FACHBEREICH WASSER, UMWELT, BAU UND SICHERHEIT

Antrag auf Re-Akkreditierung
der Bachelor-Studiengänge „*Wasserwirtschaft*" sowie „*Recycling und Entsorgungsmanagement*" und
der Master-Studiengänge „*Wasserwirtschaft*" und „*Water Engineering*"

Anlage

Modulhandbuch
Master Water Engineering

HOCHSCHULE MAGDEBURG-STENDAL

Fachbereich Wasser, Umwelt, Bau und Sicherheit

Modulhandbuch des internationalen Masterstudiengangs

Water Engineering (M. Eng.)

Regelstudienzeit: **3 Semester Vollzeit**

Anzahl der Credits : **90**

Magdeburg, September 2020

Inhaltsverzeichnis

Modulbezeichnung/ module notation	**1. Hydrological Plannings and Projects I**
Modulniveau/ module level	Master
Studiensemester/ semester	2
Kürzel/ abbreviation	HPPI
Lehrveranstaltungen/ courses	1.1 Analysis of water resource systems
	1.2 Design of water resources systems
	1.3 Water management plans
	1.4 Water economy and legislation
Modulverantwortlicher/ module responsible	Prof. Dr. Sc Francisco Padilla Benitez
Dozent(in)/ lecturer	Prof. Dr. Sc Francisco Padilla Benitez, Prof. Dr. Meng. Ricardo Juncosa Rivera, Prof. Dr. MEng. Juan Acinas, Ass. Prof. Gustavo Vazquez
Sprache/ language	english
Zuordnung zum Curriculum/ correlation to curriculum	Compulsory module
Lehrform/SWS/ teaching form/contact hours	6 SWS lecture
Arbeitsaufwand/ amount of work	180 h
Kreditpunkte/ credit points	6
Voraussetzungen nach Prüfungsordnung/ requirements	Bachelor degree
Empfohlene Voraussetzungen/ recommended requirements	Hydraulics, Hydrology, Environmental Engineering
Form der Prüfung/ form of exam	homework or project
Angestrebte Lernergebnisse/ target educational objective	Students are able to analyse and design water management systems
1.1 Analysis of water resource systems	Assessment and analysis of water resource systems. Water withdrawals and uses.
1.2 Design of water resources systems	Methods of analysis: identification, optimization, uncertainties, objectives and control of water management plans. Introduction to data management systems by GIS. Design of water resources systems and planning. Water economy and legislation.
1.3 Water management plans	Groundwater management. Surface water management.
1.4 Water economy and legislation	
Medienformen/ used media	Powerpoint presentation, White board

Literatur/ literature	Script -Andreu J., 1993. “Conceptos y métodos para la planificación hidrológica”, Ed. CIMNE. -Balairón, L., 2000. “Gestión de recursos hídricos”, E.U.I.T. Obras Públicas de Ávila, Universidad de Salamanca, 2000. -Goodman A., 1984. “Principles of Water Resources Planning”, Prentice-Hall. -Estrada, L. (1994). Garantía en los sistemas de explotación de los recursos hidráulicos. CEDEX -Estrela, T., 1993. “Modelos matemáticos para la evaluación de los recursos hídricos”, CEDEX. -Ferrer Polo F.J., 1993. “Recomendaciones para el cálculo hidrometeorológico de avenidas”. CEDEX. -Goodman A. (1984). Principles of Water Resources Planning. Prentice-Hall -Liria J. y Sáinz J.A., 1982. “Recursos Hidráulicos y su Planificación”, Apuntes de la ETSICCP de Santander. -Loucks D., Stedinger J. y Haith D., 1981. “Water Resource Systems Planning and Analysis”, Prentice-Hall. -Mays, L.W. 2011. “Water resources engineering” John Wiley & Sons. -Sainz, J.A. y Ascorbe, A., 1984. “Metodología aplicada a estudios de regulación”, Univ. de Santander. -Vallarino E., 1980. “Planificación Hidráulica”, Apuntes de la ETSICCP de Madrid, 1980.

