



**Universität Stuttgart**

**Modulhandbuch**  
**Studiengang Master of Science Water**  
**Resources Engineering and Management**  
**Prüfungsordnung: 2012**

Wintersemester 2013/14  
Stand: 01. Oktober 2013

Universität Stuttgart  
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70174 Stuttgart

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## Qualifikationsziele

Die im Studiengang Water Resources Engineering and Management (WAREM) ausgebildeten Ingenieurinnen und Ingenieure

- 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 und 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.

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## 100 Vertiefungsmodule (51 LP)

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Zugeordnete Module:	110	Vertiefungsmodule Pflicht (21 LP)
	120	Vertiefungsmodule Wahlpflicht (30 LP)

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## 110 Vertiefungsmodule Pflicht (21 LP)

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Zugeordnete Module:    19120 Sanitary Engineering  
                              50090 Environmental Fluid Mechanics I  
                              50100 Hydraulic Structures  
                              50110 Requirements of Professional Life and Engineering in Practise

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## Modul: 50090 Environmental Fluid Mechanics I

2. Modulkürzel:	021420012	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	5.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Prof.Dr.-Ing. Rainer Helmig		
9. Dozenten:	<ul style="list-style-type: none"> <li>• Jürgen Braun</li> <li>• Holger Class</li> <li>• Wolfgang Nowak</li> </ul>		
10. Zuordnung zum Curriculum in diesem Studiengang:	<p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Chalmers</li> <li>→ Incoming</li> <li>→ Semi-Compulsory Modules</li> </ul> <p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Chalmers</li> <li>→ Outgoing</li> <li>→ Pflichtmodule</li> </ul> <p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Mara</li> <li>→ Incoming</li> <li>→ Compulsory Modules</li> </ul> <p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Mara</li> <li>→ Outgoing</li> <li>→ Pflichtmodule</li> </ul> <p>M.Sc. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Vertiefungsmodule (51 LP)</li> <li>→ Vertiefungsmodule Pflicht (21 LP)</li> </ul>		
11. Empfohlene Voraussetzungen:	<p>Technical Mechanics</p> <ul style="list-style-type: none"> <li>• Introduction to the statics of rigid bodies</li> <li>• Introduction to elastostatics</li> <li>• Introduction to the mechanics of incompressible fluids</li> </ul> <p>Higher Mathematics</p> <ul style="list-style-type: none"> <li>• Partial differential equations</li> <li>• Vector analysis</li> <li>• Numerical integration</li> </ul> <p>Fundamentals of Flow Mechanics</p> <ul style="list-style-type: none"> <li>• Conservation equations for mass, momentum, energy</li> <li>• Navier-Stokes, Euler, Reynolds, Bernoulli equation</li> </ul>		
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 characteisitics are explained. The contents are:

- Potential flow and groundwater flow
- Computational Fluid Dynamics
- Shallow water equations for surface water
- Charakteristikenmethode
- Examples from civil and environmental engineering

14. Literatur:	Lecture notes: Hydromechanics, Helmig and Class Lecture notes: Ausbreitungs- und Transportvorgänge in Strömungen, Cirpka White, F.M.: Fluid Mechanics, WCB/McGraw-Hill, New York, 1999 Freeze, R.A. and Cherry J.A.: Groundwater, Prentice Hall, 1979
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"> <li>• 500901 Lecture Environmental Fluid Mechanics I</li> <li>• 500902 Excersice Environmental Fluid Mechanics I</li> </ul>
16. Abschätzung Arbeitsaufwand:	Sum 180 h
17. Prüfungsnummer/n und -name:	
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

## Modul: 50100 Hydraulic Structures

2. Modulkürzel:	021410106	5. Moduldauer:	2 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Prof.Dr. Silke Wieprecht		
9. Dozenten:	<ul style="list-style-type: none"> <li>• Walter Marx</li> <li>• Silke Wieprecht</li> </ul>		
10. Zuordnung zum Curriculum in diesem Studiengang:	<p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Chalmers</li> <li>→ Incoming</li> <li>→ Semi-Compulsory Modules</li> </ul> <p>M.Sc. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Vertiefungsmodule (51 LP)</li> <li>→ Vertiefungsmodule Pflicht (21 LP)</li> </ul>		
11. Empfohlene Voraussetzungen:			
12. Lernziele:	<p>Advanced Studies in Hydraulic Structures: The students...</p> <ul style="list-style-type: none"> <li>• Know about the basic features of hydraulic structures</li> <li>• have an overview what are the main components and know how to arrange them in order to ensure a satisfying operation</li> <li>• are able to dimension all parts of different hydraulic structures</li> <li>• 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</li> <li>• are able to realize the economic and ecologic significance of hydraulic structures as dams, reservoirs and hydro power plants</li> </ul> <p>Case Study in Hydraulic Structures: The students...</p> <ul style="list-style-type: none"> <li>• are able to use of the gained theoretical knowledge with the help of a practical example</li> <li>• are aware of the technical relations and their effects on non-technical areas of interest</li> <li>• can give a well-founded argumentation of chosen estimations and are able to present their own results</li> <li>• can give a convincing presentation</li> <li>• are able to assess objectively different planning alternatives</li> </ul>		
13. Inhalt:	<p><b>Advanced Studies in Hydraulic Structures:</b> 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.</p> <p><b>Case Study in Hydraulic Structures:</b> The case study uses the content of the lecture „Advanced Studies in Hydraulic Structures“. In working groups of 3 to five students a real</p>		

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:	<ul style="list-style-type: none"> <li>• 501001 Lecture and Practice Advanced Studies in Hydraulic Structures</li> <li>• 501002 Lecture and Presentation Case Study in Hydraulic Structures,</li> </ul>
16. Abschätzung Arbeitsaufwand:	Sum 180h
17. Prüfungsnummer/n und -name:	
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

## Modul: 50110 Requirements of Professional Life and Engineering in Practise

2. Modulkürzel:	021410901	5. Moduldauer:	3 Semester
3. Leistungspunkte:	3.0 LP	6. Turnus:	jedes Semester
4. SWS:	2.0	7. Sprache:	Englisch

8. Modulverantwortlicher:

9. Dozenten:

10. Zuordnung zum Curriculum in diesem Studiengang:	DoubleM.D. Water Resources Engineering and Management, PO 2012 → Chalmers → Outgoing → Pflichtmodule  DoubleM.D. Water Resources Engineering and Management, PO 2012 → Mara → Outgoing → Pflichtmodule  M.Sc. Water Resources Engineering and Management, PO 2012 → Vertiefungsmodule (51 LP) → Vertiefungsmodule Pflicht (21 LP)
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11. Empfohlene Voraussetzungen:

12. Lernziele:	<ul style="list-style-type: none"> <li>• 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.</li> <li>• Ability to participate in a scientific discussion, asking questions to presenters.</li> <li>• Writing a summary of a visit at a technical site, condense information to a short report.</li> </ul>
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13. Inhalt:	<ul style="list-style-type: none"> <li>• Treatment of a water related topic or a recent scientific problem in an international research environment.</li> <li>• The successful treatment of the scientific problem requires the specialisation in the related field of research and the acquisition of the necessary knowledge.</li> </ul>
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14. Literatur:	Recent literature on the water related topic/ scientific problem,.
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15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"> <li>• 501101 Seminar Requirements of Professional Life and Engineering in Practise</li> <li>• 501102 Excursion Requirements of Professional Life and Engineering in Practise</li> </ul>
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16. Abschätzung Arbeitsaufwand:	90 h (Contact time: 70 h)
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17. Prüfungsnummer/n und -name:

18. Grundlage für ... :

19. Medienform:

20. Angeboten von:

## Modul: 19120 Sanitary Engineering

2. Modulkürzel:	021220012	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Dr.-Ing. Klaus Fischer		
9. Dozenten:	<ul style="list-style-type: none"> <li>• Klaus Fischer</li> <li>• Heidrun Steinmetz</li> </ul>		
10. Zuordnung zum Curriculum in diesem Studiengang:	<p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Chalmers</li> <li>→ Outgoing</li> <li>→ Pflichtmodule</li> </ul> <p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Mara</li> <li>→ Outgoing</li> <li>→ Pflichtmodule</li> </ul> <p>M.Sc. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Vertiefungsmodule (51 LP)</li> <li>→ Vertiefungsmodule Pflicht (21 LP)</li> </ul>		
11. Empfohlene Voraussetzungen:			
12. Lernziele:	<p>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.</p> <p>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.</p>		
13. Inhalt:	<p>Solid Waste Management:</p> <ul style="list-style-type: none"> <li>• Waste generation and waste composition</li> <li>• National and international regulations for waste</li> <li>• Waste avoidance</li> </ul>		

- 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:	<p>Lecture Manuscripts Solid Waste Management                  G. Tchobanoglous et. Al.: Handbook of solid waste management;                  Biliteski, B. et.al.: Waste Management, Springer 1994 ISBN:                  3-540-59210-5                  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</p>
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"> <li>• 191201 Vorlesung Solid Waste Management</li> <li>• 191202 Vorlesung Waste Water</li> <li>• 191203 Exkursion Sanitary Engineering</li> </ul>
16. Abschätzung Arbeitsaufwand:	<p>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</p>
17. Prüfungsnummer/n und -name:	<ul style="list-style-type: none"> <li>• 19121 Solid Waste Management and Waste Water Technology (PL),                  schriftliche Prüfung, 120 Min., Gewichtung: 1.0</li> <li>• V Vorleistung (USL-V), schriftlich, eventuell mündlich</li> </ul>
18. Grundlage für ... :	<ul style="list-style-type: none"> <li>• 19310 Urban Drainage and Design of Wastewater Treatment Plants</li> <li>• 19330 Industrial Waste Water</li> </ul>
19. Medienform:	
20. Angeboten von:	

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## 120 Vertiefungsmodule Wahlpflicht (30 LP)

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Zugeordnete Module:	15010	Integrated River Management and Engineering
	15160	Water and Power Supply
	19100	Chemistry and Biology for Environmental Engineers
	19310	Urban Drainage and Design of Wastewater Treatment Plants
	19360	Water Quality and Treatment
	50120	Environmental Informatics
	50130	Integrated Watershed Modeling
	50140	Modeling of Hydrosystems
	50150	Stochastical Modeling and Geostatistics

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## Modul: 19100 Chemistry and Biology for Environmental Engineers

2. Modulkürzel:	021230502	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	6.0	7. Sprache:	-
8. Modulverantwortlicher:		Univ.-Prof.Dr. Jörg Metzger	
9. Dozenten:		<ul style="list-style-type: none"> <li>• Jörg Metzger</li> <li>• Karl Heinrich Engesser</li> <li>• Brigitte Schwederski</li> <li>• Bertram Kuch</li> <li>• Daniel Dobslaw</li> </ul>	
10. Zuordnung zum Curriculum in diesem Studiengang:		<p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Chalmers</li> <li>→ Incoming</li> <li>→ Semi-Compulsory Modules</li> </ul> <p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Chalmers</li> <li>→ Outgoing</li> <li>→ Pflichtmodule</li> </ul> <p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Mara</li> <li>→ Incoming</li> <li>→ Elective Moduls</li> </ul> <p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Mara</li> <li>→ Outgoing</li> <li>→ Pflichtmodule</li> </ul> <p>M.Sc. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Spezialisierungsmodule (30-33 LP)</li> </ul> <p>M.Sc. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Vertiefungsmodule (51 LP)</li> <li>→ Vertiefungsmodule Wahlpflicht (30 LP)</li> </ul>	
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'.

