobenthos and fish fauna, with a focus on the species used in the CASiMiR model. Students will also get familiar with legislation on European level (WFD) and its national implementation.

They can analyse ecological impacts of hydropower driven changes in river systems. They know about the approaches to link requirements of water organisms with hydraulics. They have the skills to translate sampling data into habitat requirement data needed for habitat simulations. They are able to use modeling tools to quantify modifications in the amount and quality of riverine habitats. They are able to do basic assessments of these modifications.

13. Inhalt:

**River ecosystems**
Introduction to limnology
Large Rivers: Volga und Danube
Macrozoobenthos: Biology, demands of indicator species
Fish: Biology, migration
Legislation: European WFD, implementation and targets

**Hydropower: Environmental Impacts and mitigation**
Types of HPPs
Ecological flow
"Fish ladders"
Approaches for the description of habitats
Fuzzy-rule based modelling
Minimum flow and methods for assessment
Attraction flow and hydraulic investigation of migration facilities

**Ecohydraulic Investigations**
Ecohydraulics and environmental hydraulics
Linkages between structural, hydraulic, and biological parameters
Hydronumeric modelling in low and average flow situations
Approaches for the description of habitats
Fuzzy-rule based modelling
Minimum flow and methods for assessment
Attraction flow and hydraulic investigation of migration facilities
Morphological enhancements and model based assessment

14. Literatur:
Allan J.D.: Stream Ecology - Structure and function of running waters
The Volga River: review on research history and synthesis of current knowledge, River Systems 19
Paul Kemp, Atle Harby, Ian Maddock, Paul J. Wood.
Ecohydraulics: An Integrated Approach
CASiMiR-Fish Handbook
CASiMiR-Benthos Handbook

15. Lehrveranstaltungen und -formen:
• 559501 Hydropower: Environmental Impacts, Mitigation measures and Ecohydraulic Investigations: lecture, exercises, seminar, excursion

16. Abschätzung Arbeitsaufwand:

17. Prüfungsnummer/n und -name: 55951 Hydropower: Environmental Impacts, Mitigation measures and Ecohydraulic Investigations (BSL), Schriftlich oder Mündlich, 120 Min., Gewichtung: 1

18. Grundlage für ...

19. Medienform:

20. Angeboten von: Wasser- und Umweltsystemmodellierung
Modul: 58100 Constructed wetlands for wastewater treatment

2. Modulkürzel: -
5. Modulsdauer: Einsemestrig
3. Leistungspunkte: 3 LP
6. Turnus: Wintersemester
4. SWS: 2
7. Sprache: Englisch

8. Modulverantwortlicher: Anne Weiß
9. Dozenten: Christos Akratos

10. Zuordnung zum Curriculum in diesem Studiengang:
   ➔ Spezialisierungsmodule
   ➔ Zusatzmodule

11. Empfohlene Voraussetzungen:
Chemistry and Biology for Engineers
Sanitary Engineering

12. Lernziele:
The goal of this course is to provide advanced knowledge of the processes and concepts of constructed wetlands systems to the students. They will get familiar with the existing scientific, technical, and economic practices of using constructed wetlands for wastewater and sewage sludge treatment. For this reason all late scientific developments concerning municipal industrial and agro-industrial wastewater treatment and sewage sludge treatment will be presented. At the end of the course the students will be able to:

- Understanding constructed wetlands' main mechanisms.
- Perform a rough design of constructed wetlands treating various wastewaters and sewage sludge

13. Inhalt:
Basic principles of constructed wetlands
- Attached growth treatment systems
- Constructed wetlands (basic principles, types, vegetation, porous media, etc)
- Pollutant removal mechanisms and kinetics (organic matter, nitrogen, phosphorus, heavy metals, suspended solids)
- Sewage sludge treatment (dewatering mechanisms, mineralization processes)

Design of constructed wetlands
- Constructed wetlands' design models (hydrodynamic and pollutant removal models)
- Determination of required constructed wetland area
- Sewage sludge treatment (sludge loading rates, duration of loading and resting periods)