Modulbezeichnung/ module notation	**2. Water supply and drainage systems**
Modulniveau/ module level	Master
Studiensemester/ semester	2
Kürzel/ abbreviation	WSDS
Lehrveranstaltungen/ courses	2.1 Supply systems design
	2.2 Urban drainage
Modulverantwortlicher/ module responsible	Prof. Dr Meng Pablo Rodriguez-Vellando
Dozent(in)/ lecturer	Prof. Dr Meng Pablo Rodriguez-Vellando, Ass. Prof. Gustavo Vazquez, Prof. Dr. Javier Sanz, Prof. Alberte Martinez, Meng Hector Garcia Rabade, Prof. Dr. Meng. Cristina Vazquez
Sprache/ language	english
Zuordnung zum Curriculum/ correlation to curriculum	Compulsory module
Lehrform/SWS/ teaching form/contact hours	6 SWS lecture
Arbeitsaufwand/ amount of work	180 h
Kreditpunkte/ credit points	6
Voraussetzungen nach Prüfungsordnung/ requirements	Bachelor degree
Empfohlene Voraussetzungen/ recommended requirements	Hydraulics, Hydrology, Environmental Engineering
Form der Prüfung/ form of exam	practica
Angestrebte Lernergebnisse/ target educational objective	Students are able to
2.1 Supply systems design	Construction planning, Introduction to SUDS, Pre-treatment systems, green roofs, rainwater, filter strips, trenches, swales, bioretention,
2.2 Urban drainage	How SUDS differ from conventional drainage, Erision, Sediment control, Pollution control, inspections, Method statement, Sand filters, infiltration basins, wetlands
Medienformen/ used media	Script, Powerpoint presentation, White board

Literatur/ literature	-Crittenden J.C. Water Treatment: Principles and design. Wiley, 2005 -Gray N.F., Water Technology. An Introduction for Environmental Scientists and Engineers. Elsevier, 2010 -Gray N.F., Drinking water quality. Problems and solutions. Cambridge University press, 2008 -Hammer M.J., Water and Wastewater Technology. Pearson/Pentice Hall, 2004 '-BARLOW, M. and CLARKE, T. (2002), Blue Gold: The Fight to Stop the Corporate Theft of the World's Water. New York: The New Press. -BENNETT, V., 1995: The Politics of Water. Urban Protest, Gender, and Power in Monterrey, Mexico, Pittsburgh y Londres: University of Pittsburgh Press. -BLACK, Maggie, 2009. The atlas of water: mapping the world's most critical resource. Berkeley: University of California Press. -BROWN, J. C., 1988: «Coping with Crisis? The Diffusion of Waterworks in Late Nineteenth-Century German Towns», The Journal of Economic History, Volumen XLVIII, n.º 2, 307-318. -Alexis Carles et Emmanuel Petrella, World Water Atlas. Brussels, 12 and 13 February 2009, European Parliament. -GEORGE, S., 2008. Water and sustainable development. Expoagua Zaragoza. -Francisco Nunes Correia, editor. Water resources management in Europe. Rotterdam: A.A.Balkema, 1998. -UNICEF and World Health Organization, Progress on Drinking Water and Sanitation: 2012. C41