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**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:	<ul style="list-style-type: none"> <li>• 191001 Lecture Inorganic chemistry</li> <li>• 191002 Lecture Organic chemistry</li> <li>• 191003 Lecture Biology and ecology of water, soil and air systems</li> <li>• 191004 Lecture Technical and medical microbiology for engineers</li> </ul>
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: 1.0
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: 50120 Environmental Informatics

2. Modulkürzel:	021430002	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Prof.Dr.-Ing. Andras Bardossy		
9. Dozenten:	Johannes Riegger		
10. Zuordnung zum Curriculum in diesem Studiengang:	<p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Chalmers</li> <li>→ Incoming</li> <li>→ Semi-Compulsory Modules</li> </ul> <p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Chalmers</li> <li>→ Outgoing</li> <li>→ Wahlmodule</li> </ul> <p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Mara</li> <li>→ Incoming</li> <li>→ Compulsory Modules</li> </ul> <p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Mara</li> <li>→ Outgoing</li> <li>→ Wahlmodule</li> </ul> <p>M.Sc. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Spezialisierungsmodule (30-33 LP)</li> </ul> <p>M.Sc. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Vertiefungsmodule (51 LP)</li> <li>→ Vertiefungsmodule Wahlpflicht (30 LP)</li> </ul>		
11. Empfohlene Voraussetzungen:			
12. Lernziele:	<p>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</p>		
13. Inhalt:	<p><b>Information Processing &amp; Environmental Data Management</b> (Excel &amp; Access): Environmental Database Design, Relational Database Management, Data Normalization, Data Security</p> <p><b>GIS Tools in Environmental Engineering (ArcGIS):</b> Basics of GIS, Data implementation, Spatial Structures and Attributes, Display of Environmental Information, Charts &amp; Diagrams, Digitization, Spatial and Logical Queries, Data Links, Geo-Referencing, Field Calculations</p>		
14. Literatur:	<p>Script: J. Riegger 'Environmental Informatics' User Handbooks for Excel, Access, ArcGIS <b>Getting to know ArcGIS Desktop ISBN: 9781589482609</b></p>		
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"> <li>• 501201 Lecture Environmental Data Management</li> <li>• 501202 Lecture GIS Tools in Environmental Engineering</li> </ul>		
16. Abschätzung Arbeitsaufwand:	Time of attendance: approx. 56 hours		

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Private Study: approx. 124 hours during semester

Sum: 180h

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17. Prüfungsnummer/n und -name:

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18. Grundlage für ... :

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19. Medienform:

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20. Angeboten von:

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## Modul: 15010 Integrated River Management and Engineering

2. Modulkürzel:	021410102	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	0.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Markus Noack		
9. Dozenten:	<ul style="list-style-type: none"> <li>• Silke Wieprecht</li> <li>• Markus Noack</li> </ul>		
10. Zuordnung zum Curriculum in diesem Studiengang:	<p>M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP)</p> <p>M.Sc. Water Resources Engineering and Management, PO 2012 → Vertiefungsmodule (51 LP) → Vertiefungsmodule Wahlpflicht (30 LP)</p>		
11. Empfohlene Voraussetzungen:	<p>none (BAU), advisable LWW_Wabau none (UMW), advisable LWW_Gew Hydraulic Structures (WAREM)</p>		
12. Lernziele:	<p><b>River Engineering and Sediment Management</b> The students...</p> <ul style="list-style-type: none"> <li>• are aware of rivers must be regarded and managed based on an integrated approach</li> <li>• know the basic concept of the European Water Framework Directive (WFD) and the German legal framework for river basin management</li> <li>• are able to analyze and estimate the consequences of the WFD based inventory for future management</li> <li>• are aware of sediment transport processes and of the complexity of the interactions and relations</li> <li>• recognize the possibilities and limitations of sediment managements strategies</li> </ul> <p><b>Integrated Flood Protection Measures</b> The students...</p> <ul style="list-style-type: none"> <li>• are aware of the fact that flood protection is an integral process, based on different components (e.g. technical flood protection measures, prevention)</li> <li>• 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</li> <li>• know 1-D and 2-D numerical hydro-dynamic models</li> <li>• are able to apply their knowledge on practical engineering problems related to flood protection</li> </ul>		
13. Inhalt:	<p>The module consists of two lectures: <b>River Engineering and Sediment Management</b></p> <ul style="list-style-type: none"> <li>• Basic approaches of river basin management (legal framework)</li> <li>• Systematics and results of basic inventory due to the WFD</li> <li>• Anthropogenic impacts on river basins</li> <li>• Origin of sediments and fundamental principles of transport</li> <li>• Sediment management measures on different scales</li> </ul>		

### 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:	<ul style="list-style-type: none"> <li>• 150101 Vorlesung River Engineering and Sediment Management</li> <li>• 150102 Vorlesung Integrated Flood Protection</li> <li>• 150103 Übung Integrated Flood Protection</li> </ul>
16. Abschätzung Arbeitsaufwand:	Time of attendance: 55 h Private study: 125 h
17. Prüfungsnummer/n und -name:	15011 Integrated River Management and Engineering (PL), schriftliche Prüfung, 150 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

## Modul: 50130 Integrated Watershed Modeling

2. Modulkürzel:	021430009	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Deutsch
8. Modulverantwortlicher:	Prof.Dr.-Ing. Andras Bardossy		
9. Dozenten:	<ul style="list-style-type: none"> <li>• Johannes Riegger</li> <li>• Andras Bardossy</li> </ul>		
10. Zuordnung zum Curriculum in diesem Studiengang:	<p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Chalmers</li> <li>→ Outgoing</li> <li>→ Wahlmodule</li> </ul> <p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Mara</li> <li>→ Outgoing</li> <li>→ Wahlmodule</li> </ul> <p>M.Sc. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Spezialisierungsmodule (30-33 LP)</li> </ul> <p>M.Sc. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Vertiefungsmodule (51 LP)</li> <li>→ Vertiefungsmodule Wahlpflicht (30 LP)</li> </ul>		
11. Empfohlene Voraussetzungen:	<p>Recommended background knowledge: Basic knowledge of hydrology and geohydrology</p> <p>Prerequisite module: none</p>		
12. Lernziele:	<p><b>Hydrological Modeling:</b> Construction of models for each part in the runoff process and how these models are used and integrated in different environment management systems.</p> <p><b>Integrated model systems for the groundwater management:</b> Design of hydrogeological databases, visualization of data, GIS-Operations for the groundwater and hydrological modeling, Geostatistic, stochastic modeling, Monte Carlo Methods.</p>		
13. Inhalt:	<p><b>Hydrological Modeling:</b> 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.</p> <p>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.</p>		

**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: Beven, K.J., 2000. Rainfall-Runoff Modelling: The Primer. Wiley, 360pp. Singh, V.P. (Ed.), 1995. Computer Models of Watershed Hydrology. Water Resource Publications, Littleton, Colorado, USA.
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"> <li>• 501301 Lecture and exercise Hydrological Modeling</li> <li>• 501302 Lecture and exercise Integrated model systems for the groundwater management</li> </ul>
16. Abschätzung Arbeitsaufwand:	Sum: 180h
17. Prüfungsnummer/n und -name:	
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

## Modul: 50140 Modeling of Hydrosystems

2. Modulkürzel:	021420011	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	5.0	7. Sprache:	Englisch
8. Modulverantwortlicher:		Prof.Dr.-Ing. Rainer Helmig	
9. Dozenten:		Bernd Flemisch	
10. Zuordnung zum Curriculum in diesem Studiengang:		M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP) M.Sc. Water Resources Engineering and Management, PO 2012 → Vertiefungsmodule (51 LP) → Vertiefungsmodule Wahlpflicht (30 LP)	
11. Empfohlene Voraussetzungen:		Recommended background knowledge: Higher Mathematics: <ul style="list-style-type: none"> <li>• Partial differential equations</li> <li>• Numerical integration</li> </ul> Fundamentals of fluid mechanics: <ul style="list-style-type: none"> <li>• Conservation equations for mass, momentum, energy</li> <li>• Mathematical descr</li> </ul>	
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: <ul style="list-style-type: none"> <li>• Knowledge of the common methods (finite differences, finite elements, finite volume) and the differences between them</li> <li>• Advantages and disadvantages and of the methods and thus of their applicability</li> <li>• Derivation of the various methods</li> <li>• Use and choice of the correct boundary conditions for the various methods</li> </ul> Time discretisation: <ul style="list-style-type: none"> <li>• Knowledge of the various possibilities</li> <li>• Assessment of stability, computational effort, precision</li> <li>• Courant number, CFL criterion</li> </ul> Transport equation: <ul style="list-style-type: none"> <li>• Various discretisation possibilities</li> <li>• Physical background</li> <li>• Stability criteria of the methods (Peclet number)</li> </ul> Choice of a grid Overview of discretisation techniques on the basis of the stationary groundwater equation: <ul style="list-style-type: none"> <li>• Finite differences</li> <li>• Finite volume (integral finite differences)</li> </ul>	

- Finite elements

Time discretisation on the basis of the instationary groundwater equation:

- explicit and implicit methods

Discretisation of the transport equation:

- Central difference methods
- Upwinding

Introduction to stability analysis, convergence

Clarification of concepts: model, simulation

Derivation of the finite element method

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 Helmig, R.: Multiphase Flow and Transport Processes in the Subsurface, Springer Verlag, 1997
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"> <li>• 501401 Lecture Modeling of Hydrosystems 1.Fundamentals,</li> <li>• 501402 Excercise Modeling of Hydrosystems 1.Fundamentals,</li> <li>• 501403 Lecture Modeling of Hydrosystems 2.Fundamentals,</li> <li>• 501404 Excercise Modeling of Hydrosystems 2.Fundamentals,</li> </ul>
16. Abschätzung Arbeitsaufwand:	Sum: 180h
17. Prüfungsnummer/n und -name:	
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

## Modul: 50150 Stochastic Modeling and Geostatistics

2. Modulkürzel:	021430003	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Deutsch
8. Modulverantwortlicher:	Prof.Dr.-Ing. Andras Bardossy		
9. Dozenten:	Andras Bardossy		
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP) M.Sc. Water Resources Engineering and Management, PO 2012 → Vertiefungsmodule (51 LP) → Vertiefungsmodule Wahlpflicht (30 LP)		
11. Empfohlene Voraussetzungen:	Recommended background knowledge: Basic knowledge of statistics Prerequisite module: none		
12. Lernziele:	<p><b>Concepts of Geostatistics:</b>          Knowledge of the basic geostatistical concepts, difference between Kriging and simulation, advantages and disadvantages of the discussed methods, application of Kriging and simulation</p> <p><b>Stochastic Modeling:</b>          The participants have skills in basic statistical methods used in hydrology, like time series analysis, extreme value statistics, parameter estimation methods and statistical tests.</p>		
13. Inhalt:	<p><b>Concepts of Geostatistics:</b>          Geostatistical procedures for the interpolation of measured values, assessment of model parameters and planning of Measuring networks are dealt with.          Contents:</p> <ul style="list-style-type: none"> <li>• Introduction</li> <li>• Statistical hypotheses: Basic concepts; Regionalized variables; Second order stationarity; Intrinsic hypothesis; Comparison of the two hypotheses; Selection of the regionalized variable</li> <li>• The variogram: The experimental variogram; The theoretical variogram; Variogram models; Variogram fitting; Isotropy — anisotropy</li> <li>• 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.</li> <li>• Non stationary methods: Universal kr.; Intrinsic random functions of order k; External-Drift-Kr.</li> <li>• Indicator Kriging: Indicator Kriging; Applications</li> <li>• Kriging with arbitrary additional information: Markov-Bayes-Kriging; Simple Updating (SU)</li> <li>• Time dependent variables</li> <li>• Simulations: Basic definitions; Monte Carlo; Turning Band; Unconditional simulation; Conditional simulation; Sequential Simulation; Simulation using Markov Chains; The Hastings Algorithm; Simulated annealing; Indicator Simulation; Truncated-Gaussian Simulation; Application of simulations</li> <li>• Exercises</li> </ul> <p><b>Stochastic Modeling:</b></p>		

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:**

Plate, E. 1994. Statistik und angewandte Wahrscheinlichkeitslehre für Bauingenieure. Berlin.  
 Bras, R. L. and Ignacio Rodriguez-Iturbe. 1993. Random Functions and Hydrology. Dover Publications, Inc. New York.  
 Hipel, K. W. and McLeod. A. I. 1994. Time Series Modeling of Water Resources and Environmental Systems. Elsevier. Amsterdam.  
 Chow, V.-E. 1964. Handbook of applied Hydrology. McGraw-Hill Book. Company. New York.  
 Maniak, U. 1997. Hydrologie und Wasserwirtschaft: Eine Einführung für Ingenieure. 4. überarb. und erw. Auflage. Springer. Berlin

15. Lehrveranstaltungen und -formen:

- 501501 Lecture Concepts of Geostatistics
- 501502 Lecture and Excercise Stochastical Modeling

16. Abschätzung Arbeitsaufwand:

Sum:180h

17. Prüfungsnummer/n und -name:

18. Grundlage für ... :

19. Medienform:

20. Angeboten von:

## Modul: 19310 Urban Drainage and Design of Wastewater Treatment Plants

2. Modulkürzel:	021210251	5. Moduldauer:	-
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	5.0	7. Sprache:	-
8. Modulverantwortlicher:			
9. Dozenten:			
10. Zuordnung zum Curriculum in diesem Studiengang:	DoubleM.D. Water Resources Engineering and Management, PO 2012 → Chalmers → Outgoing → Pflichtmodule  DoubleM.D. Water Resources Engineering and Management, PO 2012 → Mara → Outgoing → Pflichtmodule  M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP)  M.Sc. Water Resources Engineering and Management, PO 2012 → Vertiefungsmodule (51 LP) → Vertiefungsmodule Wahlpflicht (30 LP)		
11. Empfohlene Voraussetzungen:			
12. Lernziele:			
13. Inhalt:			
14. Literatur:			
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"> <li>• 193101 Vorlesung und Übung Design of Sewer System and Stormwater Treatment</li> <li>• 193102 Vorlesung und Übung Design of Wastewater Treatment Plants</li> <li>• 193103 Seminar Case Study</li> <li>• 193104 Exkursion</li> </ul>		
16. Abschätzung Arbeitsaufwand:			
17. Prüfungsnummer/n und -name:	19311 Urban Drainage and Design of Wastewater Treatment Plants (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0		
18. Grundlage für ... :			
19. Medienform:			
20. Angeboten von:			

## Modul: 19360 Water Quality and Treatment

2. Modulkürzel:	021210011	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch
8. Modulverantwortlicher:			
9. Dozenten:			
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP) M.Sc. Water Resources Engineering and Management, PO 2012 → Vertiefungsmodule (51 LP) → Vertiefungsmodule Wahlpflicht (30 LP)		
11. Empfohlene Voraussetzungen:			
12. Lernziele:			
13. Inhalt:			
14. Literatur:			
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"> <li>• 193601 Lecture Water Treatment</li> <li>• 193602 Lecture Water Quality Management</li> </ul>		
16. Abschätzung Arbeitsaufwand:			
17. Prüfungsnummer/n und -name:	<ul style="list-style-type: none"> <li>• 19361 Water Quality Management (PL), schriftliche Prüfung, 60 Min., Gewichtung: 1.0</li> <li>• 19362 Water Treatment (PL), schriftliche Prüfung, 60 Min., Gewichtung: 1.0</li> </ul>		
18. Grundlage für ... :			
19. Medienform:			
20. Angeboten von:			