Case studies
- Municipal wastewater treatment
- Agro-industrial wastewater treatment

Sewage sludge treatment
### 14. Literatur:
Kadlec, R.H., Wallace, S. *Treatment wetlands*, send ed. CRC Press Lecture notes

### 15. Lehrveranstaltungen und -formen:
- 581001 Vorlesung Design of constructed wetlands

### 16. Abschätzung Arbeitsaufwand:
90 h

### 17. Prüfungsnummer/n und -name:
58101 Constructed wetlands for wastewater treatment (BSL), Schriftlich, 120 Min., Gewichtung: 1

### 18. Grundlage für ... :

### 19. Medienform:

### 20. Angeboten von:
Water Resources Engineering and Management (WAREM)
Modul: 68060 Advanced Methods in Biofilm Research

2. Modulkürzel: 021410206
5. Modulduer: Einsemestrig
3. Leistungspunkte: 6 LP
6. Turnus: Sommersemester
4. SWS: 4
7. Sprache: Englisch
8. Modulverantwortlicher: Dr. Sabine-Ulrike Gerbersdorf
9. Dozenten: Sabine-Ulrike Gerbersdorf
10. Zuordnung zum Curriculum in diesem Studiengang:
    M.Sc. Water Resources Engineering and Management, PO 913-2012,
    ➞ Zusatzmodule
    M.Sc. Water Resources Engineering and Management, PO 913-2012,
    ➞ Spezialisierungsmodule
11. Empfohlene Voraussetzungen:
    • Basic experience in laboratory work as well as basic knowledge in ecology, microbiology, chemistry and physics
    • Basic knowledge in microscopy would be desirable
12. Lernziele:
    • The students acquire fundamental knowledge of biofilms (composition, main species, requirements, occurrence, functionality and ecosystem services)
    • The students deepen their ability to work analytical in the laboratory on the micro- and macroscale
    • The students broaden their portfolio of applied methods ranging from autoclaving to photometry
    • The students apply microbiological techniques in freshwater ecology
    • The students learn about the most common biological and chemical parameters concerning biofilm research but also beyond
    • The students are familiar with light microscopy and get first hands-on experience with electron microscopy
    • The students know techniques to determine biofilm topography
    • He/she can measure biofilm adhesion with electromagnets
13. Inhalt:
    • Growth of a monocultural biofilm (bacterial origin) (cultures, nutrient broth, autoclaving)
    • Growth of a natural highly diverse biofilm (preparing substrates, circulating freshwater from river in mini-flumes)
    • Monitoring of biomass/cell numbers and growth (bacteria: Ultrasound, Staining, Flow Cytometry, Microalgae: Chlorophyll a Extraction, Photometer)
    • Extracellular polymeric substrancen (EPS) : Extraction, Determination of sugar - and proteincontent in the matrix
    • Microscopy: Ligth-Microscopy to determine the most prominent species as well as address biofilm topography. Electron-Microscope to visualize various biofilm structures
    • Structure from Motion: Visualisation of three dimensional biofilm structures
    • Functionality of biofilm: Biostabilisation of sediments, measurements of the biofilm adhesion via MagPI (Magnetic Particle Induction)
    • Excursion to collect and observe biofilms in their natural habitat
More milestone publications (e.g. Reviews) will be recommended

15. Lehrveranstaltungen und -formen:  
• 680601 Vorlesung Fortgeschrittene Methoden in der Biofilm Forschung  
• 680602 Übung Fortgeschrittene Methoden in der Biofilm Forschung

16. Abschätzung Arbeitsaufwand:  
Lecture:  
Präsenzzeit/Presence: 14h  
Selbststudium/post-preparation: ca. 28h  
Summe: 42h  
Laboratory course:  
Präsenzzeit/Presence: 42h  
Selbststudium/post-preparation: ca. 96h  
Summe: 138 h