Modulbezeichnung/ module notation	**3. Physico-Chemistry and Quality of Water**
Modulniveau/ module level	Master
Studiensemester/ semester	2
Kürzel/ abbreviation	PCQW
Lehrveranstaltungen/ courses	3.1 Principles of water chemistry
	3.2 Water quality
	3.3 Analytical technics
Modulverantwortlicher/ module responsible	Prof.Dr. MSc Jordi Delgado Martinez
Dozent(in)/ lecturer	Prof.Dr. MSc Jordi Delgado Martinez, Dr. Sc. Ana Vazquez
Sprache/ language	english
Zuordnung zum Curriculum/ correlation to curriculum	Compulsory module
Lehrform/SWS/ teaching form/contact hours	6 SWS lecture
Arbeitsaufwand/ amount of work	180 h
Kreditpunkte/ credit points	6
Voraussetzungen nach Prüfungsordnung/ requirements	Bachelor degree
Empfohlene Voraussetzungen/ recommended requirements	Chemistry and Physics
Form der Prüfung/ form of exam	Experimental work and homework
Angestrebte Lernergebnisse/ target educational objective	Learning the basic principles of water chemistry. Learning the basic principles of the analytical techniques aimed at quantifying the concentrations of water contaminants and their constituents.bility to establish relationships between physico-chemical data and the chemical state of a water body or the prescribed legal environmental quality objectives. Concentration units, Colligative properties Mass action law and the equilibrium constant Sampling and monitroing Routine parameters Special determinations, In situ vs. laboratory determinations Sampling surveys for ground, precipitation, stream and lake/reservoir waters, Sampling frequency Analitical techniques and quality assessment Accuracy, precission, bias Detection and quatification limits, Titrations Analytical techniques (spectrophtometry, ICP, ...) Data analysis and interpretation Fundamentals of descriptive statistics Graphic analysis of water chemistry data Time series representation and analysis Hydrochemical processes and modelling Chemical reactions and temperature dependence Equilibrium vs. kinetic processes, Ion speciation Acidity and alkalinity Solid dissolution/precipitation processes

	Ion exchange and sorption Redox processes Aqueous modelling with PHREEQC
3.1 Principles of water chemistry	Basics of water chemistry, Mol and stoichiometry Aqueous interactions and chemical bonding, Structure and properties of water, Aqueous interactions and chemical bonding, Routine parameters, In situ vs. laboratory determinations, Sampling frequency, Accuracy, precission, bias
3.2 Water quality	Concentration units, Mass action law and the equilibrium constant, Sampling surveys for ground, precipitation, stream and lake/reservoir waters, Detection and qualification limits, Graphic analysis of water chemistry data, Acidity and alkalinity, Chemical reactions and temperature dependence, Equilibrium vs. kinetic processes
3.3 Analytical technics	Analytical techniques (spectrophtometry, ICP, ...), Redox processes, Aqueous modelling with PHREEQC, Ion exchange and sorption
Medienformen/ used media	Script, Powerpoint presentation, White board
Literatur/ literature	-C.A.J. Applo, D. Postma "Geochemistry, Groundwater and Pollution" -Robert M. Garrels, Charles L. Christ "Solutions, minerals and equilibria" -Arthur W. Hounslow "Water Quality Data: Analysis and Interpretation" -Hem, J.D. (1991) Study and Interpretation of the Chemical Characteristics of Natural Waters. 3ª edición. U.S. Geological Survey Water-Supply Paper 2254, 363 pp. -U.S.G.S. (1998) National Field Manual for the Collection of Water-Quality Data. Book 9. Handbooks for WaterResources Investigations. U.S. Geological Survey. -Deutsch, W.J. (1997) Groundwater Geochemistry: Fundamentals and Applications to Contamination. Lewis Publishers; 221 pp. -Misstear, B.; Banks, D. y Clark, L. (2006) Water Wells and Boreholes. John Wiley & Sons; 498 pp. -Wilson, N. (1995) Soil Water and Ground Water Sampling. Lewis Publishers, 188 pp. -Cook, P. y Herczeg, A.L., Eds. (2000) Environmental Tracers in Subsurface Hydrology. Kluwer Academic Publishers, 529 pp. -Clark, I. y Fritz, P. (1997) Environmental isotopes in Hydrogeology; Lewis Publishers, 328 pp.