## Modul: 15160 Water and Power Supply

2. Modulkürzel:	021410105	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	0.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Markus Noack		
9. Dozenten:	<ul style="list-style-type: none"> <li>• Ralf Minke</li> <li>• Markus Noack</li> </ul>		
10. Zuordnung zum Curriculum in diesem Studiengang:	<p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Chalmers</li> <li>→ Outgoing</li> <li>→ Wahlmodule</li> </ul> <p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Mara</li> <li>→ Outgoing</li> <li>→ Wahlmodule</li> </ul> <p>M.Sc. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Spezialisierungsmodule (30-33 LP)</li> </ul> <p>M.Sc. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Vertiefungsmodule (51 LP)</li> <li>→ Vertiefungsmodule Wahlpflicht (30 LP)</li> </ul>		
11. Empfohlene Voraussetzungen:	None		
12. Lernziele:	<p><b>Power Demand, Supply and Distribution:</b></p> <p>The students...</p> <ul style="list-style-type: none"> <li>• know the German, European and worldwide energy markets related to demand, supply and its distribution capabilities</li> <li>• are aware of that non-renewable energy sources are strictly limited and time-scales for conversion of energy markets long</li> <li>• have an idea about the relations between energy, politics, social changes and influences on environment</li> <li>• have a basic knowledge about present energy conversion systems, theoretical limits of efficiencies, and the potential to enhance applied technology</li> <li>• have a basic understanding about where and how energy is provided and distributed</li> <li>• comprehend the balance between load and supply in electrical grids and the resulting necessity for control energy.</li> </ul> <p><b>Water Demand, Supply and Distribution:</b></p> <p>The students...</p> <ul style="list-style-type: none"> <li>• know the German and worldwide water systems related to demand, supply and its distribution capabilities</li> <li>• have an overview on the water supply situation all over the world.</li> <li>• recognize the different possibilities and levels of water supply</li> <li>• have an idea of the relations between water, politics, social changes and influences on environment.</li> </ul>		
13. Inhalt:	<b>Power Demand, Supply and Distribution:</b>		

- 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:	<ul style="list-style-type: none"> <li>• 151601 Vorlesung Energy Demand, Supply and Distribution</li> <li>• 151602 Vorlesung Water Demand, Supply and Distribution</li> </ul>				
16. Abschätzung Arbeitsaufwand:	<table border="0" style="width: 100%;"> <tr> <td style="width: 60%;">Time of attendance:</td> <td style="text-align: right;">45 h</td> </tr> <tr> <td>Private Study:</td> <td style="text-align: right;">135 h</td> </tr> </table>	Time of attendance:	45 h	Private Study:	135 h
Time of attendance:	45 h				
Private Study:	135 h				
17. Prüfungsnummer/n und -name:	15161 Water and Power Supply (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0				
18. Grundlage für ... :					
19. Medienform:					
20. Angeboten von:					

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## 200 Spezialisierungsmodule (30-33 LP)

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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
	29220	Environmental Aspects
	34420	Regional and Urban Planning II
	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
	50250	Limnische Ökologie/Limnic Ecology
	50260	Measurements in the Watercycle
	50270	Methodological Aspects of Infrastructure Planning
	50280	Multiphase Modeling in Porous Media
	50290	Numerical Methods for Differential Equations
	50300	Planning and Design of Water Supply Facilities
	50310	Project Planning and Financing
	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

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## Modul: 50160 Applied GIS

2. Modulkürzel:	062300071	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Prof.Dr.-Ing. Volker Schwieger		
9. Dozenten:	<ul style="list-style-type: none"> <li>• Volker Schwieger</li> <li>• Stefan Siedentop</li> <li>• Jürgen Schweitzer</li> <li>• Stefan Fina</li> <li>• Hans-Georg Schwarz von Raumer</li> </ul>		
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP)		
11. Empfohlene Voraussetzungen:	Modul „Statistics and GIS“		
12. Lernziele:	<p>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.</p>		
13. Inhalt:	<p>GIS-based Data Acquisition Lecture:</p> <ul style="list-style-type: none"> <li>• introduction</li> <li>• GIS hard- and software for primary data acquisition</li> <li>• coordinate systems, geodetic datum and projections</li> <li>• coordinate transformations and conversions</li> <li>• terrestrial positioning and laser scanning</li> <li>• satellite-based positioning (GNSS)</li> <li>• overview of other acquisition methods</li> <li>• additional topics of mapping</li> <li>• data import from various sources (e.g. Web)</li> <li>• Web-GIS (e.g. Open Street Map)integration of data into GIS</li> </ul> <p>Exercices :</p> <ul style="list-style-type: none"> <li>• terrestrial and satellite-based data acquisition (field project)</li> <li>• integration of measured data into GIS (computer lab)</li> <li>• integration of web-data into GIS (computer lab)</li> </ul> <p>GIS in Environmental and Regional Planning Application cases:</p> <ul style="list-style-type: none"> <li>• land suitability analysis for urban development</li> <li>• accessibility of infrastructure facilities</li> <li>• Evaluation of soil functions</li> <li>• Urban Heat Island modelling</li> <li>• Biotope Networks and animal movement</li> <li>• Flood risk</li> <li>• Development capacity studies</li> </ul>		

- 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-based Data Acquisition : ILIAS - Elearning Modules, Chen, Y., Lee, Y.: Geographical Data Acquisition, Springer, Wien - New York, 2001. GIS in Environmental and Regional Planning: ILIAS-Material; Exercise sheets; onlins-tutorial

15. Lehrveranstaltungen und -formen:

- 501601 Lecture GIS-based Data Acquisition
- 501602 Laboratory and Practical Training GIS-based Data Acquisition
- 501603 Lecture GIS in Environmental and Regional Planning
- 501604 Practical Training GIS in Environmental and Regional Planning

16. Abschätzung Arbeitsaufwand:                      Summe: 180 h

17. Prüfungsnummer/n und -name:

18. Grundlage für ... :

19. Medienform:

20. Angeboten von:

## Modul: 19100 Chemistry and Biology for Environmental Engineers

2. Modulkürzel:	021230502	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	6.0	7. Sprache:	-
8. Modulverantwortlicher:		Univ.-Prof.Dr. Jörg Metzger	
9. Dozenten:		<ul style="list-style-type: none"> <li>• Jörg Metzger</li> <li>• Karl Heinrich Engesser</li> <li>• Brigitte Schwederski</li> <li>• Bertram Kuch</li> <li>• Daniel Dobslaw</li> </ul>	
10. Zuordnung zum Curriculum in diesem Studiengang:		<p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Chalmers</li> <li>→ Incoming</li> <li>→ Semi-Compulsory Modules</li> </ul> <p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Chalmers</li> <li>→ Outgoing</li> <li>→ Pflichtmodule</li> </ul> <p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Mara</li> <li>→ Incoming</li> <li>→ Elective Moduls</li> </ul> <p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Mara</li> <li>→ Outgoing</li> <li>→ Pflichtmodule</li> </ul> <p>M.Sc. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Spezialisierungsmodule (30-33 LP)</li> </ul> <p>M.Sc. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Vertiefungsmodule (51 LP)</li> <li>→ Vertiefungsmodule Wahlpflicht (30 LP)</li> </ul>	
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'.

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**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:	<ul style="list-style-type: none"> <li>• 191001 Lecture Inorganic chemistry</li> <li>• 191002 Lecture Organic chemistry</li> <li>• 191003 Lecture Biology and ecology of water, soil and air systems</li> <li>• 191004 Lecture Technical and medical microbiology for engineers</li> </ul>
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: 1.0
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: 29220 Environmental Aspects

2. Modulkürzel:	011000801	5. Moduldauer:	2 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Dr. Hans-Georg Schwarz-von Raumer		
9. Dozenten:	<ul style="list-style-type: none"> <li>• Hans-Georg Schwarz-von Raumer</li> <li>• Antje Stokman</li> <li>• Silke Wieprecht</li> <li>• Walter Vogt</li> </ul>		
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP)		
11. Empfohlene Voraussetzungen:	M2 Statistics and GIS		
12. Lernziele:	<p>The students have basic knowledge of 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</p> <ul style="list-style-type: none"> <li>• ecological analysis methods (e.g. land suitability)</li> <li>• how to use Models, computer tools and geographical information systems (GIS)</li> <li>• and Environmental Impact Assessment</li> </ul> <p>The students have first experiences in project exercises.</p>		
13. Inhalt:	<p><b><u>A: Lecture "Ecological aspects of infrastructure planning"</u></b></p> <p>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).</p> <p><b><u>B: Seminar "Environmental impact assessment"</u></b></p> <p>In the seminar students have the task to prepare a presentation and a paper about:</p> <ul style="list-style-type: none"> <li>• Structuring and evaluation of environmental impacts of strategies and projects</li> <li>• Legislative aspects</li> <li>• Modelling and evaluation methods</li> <li>• Tools for impact modelling</li> <li>• Case study examples</li> </ul> <p>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</p>		
14. Literatur:	Information will be provided during the lectures Additional material can be downloaded from ILIAS		
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"> <li>• 292201 Vorlesung Ecological aspects of infrastructure planning</li> <li>• 292202 Übung Environmental impact assessment</li> </ul>		
16. Abschätzung Arbeitsaufwand:	Time of attendance: ca. 42 h		

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Private Study: ca. 138 h

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17. Prüfungsnummer/n und -name:
- 29221 Environmental Aspects - Presentation (PL), schriftlich oder mündlich, Gewichtung: 1.0
  - 29222 Environmental Aspects - Presentation (PL), schriftlich oder mündlich, Gewichtung: 1.0
  - 29223 Environmental Aspects - Report (PL), schriftlich oder mündlich, Gewichtung: 1.0
  - 29224 Environmental Aspects - Written Exam (PL), schriftlich oder mündlich, Gewichtung: 1.0
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18. Grundlage für ... :

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19. Medienform:

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20. Angeboten von:

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## Modul: 50170 Environmental Fluid Mechanics II

2. Modulkürzel:	021420013	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	5.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Prof.Dr.-Ing. Rainer Helmig		
9. Dozenten:	<ul style="list-style-type: none"> <li>• Rainer Helmig</li> <li>• Wolfgang Nowak</li> </ul>		
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP)		
11. Empfohlene Voraussetzungen:	<p>Recommended background knowledge:          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).          Contents of Environmental Fluid Mechanics I</p>		
12. Lernziele:	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.		
13. Inhalt:	<p>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.</p> <p>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.</p>		
14. Literatur:	Lecture notes: Fluidmechanics II, Helmig Helmig, R.: Multiphase Flow and Transport Processes in the Subsurface. Springer, 1997		
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"> <li>• 501701 Lecture Environmental Fluid Mechanics II</li> <li>• 501702 Exercise Environmental Fluid Mechanics II</li> </ul>		
16. Abschätzung Arbeitsaufwand:	Sum: 180h		
17. Prüfungsnummer/n und -name:			
18. Grundlage für ... :			
19. Medienform:			
20. Angeboten von:			

## Modul: 50120 Environmental Informatics

2. Modulkürzel:	021430002	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Prof.Dr.-Ing. Andras Bardossy		
9. Dozenten:	Johannes Riegger		
10. Zuordnung zum Curriculum in diesem Studiengang:	<p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Chalmers</li> <li>→ Incoming</li> <li>→ Semi-Compulsory Modules</li> </ul> <p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Chalmers</li> <li>→ Outgoing</li> <li>→ Wahlmodule</li> </ul> <p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Mara</li> <li>→ Incoming</li> <li>→ Compulsory Modules</li> </ul> <p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Mara</li> <li>→ Outgoing</li> <li>→ Wahlmodule</li> </ul> <p>M.Sc. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Spezialisierungsmodule (30-33 LP)</li> </ul> <p>M.Sc. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Vertiefungsmodule (51 LP)</li> <li>→ Vertiefungsmodule Wahlpflicht (30 LP)</li> </ul>		
11. Empfohlene Voraussetzungen:			
12. Lernziele:	<p>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</p>		
13. Inhalt:	<p><b>Information Processing &amp; Environmental Data Management</b> (Excel &amp; Access): Environmental Database Design, Relational Database Management, Data Normalization, Data Security</p> <p><b>GIS Tools in Environmental Engineering (ArcGIS):</b> Basics of GIS, Data implementation, Spatial Structures and Attributes, Display of Environmental Information, Charts &amp; Diagrams, Digitization, Spatial and Logical Queries, Data Links, Geo-Referencing, Field Calculations</p>		
14. Literatur:	<p>Script: J. Riegger 'Environmental Informatics' User Handbooks for Excel, Access, ArcGIS <b>Getting to know ArcGIS Desktop ISBN: 9781589482609</b></p>		
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"> <li>• 501201 Lecture Environmental Data Management</li> <li>• 501202 Lecture GIS Tools in Environmental Engineering</li> </ul>		
16. Abschätzung Arbeitsaufwand:	Time of attendance: approx. 56 hours		