17. Prüfungsnummer/n und -name: 68061 Fortgeschrittene Methoden in der Biofilm Forschung (PL), Schriftlich, 90 Min., Gewichtung: 1

18. Grundlage für ... :

19. Medienform:

20. Angeboten von: Wasser- und Umweltsystemmodellierung
400 Deutschkurse

Zugeordnete Module: 19150 German as a Foreign Language
Modul: 19150 German as a Foreign Language

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<td>4. SWS:</td>
<td>8</td>
<td>7. Sprache:</td>
<td>Weitere Sprachen</td>
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<td>8. Modulverantwortlicher:</td>
<td>John Nixon</td>
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9. Dozenten:

10. Zuordnung zum Curriculum in diesem Studiengang:
M.Sc. Water Resources Engineering and Management Mara Outgoing Double Degree, PO 913MaO2012, 1. Semester
→ Pflichtmodule
M.Sc. Water Resources Engineering and Management, PO 913-2012, 1. Semester
→ Deutschkurse
M.Sc. Water Resources Engineering and Management Chalmers Outgoing Double Degree, PO 913ChO2012, 1. Semester
→ Pflichtmodule

11. Empfohlene Voraussetzungen:

12. Lernziele:

13. Inhalt:

14. Literatur:

15. Lehrveranstaltungen und -formen:

| 191501 Seminar German as a Foreign Language I |
| 191502 Seminar German as a Foreign Language II |

16. Abschätzung Arbeitsaufwand:

17. Prüfungsnummer/n und -name:

| 19151 German as a Foreign Language I (BSL), Schriftlich oder Mündlich, Gewichtung: 1 |
| 19152 German as a Foreign Language II (BSL), Schriftlich oder Mündlich, Gewichtung: 1 |

18. Grundlage für ...

19. Medienform:

20. Angeboten von: Infrastructure Planning (MIP)
Modul: 80990 Master's Thesis WAREM

2. Modulkürzel: -
5. Moduldauer: Einsemestrig

3. Leistungspunkte: 30 LP
6. Turnus: Wintersemester/
Sommersemester

4. SWS: 20
7. Sprache: Englisch

8. Modulverantwortlicher: Univ.-Prof. Dr. Silke Wieprecht

10. Zuordnung zum Curriculum in diesem Studiengang:
M.Sc. Water Resources Engineering and Management, PO 913-2012,
M.Sc. Water Resources Engineering and Management Mara Incoming Double Degree, PO 913Mal2012,
M.Sc. Water Resources Engineering and Management Chalmers Incoming Double Degree, PO 913Chl2012,

11. Empfohlene Voraussetzungen:
The topic of the Master Thesis can be handed out only the moment at least 78 credit points have been acquired already by the candidate. One month after 90 credit points have been acquired the candidate is supposed to start the work on his master thesis or to ask for the assignment of the topic at the latest.

12. Lernziele:
Capability to implement an independently composed project schedule for the treatment of a recent scientific problem in an international research environment.
Effective scientific work in a team, enforcement of strategies internally and particularly externally. Acquire the necessary stamina to not be discouraged by unexpected problems and throwbacks in scientific projects and to finally be successful by the formulation of alternative methods of resolution.
Multidisciplinarity through contacts with representatives of other fields like Chemistry, Mathematics, Informatics, etc.
Obtaining the capability to discuss the own results of research in the environment of the recent international research comprehensively and to represent them in written (Master's Thesis) and oral (talk) form.

13. Inhalt:
Treatment of a recent scientific problem in an international research environment.
The successful treatment of the scientific problem requires the specialisation in the related field of research and the acquisition of the necessary knowledge.

14. Literatur:
Recent literature on the topic of the scientific problem

15. Lehrveranstaltungen und -formen:

16. Abschätzung Arbeitsaufwand: 900 h (Contact time: 900 h)

17. Prüfungsnummer/n und -name:

18. Grundlage für ...

19. Medienform:

20. Angeboten von: Wasserbau und Wassermengenwirtschaft