Modulbezeichnung/ module notation	**4. Experimental Hydraulics I**
Modulniveau/ module level	Master
Studiensemester/ semester	2
Kürzel/ abbreviation	EH I
Lehrveranstaltungen/ courses	4.1 Scale models I
	4.2 Experimental field techniques
Modulverantwortlicher/ module responsible	Prof. Meng Juan Ramon Rabunal
Dozent(in)/ lecturer	Prof. Meng Juan Ramon Rabunal, Dr, Sc Ana Vazquez
Sprache/ language	english
Zuordnung zum Curriculum/ correlation to curriculum	Optional course
Lehrform/SWS/ teaching form/contact hours	6 SWS lecture
Arbeitsaufwand/ amount of work	180 h
Kreditpunkte/ credit points	6
Voraussetzungen nach Prüfungsordnung/ requirements	Bachelor degree
Empfohlene Voraussetzungen/ recommended requirements	Hydraulics, Fluid Mechanics and Physics
Form der Prüfung/ form of exam	Experimental work
Angestrebte Lernergebnisse/ target educational objective	Students are able to use investigations and tests in experimental in hydraulics for the prediction of hydraulic processes
4.1 Scale models I	Froude-models, use of physical models, control sections, apllied physical models, hydraulic flumes, wave basin
4.2 Experimental field techniques	Experimental field technics, Instrumentation systems i.e. sensors, actuators, Control modules, data aquisition
Medienformen/ used media	Powerpoint presentation, White board
Literatur/ literature	-Frank M. White "Fluid Mechanics" -Pijush K. Kundu "Fluid Mechanics" -Boiten W. "Hydrometry" The Delft Lecture Note Series, A.A. Balkema. (2000). -Vanoni, VA (2006). "Sedimentation Engineering". ASCE Manuals and reports on engineering practice, No 54 - Chanson, H (2000). "The hydraulics of open channel flow. An introduction." Butterworth-Heinemann.

Modulbezeichnung/ module notation	**5. Computational Fluid Dynamics I**
Modulniveau/ module level	Master
Studiensemester/ semester	2
Kürzel/ abbreviation	CFD I
Lehrveranstaltungen/ courses	5.1 Mathematics I
	5.2 Finite element programming
	5.3 Porous media and geochemical models
Modulverantwortlicher/ module responsible	Prof. Dr.-Ing. Pablo Vellando
Dozent(in)/ lecturer	Prof. Dr.-Ing. Pablo Vellando, Prof. Dr Meng Jaime Fe Marques, Res Hector Garcia Rabade
Sprache/ language	english
Zuordnung zum Curriculum/ correlation to curriculum	Optional course
Lehrform/SWS/ teaching form/contact hours	6 SWS lecture and exercises
Arbeitsaufwand/ amount of work	180 h
Kreditpunkte/ credit points	6
Voraussetzungen nach Prüfungsordnung/ requirements	Bachelor degree
Empfohlene Voraussetzungen/ recommended requirements	Hydraulics, Fluid Mechanics and Physics, Mathematics for Engineers
Form der Prüfung/ form of exam	homework or written examination
Angestrebte Lernergebnisse/ target educational objective	The students are able to use computational models as an instrument for the prediction of hydraulic processes.
5.1 Mathematics I	Fundamentals of Open Channel flow, Computational Fluid Dynamics, Saint-Venant-Equation, Navier-Stokes-Equation, Shallow-Water-Convection-Diffusion
5.2 Finite element programming	Finite Elements programming, Fundamentals of Finite Volume programming, Matlab programming, Hydrodynamic models
5.3 Porous media and geochemical models	Darcy equation, Porous media models,Governing equations, Geochemical models, commercial programms
Medienformen/ used media	Powerpoint presentation, Computer
Literatur/ literature	J. Puertas Agudo (2000). Apuntes de Hidráulica de Canales. Nino, J. Donea (2003). Finite Element Methods for Flow Problems. Wiley, O. Pironneau (1989). Finite Element Methods for Fluids. Wiley, G. Carey, J. Oden (1984). Finite Elements. Prentice-Hall, A. Chadwick (1986). Hydraulics in Civil Engineering. Allen&Unwin, P. Gresho, R Sani (2000). Incompressible flow and the finite element method. Wiley, Singiresu Rao (2005). The Finite Element Method in Engineering. Elsevier, O. C. Zienkiewicz, R.L. Taylor (1982). The Finite Element Method. Vol 3, Fluid dynamics. Mc Graw Hill