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Private Study: approx. 124 hours during semester

Sum: 180h

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17. Prüfungsnummer/n und -name:

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18. Grundlage für ... :

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19. Medienform:

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20. Angeboten von:

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## Modul: 50180 Flood Control: Evaluation and Case Studies

2. Modulkürzel:	021410901	5. Moduldauer:	1 Semester
3. Leistungspunkte:	3.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	2.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Prof.Dr. Silke Wieprecht		
9. Dozenten:			
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP)		
11. Empfohlene Voraussetzungen:	none (BAU), advisable LWW_Wabau none (UMW), advisable LWW_Gew Recommended background: Hydraulic Structures (WAREM)		
12. Lernziele:	<p>The students...</p> <ul style="list-style-type: none"> <li>• are aware of the fact that flood protection is an integral process, based on different components (e.g. technical flood protection measures, prevention)</li> <li>• know different strategies and examples of implementation for flood protection</li> <li>• know about different procedure used worldwide in flood protection management</li> <li>• know about the functionality of retention and protection structures: reservoirs, dams and dikesmodels</li> <li>• are able to apply their knowledge on strategical planning and first design of engineering problems related to flood protection</li> </ul>		
13. Inhalt:	<p>The module comprises the following topics:</p> <ul style="list-style-type: none"> <li>• Introduction to flood control and flood control projects around the world</li> <li>• Details on flood control projects and its evaluation based on world bank procedures.</li> <li>• Flood control hydrological and hydraulic procedures.</li> <li>• Procedures by US Army Corps of Engineers.</li> <li>• Flood control economics</li> <li>• World bank procedures and practice.</li> <li>• Tsunami</li> <li>• Occurrence, geophysics, different types of Tsunami. Case study on Aceh, Indonesia.</li> <li>• Three Gorges dam flood control project in China</li> <li>• The biggest flood control dam project explained in detail.</li> <li>• The SMART Tunnel, Malaysia</li> <li>• The biggest flood control tunnel and road way underground built for flood reduction and roadway. This mega project is fully operational.</li> <li>• Flood Control Projects in UK and Netherlands</li> <li>• Special Topics: Rainfall Harvesting, Invisible flood walls, Floating Breakwaters</li> </ul>		
14. Literatur:	<p>Lecture notes and exercise material can be downloaded from the internet. Hints are given for additional literature from the internet as well as libraries.</p>		

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Tucci, Carlos E. M.: Urban Flood Management, Peter Van Oosterom, Siyka Zlatanova, Elfriede M. Fendel: Geo-Information for Disaster Management

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15. Lehrveranstaltungen und -formen: 501801 Lecture Flood Control: Evaluation and Case Studies

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16. Abschätzung Arbeitsaufwand: Sum: 90h

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17. Prüfungsnummer/n und -name:

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18. Grundlage für ... :

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19. Medienform:

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20. Angeboten von:

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## Modul: 15150 Fuzzy Logic and Operation Research

2. Modulkürzel:	021430004	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Deutsch
8. Modulverantwortlicher:	Prof.Dr.-Ing. Andras Bardossy		
9. Dozenten:	Andras Bardossy		
10. Zuordnung zum Curriculum in diesem Studiengang:	DoubleM.D. Water Resources Engineering and Management, PO 2012 → Chalmers → Incoming → Semi-Compulsory Modules  M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP)		
11. Empfohlene Voraussetzungen:	Modul Statistik und Informatik		
12. Lernziele:	Die Studierenden sind mit den Grundlagen der Fuzzy-Modellierung wie Fuzzy Zahlen, Fuzzy Regeln, Fuzzy Sets, Membership Funktionen vertraut und können einfache auf Fuzzy-Logik basierende Modelle erstellen. Zudem kennen sie die Anwendungsmöglichkeiten von Fuzzy-Modellen ebenso wie deren Limitierungen. Die Studierenden erkennen die Problematik der Steuerung und Optimierung von komplexen Systemen für verschiedene Zielvorgaben. Sie beherrschen die grundlegenden Methoden der Systemsteuerung und können diese anwenden.		
13. Inhalt:	<p><b>Fuzzy-Logic:</b></p> <p>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</p> <p><b>Operation Research:</b></p> <p>Die Steuerung von Systemen mit komplexer Mehrfachzielsetzung ist eine Problemstellung wie sie beispielsweise auftritt bei der Steuerung von Wasserreservoirs, die für die Trinkwasserversorgung als auch den Hochwasserschutz eingesetzt werden. Die Optimierung der kombinierten Nutzung eines Wasserspeichers für verschiedene Wasserbereitstellungen mit unterschiedlicher Versorgungssicherheit ist ein weiteres Beispiel. Die Vorlesung gibt eine Einführung in die prinzipiellen Methoden der Systemsteuerung am Beispiel der Wasserwirtschaft.</p>		
14. Literatur:	Fuzzy rule based modeling with applications to geophysical, biological and engineering systems / András Bárdossy; Lucien Duckstein. - Boca Raton [u.a.] : CRC Press, 1995		
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"> <li>• 151501 Vorlesung Fuzzy Logic</li> <li>• 151502 Vorlesung Operation Research</li> </ul>		

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16. Abschätzung Arbeitsaufwand:	Präsenzzeit:	40 h
	Selbststudium:	140 h
	Gesamt:	180 h

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17. Prüfungsnummer/n und -name:	15151 Fuzzy Logic and Operation Research (PL), schriftliche Prüfung, 90 Min., Gewichtung: 1.0
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18. Grundlage für ... :	
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19. Medienform:	
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20. Angeboten von:	
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## Modul: 50190 Geohydrological Modelling I and II

2. Modulkürzel:	021430007	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Prof.Dr.-Ing. Andras Bardossy		
9. Dozenten:	Johannes Riegger		
10. Zuordnung zum Curriculum in diesem Studiengang:	DoubleM.D. Water Resources Engineering and Management, PO 2012 → Chalmers → Outgoing → Wahlmodule  DoubleM.D. Water Resources Engineering and Management, PO 2012 → Mara → Outgoing → Wahlmodule  M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP)		
11. Empfohlene Voraussetzungen:	Contents of Geohydrology and Geoengineering		
12. Lernziele:	<ul style="list-style-type: none"> <li>• Setup of a Geohydrological Model</li> <li>• Spatial and temporal Discretization (Stability Criteria)</li> <li>• Adequate Transfer of Nature into a Model</li> <li>• Simplification of complex Geohydrological Systems</li> <li>• Choice of adequate Numerical Scheme</li> <li>• Unique Calibration of Flow and Transport</li> <li>• Assessment of Geohydrological Model Approaches and Model Realizations</li> </ul>		
13. Inhalt:	Geohydrological Modelling 1: Groundwater Flow, Conceptual Model, Numerical Model, Modelling of Natural Systems, Calibration Process, Sensitivity Analysis, Model Verification and Validation. Geohydrological Modelling 2: Complex & Transient Systems, 3D-Flow, Fractured Systems, Double Porosity, Advective and Dispersive Transport, Numerical Methods for Transport, Stability Criteria, Chemical Reactions, Measurement of Transport Parameters, Transport Calibration		
14. Literatur:	Script: J. Riegger 'Geohydrological Modelling' Anderson & Woessner 'Applied Groundwater Modelling' Spitz & Moreno : 'A Practical Guide to Groundwater and Solute Transport Modeling' Freeze & Cherry: 'Groundwater'		
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"> <li>• 501901 Lecture Geohydrological Modelling 1</li> <li>• 501902 Lecture Geohydrological Modelling 2</li> </ul>		
16. Abschätzung Arbeitsaufwand:	Sum: 180h		
17. Prüfungsnummer/n und -name:			
18. Grundlage für ... :			
19. Medienform:			
20. Angeboten von:			

## Modul: 50200 Geohydrological Modelling III

2. Modulkürzel:	021430021	5. Moduldauer:	1 Semester
3. Leistungspunkte:	3.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	2.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Dr. Johannes Riegger		
9. Dozenten:	Johannes Riegger		
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP)		
11. Empfohlene Voraussetzungen:	recommended background knowledge: Contents of Geohydrological Modelling I+II		
12. Lernziele:	Setup of Geohydrological Models for the purpose of heat transport Specific properties of heat transport parameters Pure Heat conductance (modflow) Heat transport with the fluid in porous media (mt3d) Equilibrium Approach and effective parameters Nonequilibrium Approach with Dual Porosity Boundaries and Initial Conditions Spatial and temporal Discretization (Stability Criteria)		
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:			
18. Grundlage für ... :			
19. Medienform:			
20. Angeboten von:			

## Modul: 50210 Geohydrology and Geoengineering

2. Modulkürzel:	021430004	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Prof.Dr.-Ing. Christian Moormann		
9. Dozenten:	Christian Moormann		
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP)		
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:	<p><b>Geoengineering:</b>          The students have the required skills to treat fundamental soil mechanics problems such as: groundwater flow, consolidation, slope stability, settlement and soil strength calculations.</p> <p><b>Geohydrology:</b>          The students have a strong foundation in the applied skills required to locate, analyse, assess, develop, and protect groundwater resources.</p>		
13. Inhalt:	<p><b>Geoengineering:</b></p> <p>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.</p> <p><b>Geohydrology:</b></p> <p>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.</p>		
14. Literatur:	<p>Geoengineering</p> <p>Lecture notes can be downloaded from the Internet; PowerPoint presentations</p> <p>Lancellotta, R. (1998): "Geotechnical Engineering"; A.A. Balkema, Rotterdam, Netherland          Das, B.M. (1999): "Principles of Geotechnical Engineering"; PSW, Internat Thomson Public., Boston, USA          Sutton, B.H.C. (1994): "Solving problems in Soil Mechanics"; McGraw-Hill Book Company, London, UK          Scott, C.R. (1994): "An introduction to Soil Mechanics and Foundation"; E &amp; FN Spon, London, UK</p> <p>Geohydrology:</p> <p>Lecture notes can be downloaded from the Internet via the ILIAS system; PowerPoint presentations</p>		

Fetter, C.W. (2001): Applied Hydrogeology, 4th edition. Prentice Hall; 598 pages

Wichtig: mindestens ein konkreter Titel (Monographie, Artikel o.ä.) ist anzugeben

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15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"><li>• 502101 Lecture Geoengineering</li><li>• 502102 Lecture Geohydrology</li></ul>
16. Abschätzung Arbeitsaufwand:	Geoengineering: 84h Geohydrology : 54h
17. Prüfungsnummer/n und -name:	
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

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## Modul: 50220 Groundwater and Resources Management

2. Modulkürzel:	021420016	5. Moduldauer:	2 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Prof.Dr.-Ing. Rainer Helmig		
9. Dozenten:	Frieder Haakh		
10. Zuordnung zum Curriculum in diesem Studiengang:	<p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Chalmers</li> <li>→ Incoming</li> <li>→ Semi-Compulsory Modules</li> </ul> <p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Mara</li> <li>→ Incoming</li> <li>→ Elective Moduls</li> </ul> <p>M.Sc. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Spezialisierungsmodule (30-33 LP)</li> </ul>		
11. Empfohlene Voraussetzungen:	<p>Recommended background knowledge:</p> <p>Technical Mechanics          Introduction to the mechanics of incompressible fluids          Higher Mathematics          Partial differential equations          Fluid Mechanics          Groundwater flow, allocation of type-curves (Theis,...)</p>		
12. Lernziele:	<p>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</p>		
13. Inhalt:	<p>Methods commonly used in practice for monitoring and exploring groundwater as well as making it accessible are presented. The contents are:</p> <p>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</p>		

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)  
 Excercises (via Mail)
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15. Lehrveranstaltungen und -formen:
  - 502201 Lecture Grundwassererschließung und Grundwasserschutz
  - 502202 Seminar practical aspects of groundwater resources management for drinking water supply
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16. Abschätzung Arbeitsaufwand: Sum: 180h
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17. Prüfungsnummer/n und -name:
- 
18. Grundlage für ... :
- 
19. Medienform:
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20. Angeboten von:
-

## Modul: 50230 Hydrogeological Investigations

2. Modulkürzel:	021430008	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Deutsch
8. Modulverantwortlicher:	Prof.Dr.-Ing. Andras Bardossy		
9. Dozenten:	<ul style="list-style-type: none"> <li>• Johannes Riegger</li> <li>• Roland Barthel</li> <li>• Jochen Seidel</li> </ul>		
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP)		
11. Empfohlene Voraussetzungen:	Recommended background knowledge: Hydrology, Hydrogeology, Fluid Mechanics		
12. Lernziele:	<p><b>Field Course Hydrogeology:</b> 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.</p> <p><b>Pumping Test Analysis</b> 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.</p>		
13. Inhalt:	<p><b>Field Course Hydrogeology:</b> In the field:</p> <ul style="list-style-type: none"> <li>• Soil Sampling / Drilling</li> <li>• Surveying / Levelling</li> <li>• Piezometric Heads / Potentiometric Surfaces</li> <li>• Pumping Test - Recovery Test</li> <li>• Piezometer test / Slug test</li> <li>• Tracer Test</li> <li>• Geophysical Borehole measurements / Natural groundwater velocity</li> <li>• Groundwater Chemistry</li> <li>• Hydrogeological Site Assessment</li> </ul> <p>In the lab:</p> <ul style="list-style-type: none"> <li>• Column Experiments to Determine the Hydrodynamic Dispersion Coefficient and the Hydraulic Conductivity</li> <li>• Particle-Size Distribution and Soil Characterisation</li> <li>• Rocks: Definitions, Characterisation, Classification, Genesis, Hydraulic Properties</li> </ul> <p>In the classroom:</p> <ul style="list-style-type: none"> <li>• Theoretical background of the methods applied in the field and in the laboratory (see above)</li> </ul> <p><b>Pumping Test Analysis :</b></p>		

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

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14. Literatur:	<b>Field Course Hydrogeology:</b> Marsily: Quantitative Hydrogeology. Groundwater Hydrology for Engineers. Lecture Notes: Barthel/Seidel Field Course Hydrogeology <b>Pumping Test Analysis</b> Script: J. Riegger 'Pumping Test Analysis' Kruseman & de Ridder: 'Analysis and Evaluation of Pumping Test Data'
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"><li>• 502301 Lecture Field Course Hydrology</li><li>• 502302 Lecture Pumping Test Analysis</li></ul>
16. Abschätzung Arbeitsaufwand:	Sum 180h
17. Prüfungsnummer/n und -name:	
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

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## Modul: 50240 Independent Study

2. Modulkürzel:	021410902	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes Semester
4. SWS:	0.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Dr. Matthias Schneider		
9. Dozenten:			
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP)		
11. Empfohlene Voraussetzungen:			
12. Lernziele:	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.		
13. Inhalt:	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 Preparation of a presentation Giving presentation and defending results in discussion		
14. Literatur:	depends on chosen subject		
15. Lehrveranstaltungen und -formen:	502401 Lecture Independent Study		
16. Abschätzung Arbeitsaufwand:	Sum 180h		
17. Prüfungsnummer/n und -name:			
18. Grundlage für ... :			
19. Medienform:			
20. Angeboten von:			

## Modul: 19330 Industrial Waste Water

2. Modulkürzel:	021210151	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Prof./Uni.Reg.deBlumenau Uwe Menzel		
9. Dozenten:	<ul style="list-style-type: none"> <li>• Uwe Menzel</li> <li>• Michael Koch</li> </ul>		
10. Zuordnung zum Curriculum in diesem Studiengang:	<p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Chalmers</li> <li>→ Incoming</li> <li>→ Semi-Compulsory Modules</li> </ul> <p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Mara</li> <li>→ Incoming</li> <li>→ Compulsory Modules</li> </ul> <p>M.Sc. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Spezialisierungsmodule (30-33 LP)</li> </ul>		
11. Empfohlene Voraussetzungen:			
12. Lernziele:	<p>Students have:</p> <ul style="list-style-type: none"> <li>• a basic understanding for the problems and requirements of industrial waste water treatment</li> <li>• an overview of measures for production integrated environmental protection, relevant treatment methods for process water and its characterization</li> <li>• an overview of water analysis including sampling, the main principles of different analytical techniques and the ways to assure the quality of chemical analysis</li> </ul>		
13. Inhalt:	<p>Fundamentals of industrial waste water treatment Determination of current situation possible process integrated measures measures for reuse and recirculation of water mass and concentration balance Basic elements and examples for applications to the advanced purification processes: biological waste water treatment Sampling and analytical techniques using: onsite measurements oxidation - reduction acids and bases sum parameters photometry spectrometry chromatography Analytical quality assurance</p>		
14. Literatur:	<p>-lecture notes (approx. 400 pages) -exercis -Lehr- und Handbuch der Abwassertechnik, 4. revised edition, volume I. GFA-Verlag St. Augustin 1994. -ATV V: Lehr- und Handbuch der Abwassertechnik, volume v: Organisch verschmutzte Abwässer der Lebensmittelindustrie, Wilhelm Ernst &amp; Sohn Verlag, Berlin. -ATV VII: Lehr- und Handbuch der Abwassertechnik, volume VII: Industrieabwässer mit anorganischen Inhaltsstoffen, Wilhelm Ernst &amp; Sohn Verlag, Berlin. (in each case the current edition) -Deutsche Einheitsverfahren zur Wasser-, Abwasser und Schlammuntersuchung -Standard Methods for the Examination of Water and Wastewater -Wenclawiak, Koch, Hajicostas: Quality Assurance in Analytical Chemistry. Springerverlag 2003</p>		
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"> <li>• 193301 Lecture Treatment of Industrial Waste Water</li> <li>• 193302 Lecture Water Analysis and Analytical Quality Control</li> </ul>		

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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 <b>total: 180 hours</b>
17. Prüfungsnummer/n und -name:	19331 Industrial Waste Water (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	power-point-presentation, blackboard and over-head projector
20. Angeboten von:	Institut für Siedlungswasserbau, Wassergüte- und Abfallwirtschaft

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## Modul: 15010 Integrated River Management and Engineering

2. Modulkürzel:	021410102	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	0.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Markus Noack		
9. Dozenten:	<ul style="list-style-type: none"> <li>• Silke Wieprecht</li> <li>• Markus Noack</li> </ul>		
10. Zuordnung zum Curriculum in diesem Studiengang:	<p>M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP)</p> <p>M.Sc. Water Resources Engineering and Management, PO 2012 → Vertiefungsmodule (51 LP) → Vertiefungsmodule Wahlpflicht (30 LP)</p>		
11. Empfohlene Voraussetzungen:	<p>none (BAU), advisable LWW_Wabau none (UMW), advisable LWW_Gew Hydraulic Structures (WAREM)</p>		
12. Lernziele:	<p><b>River Engineering and Sediment Management</b> The students...</p> <ul style="list-style-type: none"> <li>• are aware of rivers must be regarded and managed based on an integrated approach</li> <li>• know the basic concept of the European Water Framework Directive (WFD) and the German legal framework for river basin management</li> <li>• are able to analyze and estimate the consequences of the WFD based inventory for future management</li> <li>• are aware of sediment transport processes and of the complexity of the interactions and relations</li> <li>• recognize the possibilities and limitations of sediment managements strategies</li> </ul> <p><b>Integrated Flood Protection Measures</b> The students...</p> <ul style="list-style-type: none"> <li>• are aware of the fact that flood protection is an integral process, based on different components (e.g. technical flood protection measures, prevention)</li> <li>• 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</li> <li>• know 1-D and 2-D numerical hydro-dynamic models</li> <li>• are able to apply their knowledge on practical engineering problems related to flood protection</li> </ul>		
13. Inhalt:	<p>The module consists of two lectures: <b>River Engineering and Sediment Management</b></p> <ul style="list-style-type: none"> <li>• Basic approaches of river basin management (legal framework)</li> <li>• Systematics and results of basic inventory due to the WFD</li> <li>• Anthropogenic impacts on river basins</li> <li>• Origin of sediments and fundamental principles of transport</li> <li>• Sediment management measures on different scales</li> </ul>		

### 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:	<ul style="list-style-type: none"> <li>• 150101 Vorlesung River Engineering and Sediment Management</li> <li>• 150102 Vorlesung Integrated Flood Protection</li> <li>• 150103 Übung Integrated Flood Protection</li> </ul>
16. Abschätzung Arbeitsaufwand:	Time of attendance: 55 h Private study: 125 h
17. Prüfungsnummer/n und -name:	15011 Integrated River Management and Engineering (PL), schriftliche Prüfung, 150 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

## Modul: 50130 Integrated Watershed Modeling

2. Modulkürzel:	021430009	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Deutsch
8. Modulverantwortlicher:		Prof.Dr.-Ing. Andras Bardossy	
9. Dozenten:		<ul style="list-style-type: none"> <li>• Johannes Riegger</li> <li>• Andras Bardossy</li> </ul>	
10. Zuordnung zum Curriculum in diesem Studiengang:		<p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Chalmers</li> <li>→ Outgoing</li> <li>→ Wahlmodule</li> </ul> <p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Mara</li> <li>→ Outgoing</li> <li>→ Wahlmodule</li> </ul> <p>M.Sc. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Spezialisierungsmodule (30-33 LP)</li> </ul> <p>M.Sc. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Vertiefungsmodule (51 LP)</li> <li>→ Vertiefungsmodule Wahlpflicht (30 LP)</li> </ul>	
11. Empfohlene Voraussetzungen:		<p>Recommended background knowledge: Basic knowledge of hydrology and geohydrology</p> <p>Prerequisite module: none</p>	
12. Lernziele:		<p><b>Hydrological Modeling:</b> Construction of models for each part in the runoff process and how these models are used and integrated in different environment management systems.</p> <p><b>Integrated model systems for the groundwater management:</b> Design of hydrogeological databases, visualization of data, GIS-Operations for the groundwater and hydrological modeling, Geostatistic, stochastic modeling, Monte Carlo Methods.</p>	
13. Inhalt:		<p><b>Hydrological Modeling:</b> 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.</p> <p>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.</p>	

**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: Beven, K.J., 2000. Rainfall-Runoff Modelling: The Primer. Wiley, 360pp. Singh, V.P. (Ed.), 1995. Computer Models of Watershed Hydrology. Water Resource Publications, Littleton, Colorado, USA.
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"> <li>• 501301 Lecture and excercise Hydrological Modeling</li> <li>• 501302 Lecture and excercise Integrated model systems for the groundwater management</li> </ul>
16. Abschätzung Arbeitsaufwand:	Sum: 180h
17. Prüfungsnummer/n und -name:	
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

## Modul: 50250 Limnische Ökologie/Limnic Ecology

2. Modulkürzel:	021410205	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	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 2012 → Spezialisierungsmodule (30-33 LP)		
11. Empfohlene Voraussetzungen:			
12. Lernziele:	<p>Knowledge on Limnology, Hydrobiology and Limnic Ecology is essential to analyse the present state of the aquatic habitat, to predict the impact of construction activity on organisms and habitat functions, and if necessary, to act with the right “cure” to re-establish ecosystem health and important ecosystem services of freshwater habitats. Freshwater ecosystems drive important functions, reaching from provisioning (e.g. food, clean drinking water), regulating (e.g. carbon sequestration, self-purification) to supporting (e.g. biogeochemical fluxes) services.</p> <p>Lecture I “Basics of Limnic Ecology” The student knows about physical (e.g. light, temperature, flow regime) and chemical (e.g. pH, oxygen, nutrients) parameters determining the freshwater environment to impact the inhabiting organisms. He/She got an overview on the prevalent and important species in the pelagic, benthic and littoral zone and on their metabolic activities and functions; ranging from primary producers (microalgae, macrophytes) to secondary producers and consumers (bacteria, protozoa, metazoa). The student is able to explain trophic relationships (e.g. microbial loop, food webs), importance of leading organisms (e.g. Saprobic Index) and species richness/biodiversity for indicating and maintaining water quality. He/She 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 ecological resilience of water bodies and strategies of biomanipulation, decontamination up to restoration measures to support the natural regeneration potential of aquatic systems.</p> <p>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. He/she has acquired extensive knowledge in a selected topic of Limnic Ecology by choosing his/her presentation. The students got an insight in the research and work of external lecturer that are specialized in areas related to Limnic Ecology.</p>		
13. Inhalt:	<p><b>Lecture I „Basics of Limnic Ecology“</b> This lecture gives insights into the interactions between freshwater bodies and their inhabiting organisms (“ecology”) to affect the ecosystem services of aquatic habitats, ranging from groundwater, streams, rivers, lakes to drinking reservoirs. Basic definitions and classifications schemes for a range of aquatic habitats; differences in lotic and lentic water bodies</p>		

Abiotic factors and their impact on organisms and habitat: light, temperature, flow regime/turbulence, wind, water level, chemical factors, pH, conductivity, oxygen and nutrients  
 Main "actors" from the pelagic (phytoplankton, zooplankton), the benthic (meiofauna, macrofauna, weed) and the riparian (reed, macrophytes) zone and their main features and functions  
 Biotic factors such as competition, prey-predator relations, engineering, primary and secondary production as well as decomposition  
 Ecosystem functions such as nutrient recycling, self-purification, food webs, engineering  
 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?): Remediation, Restoration, Renaturation  
**Seminar "Selected topics in Limnic Ecology"**  
 This seminar will give extensive knowledge on selected topics related to Limnic Ecology, according to the choice of the students. Potential topics are biofouling, neophyte/neozoa, toxic algal blooms, noxious weed, parasites, climate change impacts

14. Literatur:	z.B. Pflichtlektüre, Skript, e-learning Programme <b>Wichtig</b> : mindestens ein konkreter Titel (Monographie, Artikel o.ä.) ist anzugeben
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"> <li>• 502501 Lecture Limnic Ecology</li> <li>• 502502 Seminar Limnic Ecology</li> </ul>
16. Abschätzung Arbeitsaufwand:	Sum 180h
17. Prüfungsnummer/n und -name:	
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