Modulbezeichnung/ module notation	**6. Water Treatment and Energy Efficency**
Modulniveau/ module level	Master
Studiensemester/ semester	2
Kürzel/ abbreviation	WT Codenumber 632844206
Lehrveranstaltungen/ courses	6.1 Water treatment processes
	6.2 Power consumption
	6.3 Environmental implications
Modulverantwortlicher/ module responsible	Dr Sc Maria Jose Servia
Dozent(in)/ lecturer	Dr Sc Maria Jose Servia, Meng Margarita Martinez, Dr. Sc Ana Vazquez
Sprache/ language	english
Zuordnung zum Curriculum/ correlation to curriculum	Optional course
Lehrform/SWS/ teaching form/contact hours	6 SWS lecture
Arbeitsaufwand/ amount of work	180 h
Kreditpunkte/ credit points	6
Voraussetzungen nach Prüfungsordnung/ requirements	Bachelor degree
Empfohlene Voraussetzungen/ recommended requirements	Chemistry, hydraulic engineering, Fluid dynamics
Form der Prüfung/ form of exam	homework
Angestrebte Lernergebnisse/ target educational objective	Students are able to
6.1 Water treatment processes	Effects of pollutants on aquatic ecosystems, The use of bioindicators to assess freshwater quality, The functioning of freshwater ecosystems, Lentic systems, Lotic Systems, Microbes and plants, animals suborganisam effects, supraorganism effects,
6.2 Power consumption	Chemical contaminants of water, Bioindicators recommende by the Water Framework Directive, Types, Standards, Problems, Health Effects and Impact on the environment, Coagulation precipitation, Oxidation reduction, ion exchange, Desinfection, High service pumping, water plant residuals management,
6.3 Environmental implications	Freshwater biodiversity. Types of aquatic organisms, Types of water contamination, Analytical methods for the determination of physicochemical parameters, Domestic waste water, livestock wastewater, industrial wastewater, Municipal waste water
Medienformen/ used media	Powerpoint presentation, White board

Literatur/ literature	-Source separation and decentralization for wastewater management London: IWA Publishing, 2013. -Standard methods for the examination of water and wastewater Washington: American Public Health Association, 2012. -Fundamentals of materials for energy and environmental sustainability Cambridge: Cambridge University Press, 2012. -Sustainability in project management Surrey: Gower, 2012. -Energy, sustainability, and the environment: technology, incentives, behavior. Amsterdam: Butterworth-Heinemann, 2011. -Energy conservation in water and wastewater treatment facilities New York: McGraw-Hill, 2010. -European Energy and Water Balance Monitoring System Project. Final report, April 2001. -Industrial water reuse and wastewater minimization Mann, James G. New York: McGraw-Hill, 1999. -Wastewater reclamation and reuse Lancaster: Technomic, 1998. -Estimating benefits of regional solutions for water and wastewater service Cromwell, John Denver: Awwa Research Foundation, 2008.