## Modul: 50260 Measurements in the Watercycle

2. Modulkürzel:	040401001	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Univ.-Prof.Dr. Manfred Joswig		
9. Dozenten:	<ul style="list-style-type: none"> <li>• Manfred Joswig</li> <li>• Jochen Seidel</li> </ul>		
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP)		
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:	<p><b>(I) Hydrometry and Remote Sensing</b></p> <ul style="list-style-type: none"> <li>• the basic concept of a measurement</li> <li>• handling of errors and inaccuracy</li> <li>• awareness of measurement complexity and the necessary scepticism for “results”</li> <li>• how to develop the strategy of a measurement campaign</li> <li>• relevant measurement principles in surficial watercycle and features incl. pro/cons of individual methods,</li> <li>• overview of the potential of remote sensing method</li> </ul> <p><b>(II) Hydrogeophysics</b></p> <ul style="list-style-type: none"> <li>• a basic understanding of geophysical investigation methods</li> <li>• surface sounding methods based on potential theory and approaches utilizing wave propagation</li> <li>• how to apply the techniques of electrical resistivity sounding and seismic reaction for aquifer characterization</li> </ul>		
13. Inhalt:	<p><b>(I) Hydrometry and Remote Sensing</b></p> <ul style="list-style-type: none"> <li>• basic concepts of a measurement with possible sources of errors and the determination of inaccuracy</li> <li>• measurement techniques for hydrometric quantities (flow velocity, discharge, level, force/pressure, temperature)</li> <li>• measurement techniques for hydrological quantities (precipitation by point measurements/radar, soil moisture, evaporation, infiltration)</li> <li>• an introduction in remote sensing</li> <li>• strategies for measurement campaigns</li> <li>• interpolation methods of point measurements</li> </ul> <p><b>(II) Hydrogeophysics</b></p> <ul style="list-style-type: none"> <li>• Basics in surface sounding techniques</li> <li>• Geophysical properties of rocks</li> <li>• Potential Methods</li> <li>• Electrical resistivity sounding</li> <li>• Wave propagation</li> <li>• Seismic reaction</li> </ul>		

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	<ul style="list-style-type: none"><li>• Joint interpretation of inversion results</li></ul>
14. Literatur:	(I) R. Herschey, Streamflow Measurement, Taylor & Francis, 3rd edition, 2009. S. Emais, Measurements Methods in Atomspheric Sciences, Boerntraeger, 2010. (II) P. V. Sharma, Environmental and engineering geophysics, Cambridge Univ. Press, 1997.
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"><li>• 502601 Lecture Hydrometry and Remote Sensing</li><li>• 502602 Lecture Hydrogeophysics</li></ul>
16. Abschätzung Arbeitsaufwand:	Sum 180h
17. Prüfungsnummer/n und -name:	
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

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## Modul: 50270 Methodological Aspects of Infrastructure Planning

2. Modulkürzel:	021100013	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Dr.-Ing. Richard Junesch		
9. Dozenten:	<ul style="list-style-type: none"> <li>• Ortwin Renn</li> <li>• Richard Junesch</li> <li>• Marion Aschmann</li> </ul>		
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP)		
11. Empfohlene Voraussetzungen:			
12. Lernziele:	<p>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.</p>		
13. Inhalt:	<p>The module consists of two courses: The lecture "Decision Analysis" will cover the following subjects:</p> <ul style="list-style-type: none"> <li>• Elements of Decision Problems</li> <li>• Structuring Decisions</li> <li>• Generating Objectives and Hierarchies</li> <li>• Generating Alternatives</li> <li>• Decision Making with Multiple Objectives</li> <li>• Risk and Uncertainty in Decision Situations</li> <li>• Collective Decision Making</li> <li>• Application to Infrastructure Planning</li> </ul> <p>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.</p>		
14. Literatur:	<p>Lecture notes, see  <a href="http://www.ivr.uni-stuttgart.de/vwl/studium_und_lehre/sommer/Decision_Analysis.html">http://www.ivr.uni-stuttgart.de/vwl/studium_und_lehre/sommer/Decision_Analysis.html</a>  <a href="http://www.ivr.uni-tuttgart.de/vwl/studium_und_lehre/sommer/Decision_Analysis.html">http://www.ivr.uni-tuttgart.de/vwl/studium_und_lehre/sommer/Decision_Analysis.html</a>            as well as the literature listed (see website)</p>		

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Hinde, Andrew (1998): Demographic Methods. London, Sydney, New York, Arnold Publishers  
Davis, H. Craig (1994): Demographic projection techniques for regions and smaller areas, Vancouver, University of British Columbia Press

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15. Lehrveranstaltungen und -formen:

- 502701 Lecture Decision Analysis
- 502702 Lecture Demographic Analysis and Forecasting
- 502703 Excercise Demographic Analysis and Forecasting

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16. Abschätzung Arbeitsaufwand:

Time of attendance: approx. 45 hours  
Private Study: approx.135 hours

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17. Prüfungsnummer/n und -name:

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18. Grundlage für ... :

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19. Medienform:

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20. Angeboten von:

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## Modul: 50140 Modeling of Hydrosystems

2. Modulkürzel:	021420011	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	5.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Prof.Dr.-Ing. Rainer Helmig		
9. Dozenten:	Bernd Flemisch		
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP) M.Sc. Water Resources Engineering and Management, PO 2012 → Vertiefungsmodule (51 LP) → Vertiefungsmodule Wahlpflicht (30 LP)		
11. Empfohlene Voraussetzungen:	Recommended background knowledge: Higher Mathematics: <ul style="list-style-type: none"> <li>• Partial differential equations</li> <li>• Numerical integration</li> </ul> Fundamentals of fluid mechanics: <ul style="list-style-type: none"> <li>• Conservation equations for mass, momentum, energy</li> <li>• Mathematical descr</li> </ul>		
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: <ul style="list-style-type: none"> <li>• Knowledge of the common methods (finite differences, finite elements, finite volume) and the differences between them</li> <li>• Advantages and disadvantages and of the methods and thus of their applicability</li> <li>• Derivation of the various methods</li> <li>• Use and choice of the correct boundary conditions for the various methods</li> </ul> Time discretisation: <ul style="list-style-type: none"> <li>• Knowledge of the various possibilities</li> <li>• Assessment of stability, computational effort, precision</li> <li>• Courant number, CFL criterion</li> </ul> Transport equation: <ul style="list-style-type: none"> <li>• Various discretisation possibilities</li> <li>• Physical background</li> <li>• Stability criteria of the methods (Peclet number)</li> </ul> Choice of a grid Overview of discretisation techniques on the basis of the stationary groundwater equation: <ul style="list-style-type: none"> <li>• Finite differences</li> <li>• Finite volume (integral finite differences)</li> </ul>		

- Finite elements

Time discretisation on the basis of the instationary groundwater equation:

- explicit and implicit methods

Discretisation of the transport equation:

- Central difference methods
- Upwinding

Introduction to stability analysis, convergence

Clarification of concepts: model, simulation

Derivation of the finite element method

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 Helmig, R.: Multiphase Flow and Transport Processes in the Subsurface, Springer Verlag, 1997
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"> <li>• 501401 Lecture Modeling of Hydrosystems 1.Fundamentals,</li> <li>• 501402 Excercise Modeling of Hydrosystems 1.Fundamentals,</li> <li>• 501403 Lecture Modeling of Hydrosystems 2.Fundamentals,</li> <li>• 501404 Excercise Modeling of Hydrosystems 2.Fundamentals,</li> </ul>
16. Abschätzung Arbeitsaufwand:	Sum: 180h
17. Prüfungsnummer/n und -name:	
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

## Modul: 50280 Multiphase Modeling in Porous Media

2. Modulkürzel:	021100013	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	5.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Apl. Prof.Dr.-Ing. Holger Class		
9. Dozenten:	<ul style="list-style-type: none"> <li>• Holger Class</li> <li>• Rainer Helmig</li> </ul>		
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP)		
11. Empfohlene Voraussetzungen:	<p>Theory of multiphase systems in porous media:</p> <ul style="list-style-type: none"> <li>• Phases / components</li> <li>• Capillary pressure</li> <li>• Relative permeability</li> </ul> <p>Contents of Environmental Fluid Mechanics I</p>		
12. Lernziele:	<p>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.</p>		
13. Inhalt:	<p>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:</p> <p>Theory of multiphase flow in porous media</p> <ul style="list-style-type: none"> <li>• Derivation of the differential equations</li> <li>• constitutive relations</li> </ul> <p>Numerical solution of the multiphase flow equation</p> <ul style="list-style-type: none"> <li>• Box method</li> <li>• Linearisation</li> <li>• Time discretisation</li> </ul> <p>Multicomponent systems</p> <ul style="list-style-type: none"> <li>• Thermodynamic fundamentals and non-isothermal processes</li> </ul> <p>Application examples:</p> <ul style="list-style-type: none"> <li>• Thermal remediation techniques</li> <li>• CO<sub>2</sub> storage in geological formations</li> <li>• Water / oxygen transport in gas diffusion layers of fuel cells</li> <li>• Freshwater / saltwater interaction</li> </ul>		
14. Literatur:	<p>Lecture notes: Multiphase Modeling, Class Helmig, R.: Multiphase Flow and Transport Processes in the Subsurface. Springer, 1997 Class, H.: Models for Non-Isothermal Compositional Gas-Liquid Flow and Transport in Porous Media, Habilitation, Universität Stuttgart, 2008</p>		



## Modul: 50290 Numerical Methods for Differential Equations

2. Modulkürzel:	080310506	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	3.0	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 2012 → Spezialisierungsmodule (30-33 LP)	
11. Empfohlene Voraussetzungen:			
12. Lernziele:		<ul style="list-style-type: none"> <li>• basic knowledge about the theory of ordinary and/or partial differential equations</li> <li>• overview about numerical solution methods for these problems</li> <li>• ability to link a given problem and the appropriate method</li> <li>• ability to program solution methods in MATLAB</li> </ul>	
13. Inhalt:		<p>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.</p>	
14. Literatur:		Stoer, Bulirsch: Introduction to numerical Analysis	
15. Lehrveranstaltungen und -formen:		<ul style="list-style-type: none"> <li>• 502901 Lecture Numerical Methods for Differential Equations</li> <li>• 502902 Tutorial Numerical Methods for Differential Equations</li> </ul>	
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:			
18. Grundlage für ... :			
19. Medienform:			
20. Angeboten von:			

## Modul: 50300 Planning and Design of Water Supply Facilities

2. Modulkürzel:	021210052	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	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 2012 → Spezialisierungsmodule (30-33 LP)		
11. Empfohlene Voraussetzungen:	Knowledge in Sanitary Engineering, Water Supply and Hydraulics Contents of Water and Power Supply		
12. Lernziele:	<p>The students...</p> <ul style="list-style-type: none"> <li>• Are able to plan and design centralised water supply systems as a part of rural and urban infrastructure.</li> <li>• Are able to calculate dimensions of all elements of centralised water supply systems.</li> <li>• Are able to calculate costs of all elements of centralised water supply systems.</li> <li>• have an idea of the relations between water, politics, social changes and influences on environment and on planning process.</li> <li>• Are able to design in detail all elements of centralised water supply systems.</li> </ul>		
13. Inhalt:	<ul style="list-style-type: none"> <li>• Planning process as function of topographical, economical, social, environmental boundaries.</li> <li>• Water demand calculation: water consumption, water demand, consumer groups, losses, forecasting, design periods.</li> <li>• 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.</li> <li>• Water transmission and distribution: necessity, hydraulic basics, dimensioning and calculation of branched and closed loop systems, details of planning and design.</li> <li>• Pumps and pumping stations: necessity, types, hydraulics for pumping design, pumping stations and pressure boosters, details of planning and design.</li> <li>• Water storage: necessity, types and functions of tanks, water towers and reservoirs, details of planning and design.</li> <li>• Cost calculation: Cost functions for different facilities, Calculation process, calculation of water tariff.</li> </ul>		
14. Literatur:	<p>Lecture notes can be downloaded from the internet.          Karamouz, Mohammad et al.: Urban Water Engineering and Management. Boca Raton: CRC Press, 2010. ISBN 978-1-4398-1310-2          Mutschmann, J; Stimmelmayer, F.: Taschenbuch der Wasserversorgung, Vieweg-Verlag          Hints are given for additional literature from the internet as well as libraries.</p>		
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"> <li>• 503001 Lecture Planning and design of water supply facilities</li> <li>• 503002 Case Study Planning and design of water supply facilities</li> </ul>		

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- 503003 Excursion to planning area and water supply company

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16. Abschätzung Arbeitsaufwand: Sum 180h

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17. Prüfungsnummer/n und -name:

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18. Grundlage für ... :

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19. Medienform:

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20. Angeboten von:

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## Modul: 50310 Project Planning and Financing

2. Modulkürzel:	240903002	5. Moduldauer:	2 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Elke Schneider		
9. Dozenten:	Kurt Rabenau		
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP)		
11. Empfohlene Voraussetzungen:			
12. Lernziele:	Students know how to plan and to appraise infrastructure projects in order to prepare projects themselves or to evaluate project proposals (e.g. feasibility studies) prepared by consultants. (Special focus is laid upon long-term-aspects (operation and maintenance and organization of project executing agency)).		
13. Inhalt:	<p><b>A: Project Planning and Appraisal (SS)</b> Comprehensive introduction into planning and appraisal of infrastructure projects Presentation and discussion will include:</p> <ul style="list-style-type: none"> <li>• importance of pre-screening, prefeasibility and feasibility studies</li> <li>• project appraisal (financial analysis)</li> <li>• project appraisal (economic cost benefit analysis)</li> <li>• evaluation of project alternatives</li> <li>• financial viability of projects</li> <li>• 2 case studies based on existing feasibility studies prepared for KfW</li> <li>• Logframe analysis (tool for consistent planning and risk coverage). (Will be presented in WS).</li> </ul> <p><b>B: Project Financing, Implementation and Final Evaluation (WS)</b> Comprehensive introduction into financing, implementation, monitoring, and final evaluation of infrastructure projects Subject Description:</p> <ul style="list-style-type: none"> <li>• requirements of external financing</li> <li>• external and internal sources of financing</li> <li>• Private sector participation for project financing and operation (BOT models)</li> <li>• Private sector participation for operation and maintenance</li> <li>• important steps of project implementation (implementation consultant, terms of reference, tender, contract of goods and services)</li> <li>• supervision, monitoring, disbursement of funds</li> <li>• final evaluation</li> </ul>		
14. Literatur:	<ul style="list-style-type: none"> <li>• Script,</li> <li>• Damodaran, Aswath: Corporate Finance -Theory and Practice</li> </ul>		
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"> <li>• 503101 Lecture A: Project Planning and Appraisal</li> <li>• 503102 Lecture B: Project Financing, Implementation and Final Evaluation</li> </ul>		
16. Abschätzung Arbeitsaufwand:	Sum 180h		

17. Prüfungsnummer/n und -name:

18. Grundlage für ... :

19. Medienform:

20. Angeboten von:

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## Modul: 50320 Project Preparation, Management and Finance

2. Modulkürzel:	021410801	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	6.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Prof.Dr. Silke Wieprecht		
9. Dozenten:	Andreas Hutarew		
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP)		
11. Empfohlene Voraussetzungen:	Recommended background knowledge: Basics in environmental, engineering, hydraulic structures, finance and legal administration instruments		
12. Lernziele:	Student is able to follow up necessary legal and administrative procedures. He understands to lect the relation and communication neccessities 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		
13. Inhalt:	<p>PROJECT PREPARATION, MANAGEMENT AND FINANCE, Dr.Andreas Hutarew, PPaM          Contents.          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</p> <p>DEALING WITH WATER ENDANGERING SUBSTANCES, Dr.Andreas Hutarew, VAwS          Contents. Why do we need a priciple 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</p> <p>PRACTICAL WORK , Dr.Andreas Hutarew PPaM &amp; VAws          Contents. selection of ongoing project sites, used for teaching          Project locations PPaM &amp; VAwS:          Hydro power stations Rottenburg / Neckar          Nuclear power station Phillipsburg / Rhein Pumping station          HEP Kostheim / Main          Hydro power stations Altenburg / Neckar</p>		

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Lectures take partly place on projects sites and will last till early evening

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14. Literatur: Script, e-learning Programs

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15. Lehrveranstaltungen und -formen:

- 503201 Lecture PPaM
- 503202 Lecture VAWS
- 503203 Excursion

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16. Abschätzung Arbeitsaufwand: Sum 180 h

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17. Prüfungsnummer/n und -name:

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18. Grundlage für ... :

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19. Medienform:

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20. Angeboten von:

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## Modul: 50330 Regional and Urban Planning I

2. Modulkürzel:	021100010	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Dr.-Ing. Richard Junesch		
9. Dozenten:	<ul style="list-style-type: none"> <li>• Richard Junesch</li> <li>• Nina Gribat</li> </ul>		
10. Zuordnung zum Curriculum in diesem Studiengang:	<p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Chalmers</li> <li>→ Outgoing</li> <li>→ Wahlmodule</li> </ul> <p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Mara</li> <li>→ Outgoing</li> <li>→ Wahlmodule</li> </ul> <p>M.Sc. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Spezialisierungsmodule (30-33 LP)</li> </ul>		
11. Empfohlene Voraussetzungen:			
12. Lernziele:	<p>The students understand the major challenges, objectives, strategies and instruments in spatial planning and urban development in Europe as well as in developing countries. 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.</p>		
13. Inhalt:	<p>The course Regional Planning I covers the following topics:</p> <ul style="list-style-type: none"> <li>• Overview on current planning issues</li> <li>• Basic Terms of Spatial Planning</li> <li>• Strategies in Spatial Planning</li> <li>• Instruments of Spatial Planning</li> <li>• Performance of Plans, Assessing Plans</li> </ul> <p>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.</p>		
14. Literatur:	<p>Berke, P.R. et al. (2006): Urban Land Use Planning. Urbana/Chicago: University of Illinois Press</p> <p>Hall, P. (2002): Urban and Regional Planning. New York: Routledge</p>		
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"> <li>• 503301 Lecture Regional Planning I</li> <li>• 503302 Lecture Urban Planning I</li> </ul>		
16. Abschätzung Arbeitsaufwand:	<p>Time of attendance: approx. 45 hours</p> <p>Private Study: approx. 135 hours</p>		
17. Prüfungsnummer/n und -name:			
18. Grundlage für ... :			

19. Medienform:

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20. Angeboten von:

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## Modul: 34420 Regional and Urban Planning II

2. Modulkürzel:	[pord.modulcode]	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Dr.-Ing. Richard Junesch		
9. Dozenten:	<ul style="list-style-type: none"> <li>• Stefan Siedentop</li> <li>• Philipp Misselwitz</li> <li>• Nina Gribat</li> </ul>		
10. Zuordnung zum Curriculum in diesem Studiengang:	<p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Chalmers</li> <li>→ Outgoing</li> <li>→ Wahlmodule</li> </ul> <p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Mara</li> <li>→ Outgoing</li> <li>→ Wahlmodule</li> </ul> <p>M.Sc. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Spezialisierungsmodule (30-33 LP)</li> </ul>		
11. Empfohlene Voraussetzungen:	prerequisite modules: Regional and Urban Planning I		
12. Lernziele:	<p>The students should be acquainted with basic methods of analysis and assessment in spatial planning. The students should be 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.</p>		
13. Inhalt:	<p>The course Regional Planning II deals with the following planning methods:</p> <ul style="list-style-type: none"> <li>• Indicator-based monitoring and evaluation methods</li> <li>• Multi-criteria decision analysis (e.g. cost-benefit analysis, utility value analysis, analytic hierarchy process)</li> <li>• Methods of impact assessment</li> <li>• Techniques of demand forecast and land suitability analysis</li> <li>• Hazard and vulnerability analysis (climate change adaptation)</li> </ul> <p>The course Urban Planning II gives an overview on:</p> <ul style="list-style-type: none"> <li>• Levels of spatial planning in urban areas</li> <li>• Urban development planning</li> <li>• Urban analysis</li> <li>• Urban renewal</li> <li>• Urban planning instruments</li> <li>• Land use planning and implementation planning</li> <li>• Legal framework</li> </ul>		
14. Literatur:	Skript "Regional and Urban Planning II"		
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"> <li>• 344201 Vorlesung Regional Planning II</li> <li>• 344202 Vorlesung Urban Planning II</li> </ul>		
16. Abschätzung Arbeitsaufwand:	<p>Time of attendance: approx. 45 hours</p> <p>Private Study: approx. 120 hours</p>		

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17. Prüfungsnummer/n und -name:
- 34421 Regional Planning II (PL), schriftliche Prüfung, 60 Min.,  
Gewichtung: 1.0
  - 34422 Urban Planning II (PL), schriftliche Prüfung, 60 Min.,  
Gewichtung: 1.0
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18. Grundlage für ... :

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19. Medienform: Optional

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20. Angeboten von:

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## Modul: 50340 Regional and Urban Planning III

2. Modulkürzel:	021100012	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Dr.-Ing. Richard Junesch		
9. Dozenten:	<ul style="list-style-type: none"> <li>• Anette Gangler</li> <li>• Stefan Fina</li> </ul>		
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP)		
11. Empfohlene Voraussetzungen:			
12. Lernziele:	<p>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.</p> <p>The students are able to investigate housing standards and typologies and the housing demand and supply.</p>		
13. Inhalt:	<p>The course Development Policy and Planning will be conducted as a series of Lectures, Consultation and Seminar meetings with the following requirements:</p> <p>I) Working and Presentation Techniques II) Submission of a "Topic" describing:</p> <ul style="list-style-type: none"> <li>• the development situation and the main problems of the student's country and formulating hypotheses as to the main causes underlying the problems with proposals of alternatives for viable development approaches,</li> <li>• or a specific topic and major projects to solve problems related to this topic.</li> </ul> <p>III) Preparing a comprehensive paper with the chosen theme. IV) Submission of the paper. V) Preparing a presentation and giving a lecture on the chosen theme and participating at the discussion.</p> <p>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.</p>		
14. Literatur:	OECD: Perspectives of global development, Paris, 2010		
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"> <li>• 503401 Lecture Development Policy and Planning</li> <li>• 503402 Seminar Housing</li> </ul>		
16. Abschätzung Arbeitsaufwand:	Sum 180h		
17. Prüfungsnummer/n und -name:			
18. Grundlage für ... :			
19. Medienform:			

20. Angeboten von:

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## Modul: 19390 Sanitary Engineering - Practical Class

2. Modulkürzel:	021230501	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	0.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Dr. Bertram Kuch		
9. Dozenten:	<ul style="list-style-type: none"> <li>• Detlef Clauß</li> <li>• Bertram Kuch</li> <li>• Ralf Minke</li> <li>• Matthias Rapf</li> </ul>		
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP)		
11. Empfohlene Voraussetzungen:	Prerequisite Modules : Sanitary Engineering Urban drainage and design of Wastewater treatment plants Chemistry and Biology for Environmental Engineers		
12. Lernziele:	<p>The student knows and understands in theory and practice</p> <ul style="list-style-type: none"> <li>- 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).</li> <li>- important techniques for removal of water contaminants (e.g. ion exchange, precipitation, coagulation, sorption, neutralization, aerobic, anoxic and anaerobic degradation)</li> <li>- how to take representative samples out of the different waste streams and the relevant sampling errors</li> </ul> <p>The student is aware of the most important microbiological tools to detect, handle and use microorganisms in environmental engineering systems</p> <p>The student</p> <ul style="list-style-type: none"> <li>- 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.</li> <li>- is able to apply the relevant laboratory test procedures to analyze compost within the quality assurance system and to interpret the results.</li> <li>- has the competence to develop a sampling procedure for household waste and to determine the waste composition by a sorting analyses</li> <li>- is able to apply selected test procedures in the field of hazardous waste and the analyses of odor samples</li> </ul>		
13. Inhalt:	<p>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:</p> <ul style="list-style-type: none"> <li>- water and waste water</li> <li>- solid waste</li> <li>- chemistry and microbiology</li> </ul> <p>The experiments are mainly performed directly by the students in groups of 3 to max. 6 or offered as demonstration experiments.</p>		

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14. Literatur:	Description of Experiments (available as download, pdf ) Handouts for seminar work
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"><li>• 193901 Practical Work and Seminar Water and Wastewater</li><li>• 193902 Practical Work and Seminar Chemistry and Microbiology</li><li>• 193903 Practical Work and Seminar Solid Waste</li></ul>
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), schriftliche Prüfung, 90 Min., Gewichtung: 1.0, written records of practical experiments
18. Grundlage für ... :	
19. Medienform:	<ul style="list-style-type: none"><li>• Explanation of experiments and presentation of the results of the practical work by the students (flip chart, blackboard)</li><li>• Practical Work in chemical and microbiological laboratories</li></ul>
20. Angeboten von:	Hydrochemie und Hydrobiologie in der Siedlungswasserwirtschaft

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## Modul: 36450 Special Aspects of Urban Water Management

2. Modulkürzel:	021210006	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Ralf Minke		
9. Dozenten:			
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP)		
11. Empfohlene Voraussetzungen:	<p>Inhaltlich:            Grundlegende Kenntnisse der Gesamt-zusammenhänge der Siedlungswasser- und Wasserwirtschaft.            Vertiefte Kenntnisse der Abwassertechnik, der Wassergütewirtschaft, der Wasserversorgung oder des allgemeinen Managements von Wasserressourcen.</p> <p>Formal:            Wasserversorgungstechnik I oder            Abwassertechnik I oder            Waste Water Technology oder Water Quality and Treatment</p>		
12. Lernziele:	<p>Fachlich:            Die Studierenden entwickeln ein Verständnis für Zusammenhänge über ihre Teildisziplin hinaus. Sie können bei Entscheidungen und Planungen zwischen konkurrierenden Belangen der Siedlungswasserwirtschaft, Wasserwirtschaft und anderer Infrastrukturbereiche fachlich fundiert abwägen.</p> <p>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.</p>		
13. Inhalt:	<p>- Wechselwirkungen zwischen Teilbereichen der Siedlungswasserwirtschaft am Beispiel des Umgangs mit Regenwasser            - Jährlich wechselnde Spezialthemen entsprechend dem wissenschaftlichen und technischen Fortschritt</p>		
14. Literatur:	<p>Gujer, W. Siedlungswasserwirtschaft, Springer Verlag GmbH            Mutschmann, J; Stimmelmayer, F.: Taschenbuch der Wasserversorgung, Vieweg-Verlag            Jeweils die aktuellen Auflagen            Nationale und internationale Fachzeitschriften, z.B. GWF-Wasser/ Abwasser, KA Abwasser, Abfall, Hrsg. und Verlag GFA, W.Sci.Tech., Wat. Res., Wasser und Abfall            Diverse Merk- und Arbeitsblätter des DVGW und der DWA</p>		
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"> <li>• 364501 Scientific Seminar</li> <li>• 364502 Lecture Rainwater Harvesting and Management</li> <li>• 364503 Excursions</li> </ul>		
16. Abschätzung Arbeitsaufwand:			