Modulbezeichnung/ module notation	**7. Groundwater Engineering I**
Modulniveau/ module level	Master
Studiensemester/ semester	2
Kürzel/ abbreviation	GE I
Lehrveranstaltungen/ courses	7.1 Physical Hydrogeology
	7.2 Hydrogeochemical principles
	7.3 Hydrodynamic in aquifers
Modulverantwortlicher/ module responsible	Prof. Dr. Sc Francisco Padilla Benitez
Dozent(in)/ lecturer	Prof. Dr. Sc Francisco Padilla Benitez, Prof. Dr. Meng. Ricardo Juncosa Rivera, Prof. Dr. MEng. Juan Acinas, Ass. Prof. Gemma Soriano Hoyuelos
Sprache/ language	english
Zuordnung zum Curriculum/ correlation to curriculum	Optional course
Lehrform/SWS/ teaching form/contact hours	6 SWS lecture
Arbeitsaufwand/ amount of work	180 h
Kreditpunkte/ credit points	6
Voraussetzungen nach Prüfungsordnung/ requirements	Bachelor degree
Empfohlene Voraussetzungen/ recommended requirements	Physics, Fluid dynamics
Form der Prüfung/ form of exam	Practica
Angestrebte Lernergebnisse/ target educational objective	Overwiew of basic and applied aspects of hydrogeology from needs of civil engineering. Ability to design and interpret the hydraulics tests and hydrodynamic characterization of medium, interpreting hydrogeological maps ans constructive ways of sources
7.1 Physical Hydrogeology	Introduction to the Hydrologic Cycle, Baseflow, Evapotranspiration and potencial Evapotranspiration, Infiltration and recharge, Continental environments, erosion, transportation and deposition, fluvial, eolian, lacustrine, glacial deposits, uplift, diagenesis and erosion
7.2 Hydrogeochemical principles	Basic concepts, Tectonism and the formation of fractures, Darcy´s experimental law and field extensions, porosity and hydraulic conductivity, Field mapping,
7.3 Hydrodynamic in aquifers	Flow in fractured rocks, conservation of fluid mass, storage properties of porous media, boundary conditions and flow nets, Unsaturated flow in fractured rocks, Richard´s equation, Soute and particle transport
Medienformen/ used media	Powerpoint presentation, White board

Literatur/ literature	Script -LINSLEY, R.K., KHOLER, M.A., PAULHUS, J.L.(1982). Hydrology for Engineers. McGraw-Hill. New York. -VEN TE CHOW, D.R., MAIDMENT, MAYS L.W. (1994). Applied Hydrology. McGraw-Hill. -BEAR, J., (1972). Dynamics of fluids in porous media. American Elsevier, New York -BEAR, j., (1979). Hydraulics of groundwater. Mc Graw Hill. Series in Water Resources and Environmental Engineering. 567 pp. -DOMENICO, P.A. Y SCHWARTZ, F.W. (1990). Physical and chemical hydrogeology. 824 pp. WILEY -FEITER, CW. (1999). Contaminant hydrogeology. Prentice Hall, 500 pp. -FEITER, CW. (2001). Applied hydrogeology. Prentice Hall. 598 pp. -PINDER, G.F. Y GRAW, W.G. (1977). Finite element simulation in surface and subsurface hydrology. -WEIGHT, WILLIS D. (2009). Hydrogeology field manual. Mc Graw Hill

Modulbezeichnung/ module notation	**8. Hydraulic Plannings and Projects II**
Modulniveau/ module level	Master
Studiensemester/ semester	2
Kürzel/ abbreviation	HPP II
Lehrveranstaltungen/ courses	8.1 Design of Dams
	8.2 Water Treatment
	8.3 Wastewater Plants
	8.4 Global Water resource management and strategies
Modulverantwortlicher/ module responsible	Prof. Dr.-Ing. Bernd Ettmer
Dozent(in)/ lecturer	Prof. Dr.-Ing. Bernd Ettmer Prof. Dr.-Ing. habil. Jürgen Wiese Prof. Dr. rer. nat Petra Schneider
Sprache/ language	english
Zuordnung zum Curriculum/ correlation to curriculum	Compulsory module
Lehrform/SWS/ teaching form/contact hours	6 SWS lecture and excursion
Arbeitsaufwand/ amount of work	180 h
Kreditpunkte/ credit points	6
Voraussetzungen nach Prüfungsordnung/ requirements	Bachelor degree
Empfohlene Voraussetzungen/ recommended requirements	Hydraulics, Hydrology, Environmental Engineering
Form der Prüfung/ form of exam	Homework or written examination
Angestrebte Lernergebnisse/ target educational objective	Planning strategies and design of water management systems, Rehabilitation of water management systems
8.1 Design of dams (Ettmer)	Planning and design of dams in international consulting projects
8.2 Water Treatment (N.N.)	Planning and design of Water supply and water treatment plants
8.3 Wastewater Plants (Wiese /Vergara)	Design of Wastewater plants
8.4 Global Water resource management and strategies (Schneider)	Global water resources management and strategies
Medienformen/ used media	Powerpoint presentation, White board
Literatur/ literature	-European Floods Directive -Manual for Hydropower Inventory Studies of River Basins, Ministry of mines and energy, Brasil, 2010 -River Weirs – Good Practice Guide Guide - Section A Charles Rickard, Rodney Day, Jeremy Purseglove R&D Publication W5B-023/HQP Research Contractor: Mott MacDonald Ltd and University of Hertfordshire