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17. Prüfungsnummer/n und -name: 36451 Special Aspects of Urban Water Management (Seminar presentation) (LBP), schriftlich, eventuell mündlich, Gewichtung: 1.0

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18. Grundlage für ... :

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19. Medienform:

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20. Angeboten von:

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## Modul: 50150 Stochastic Modeling and Geostatistics

2. Modulkürzel:	021430003	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Deutsch
8. Modulverantwortlicher:	Prof.Dr.-Ing. Andras Bardossy		
9. Dozenten:	Andras Bardossy		
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP) M.Sc. Water Resources Engineering and Management, PO 2012 → Vertiefungsmodule (51 LP) → Vertiefungsmodule Wahlpflicht (30 LP)		
11. Empfohlene Voraussetzungen:	Recommended background knowledge: Basic knowledge of statistics Prerequisite module: none		
12. Lernziele:	<p><b>Concepts of Geostatistics:</b>          Knowledge of the basic geostatistical concepts, difference between Kriging and simulation, advantages and disadvantages of the discussed methods, application of Kriging and simulation</p> <p><b>Stochastic Modeling:</b>          The participants have skills in basic statistical methods used in hydrology, like time series analysis, extreme value statistics, parameter estimation methods and statistical tests.</p>		
13. Inhalt:	<p><b>Concepts of Geostatistics:</b>          Geostatistical procedures for the interpolation of measured values, assessment of model parameters and planning of Measuring networks are dealt with.          Contents:</p> <ul style="list-style-type: none"> <li>• Introduction</li> <li>• Statistical hypotheses: Basic concepts; Regionalized variables; Second order stationarity; Intrinsic hypothesis; Comparison of the two hypotheses; Selection of the regionalized variable</li> <li>• The variogram: The experimental variogram; The theoretical variogram; Variogram models; Variogram fitting; Isotropy — anisotropy</li> <li>• 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.</li> <li>• Non stationary methods: Universal kr.; Intrinsic random functions of order k; External-Drift-Kr.</li> <li>• Indicator Kriging: Indicator Kriging; Applications</li> <li>• Kriging with arbitrary additional information: Markov-Bayes-Kriging; Simple Updating (SU)</li> <li>• Time dependent variables</li> <li>• Simulations: Basic definitions; Monte Carlo; Turning Band; Unconditional simulation; Conditional simulation; Sequential Simulation; Simulation using Markov Chains; The Hastings Algorithm; Simulated annealing; Indicator Simulation; Truncated-Gaussian Simulation; Application of simulations</li> <li>• Exercises</li> </ul> <p><b>Stochastic Modeling:</b></p>		

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:	<p><b>Geostatistics:</b>                  Introduction to Geostatistics (Lecture notes, English)                  Kitanidis, P. K (1997): Introduction to geostatistics: applications to hydrogeology                  Armstrong, Margaret (1998): Basic linear geostatistics</p> <p><b>Stochastical Modeling:</b>                  Plate, E. 1994. Statistik und angewandte Wahrscheinlichkeitslehre für Bauingenieure. Berlin.                  Bras, R. L. and Ignacio Rodriguez-Iturbe. 1993. Random Functions and Hydrology. Dover Publications, Inc. New York.                  Hipel, K. W. and McLeod. A. I. 1994. Time Series Modeling of Water Resources and Environmental Systems. Elsevier. Amsterdam.                  Chow, V.-E. 1964. Handbook of applied Hydrology. McGraw-Hill Book. Company. New York.                  Maniak, U. 1997. Hydrologie und Wasserwirtschaft: Eine Einführung für Ingenieure. 4. überarb. und erw. Auflage. Springer. Berlin</p>
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"> <li>• 501501 Lecture Concepts of Geostatistics</li> <li>• 501502 Lecture and Excercise Stochastical Modeling</li> </ul>
16. Abschätzung Arbeitsaufwand:	Sum:180h
17. Prüfungsnummer/n und -name:	
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

## Modul: 19310 Urban Drainage and Design of Wastewater Treatment Plants

2. Modulkürzel:	021210251	5. Moduldauer:	-
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	5.0	7. Sprache:	-
8. Modulverantwortlicher:			
9. Dozenten:			
10. Zuordnung zum Curriculum in diesem Studiengang:	DoubleM.D. Water Resources Engineering and Management, PO 2012 → Chalmers → Outgoing → Pflichtmodule  DoubleM.D. Water Resources Engineering and Management, PO 2012 → Mara → Outgoing → Pflichtmodule  M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP)  M.Sc. Water Resources Engineering and Management, PO 2012 → Vertiefungsmodule (51 LP) → Vertiefungsmodule Wahlpflicht (30 LP)		
11. Empfohlene Voraussetzungen:			
12. Lernziele:			
13. Inhalt:			
14. Literatur:			
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"> <li>• 193101 Vorlesung und Übung Design of Sewer System and Stormwater Treatment</li> <li>• 193102 Vorlesung und Übung Design of Wastewater Treatment Plants</li> <li>• 193103 Seminar Case Study</li> <li>• 193104 Exkursion</li> </ul>		
16. Abschätzung Arbeitsaufwand:			
17. Prüfungsnummer/n und -name:	19311 Urban Drainage and Design of Wastewater Treatment Plants (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0		
18. Grundlage für ... :			
19. Medienform:			
20. Angeboten von:			

## Modul: 19360 Water Quality and Treatment

2. Modulkürzel:	021210011	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch
8. Modulverantwortlicher:			
9. Dozenten:			
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP) M.Sc. Water Resources Engineering and Management, PO 2012 → Vertiefungsmodule (51 LP) → Vertiefungsmodule Wahlpflicht (30 LP)		
11. Empfohlene Voraussetzungen:			
12. Lernziele:			
13. Inhalt:			
14. Literatur:			
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"> <li>• 193601 Lecture Water Treatment</li> <li>• 193602 Lecture Water Quality Management</li> </ul>		
16. Abschätzung Arbeitsaufwand:			
17. Prüfungsnummer/n und -name:	<ul style="list-style-type: none"> <li>• 19361 Water Quality Management (PL), schriftliche Prüfung, 60 Min., Gewichtung: 1.0</li> <li>• 19362 Water Treatment (PL), schriftliche Prüfung, 60 Min., Gewichtung: 1.0</li> </ul>		
18. Grundlage für ... :			
19. Medienform:			
20. Angeboten von:			

## Modul: 50350 Water Resources and Irrigation - Planning Methods and Tools

2. Modulkürzel:	021410204	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	6.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Dr. Kristina Terheiden		
9. Dozenten:	<ul style="list-style-type: none"> <li>• Jochen Seidel</li> <li>• Kristina Terheiden</li> </ul>		
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Water Resources Engineering and Management, PO 2012 → Spezialisierungsmodule (30-33 LP)		
11. Empfohlene Voraussetzungen:			
12. Lernziele:	<p>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.</p> <p><b>Irrigation Issues (Terheiden):</b> Students have theoretical and practical back ground knowledge of irrigation and soil conservation issues.</p> <p><b>Computer Applications in Water Engineering (Terheiden):</b> Students know how to apply computer programs related to irrigation- and river basin-management.</p> <p><b>Multi Objective Decision Making in Water Resources Management (Seidel):</b> 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</p>		
13. Inhalt:	<p><b>Water Management and Irrigation Facilities:</b></p> <ul style="list-style-type: none"> <li>• Water demand, scarcity and availability</li> <li>• Assessment of crop water demand</li> <li>• Irrigation facilities</li> <li>• Health hazards of irrigation facilities</li> <li>• Soil erosion and salinization</li> </ul> <p><b>Computer Applications in Water Engineering:</b> Theory and application of computer programs such as</p> <ul style="list-style-type: none"> <li>• SimResSedim: Water and sediment balance of reservoirs</li> <li>• Sahel: Interaction between socio-economic human activities and water- and land-resources of the used area</li> <li>• Wasim: Water and salt balance in soils</li> <li>• Wepp: Water Erosion of crop- and natural land</li> <li>• Cropwat: Crop water requirements and irrigation scheduling</li> <li>• Hec-Ras, Mike11, Hydro_As 2D: One- and two-dimensional hydrodynamic modeling of river systems</li> </ul> <p><b>Multi Objective Decision Making in Water Resources Management:</b> The use of evaluation and decision making methods in order to determine long term effects on planed actions will be addressed. Registration, quantification and evaluation of project alternatives using different methods and techniques are focused:</p>		

- 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:	<p>Lecture notes to</p> <ul style="list-style-type: none"> <li>• 'Irrigation Issues' authored by W.Marx;</li> <li>• 'Computer Applications in Water Engineering', authored by: M. Noack, W. Marx and to</li> <li>• 'Multi Objective Decision Making in Water Resources Management', authored by A. Bardossy, J. Seidel</li> </ul> <p>will be provided on the e-learning Ilias-platform for downloading. Specific material will be distributed during lectures/exercises</p>
15. Lehrveranstaltungen und -formen:	<ul style="list-style-type: none"> <li>• 503501 Lecture Water Management and Irrigation Facilities</li> <li>• 503502 Lecture Computer Applications in Water Engineering</li> <li>• 503503 Lecture Multi Objective Decision Making in Water Resources Management</li> </ul>
16. Abschätzung Arbeitsaufwand:	Sum 180h
17. Prüfungsnummer/n und -name:	50351 Water Resources and Irrigation - Planning Methods and Tools (PL), schriftliche Prüfung, 180 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

## Modul: 15160 Water and Power Supply

2. Modulkürzel:	021410105	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	0.0	7. Sprache:	Englisch
8. Modulverantwortlicher:	Markus Noack		
9. Dozenten:	<ul style="list-style-type: none"> <li>• Ralf Minke</li> <li>• Markus Noack</li> </ul>		
10. Zuordnung zum Curriculum in diesem Studiengang:	<p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Chalmers</li> <li>→ Outgoing</li> <li>→ Wahlmodule</li> </ul> <p>DoubleM.D. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Mara</li> <li>→ Outgoing</li> <li>→ Wahlmodule</li> </ul> <p>M.Sc. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Spezialisierungsmodule (30-33 LP)</li> </ul> <p>M.Sc. Water Resources Engineering and Management, PO 2012</p> <ul style="list-style-type: none"> <li>→ Vertiefungsmodule (51 LP)</li> <li>→ Vertiefungsmodule Wahlpflicht (30 LP)</li> </ul>		
11. Empfohlene Voraussetzungen:	None		
12. Lernziele:	<p><b>Power Demand, Supply and Distribution:</b></p> <p>The students...</p> <ul style="list-style-type: none"> <li>• know the German, European and worldwide energy markets related to demand, supply and its distribution capabilities</li> <li>• are aware of that non-renewable energy sources are strictly limited and time-scales for conversion of energy markets long</li> <li>• have an idea about the relations between energy, politics, social changes and influences on environment</li> <li>• have a basic knowledge about present energy conversion systems, theoretical limits of efficiencies, and the potential to enhance applied technology</li> <li>• have a basic understanding about where and how energy is provided and distributed</li> <li>• comprehend the balance between load and supply in electrical grids and the resulting necessity for control energy.</li> </ul> <p><b>Water Demand, Supply and Distribution:</b></p> <p>The students...</p> <ul style="list-style-type: none"> <li>• know the German and worldwide water systems related to demand, supply and its distribution capabilities</li> <li>• have an overview on the water supply situation all over the world.</li> <li>• recognize the different possibilities and levels of water supply</li> <li>• have an idea of the relations between water, politics, social changes and influences on environment.</li> </ul>		
13. Inhalt:	<b>Power Demand, Supply and Distribution:</b>		

- 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:
 

- 151601 Vorlesung Energy Demand, Supply and Distribution
- 151602 Vorlesung Water 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), schriftliche Prüfung, 120 Min., Gewichtung: 1.0

18. Grundlage für ... :

19. Medienform:

20. Angeboten von:

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## 400 Deutschkurse (0-6 LP)

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Zugeordnete Module: 19150 German as a Foreign Language

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## Modul: 19150 German as a Foreign Language

2. Modulkürzel:	SZ	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	8.0	7. Sprache:	-
8. Modulverantwortlicher:		John Nixon	
9. Dozenten:			
10. Zuordnung zum Curriculum in diesem Studiengang:		DoubleM.D. Water Resources Engineering and Management, PO 2012 → Chalmers → Outgoing → Pflichtmodule  DoubleM.D. Water Resources Engineering and Management, PO 2012 → Mara → Outgoing → Pflichtmodule  M.Sc. Water Resources Engineering and Management, PO 2012 → Deutschkurse (0-6 LP)	
11. Empfohlene Voraussetzungen:			
12. Lernziele:			
13. Inhalt:			
14. Literatur:			
15. Lehrveranstaltungen und -formen:		<ul style="list-style-type: none"> <li>• 191501 Seminar German as a Foreign Language I</li> <li>• 191502 Seminar German as a Foreign Language II</li> </ul>	
16. Abschätzung Arbeitsaufwand:			
17. Prüfungsnummer/n und -name:		<ul style="list-style-type: none"> <li>• 19151 German as a Foreign Language I (PL), schriftlich oder mündlich, Gewichtung: 1.0</li> <li>• 19152 German as a Foreign Language II (PL), schriftlich oder mündlich, Gewichtung: 1.0</li> </ul>	
18. Grundlage für ... :			
19. Medienform:			
20. Angeboten von:			