Modulbezeichnung/ module notation	**9. GIS and Hydrology**
Modulniveau/ module level	Master
Studiensemester/ semester	2
Kürzel/ abbreviation	GH
Lehrveranstaltungen/ courses	9.1 GIS and Hydrology
	9.2 Applied Hydrology
	9.3 Realisation of European Flood Directive
Modulverantwortlicher/ module responsible	Prof. Dr. rer. nat. habil. Frido Reinstorf
Dozent(in)/ lecturer	Prof. Dr. rer. nat. habil. Frido Reinstorf Dr. Thilo Weichel (Local goverment)
Sprache/ language	english
Zuordnung zum Curriculum/ correlation to curriculum	Compulsory module
Lehrform/SWS/ teaching form/contact hours	6 SWS lecture
Arbeitsaufwand/ amount of work	180 h
Kreditpunkte/ credit points	6
Voraussetzungen nach Prüfungsordnung/ requirements	Bachelor degree
Empfohlene Voraussetzungen/ recommended requirements	Hydrology, Environmental Engineering, Mathematics for Engineers
Form der Prüfung/ form of exam	homework
Angestrebte Lernergebnisse/ target educational objective	Data processing and analysis; mapping and data visualization, Autonomous work with GIS-tools, Hydrological modeling
9.1: GIS and Hydrology (Reinstorf)	GIS is used as vehicle to deliver environmental knowledge and spatial information. The series of courses emphasize students to investigate the environment, use GPS marking geographic locations, and further collect environmental information. The students learn to work with GIS incl. georeferencing, data processing and analysis as well as mapping. All students create in a scientific project their own maps with individual hydrological subjects, integrate environmental information, and adopt the spatial analyses with ArcGIS 10 software. The objective of this courses is to cultivate students' capabilities of collecting, displaying and analyzing spatial information.
9.2: Applied Hydrology (Reinstorf)	The students learn the basics of high flood prevention and flood protection measures, including the typical buildings and facilities. They learn to create a data base and base maps for determination of hydrological flooding events like flooding maps and damage risk maps.
9.3: Realisation of European Flood Directive (Weichel)	Flood-control and flood protection in Saxony-Anhalt, Example and Excursion
Medienformen/ used media	Powerpoint presentation, White board

Literatur/ literature	-Script -ArcGIS 9, Wichmann Verlag, Heidelberg, ISBN 3-87907430-5 -Liebig, W., Mummenthey, R.-D., 2005: ArcGISArcView 9, Band 1: ArcGIS-Grundlagen, Points Verlag Norden, Halmstad, ISBN 3-9808463-6-9 -Liebig, W., Mummenthey, R.-D., 2005: ArcGISArcView 9, Band 2: ArcGIS-Analysen, Points Verlag Norden, Halmstad, ISBN 3-9808463-7-7 -Gujer, W. (2008): Systems Analysis for Water Technology, Springer, ISBN 978-3-540-77277-4

Modulbezeichnung/ module notation	**10. Restoration Ecology**
Modulniveau/ module level	Master
Studiensemester/ semester	2
Kürzel/ abbreviation	RE
Lehrveranstaltungen/ courses	10.1. Ecology and restoration of rivers
	10.2. Ecology and restoration of lakes
	10.3. Project in river restoration
Modulverantwortlicher/ module responsible	Prof. Dr. rer. nat. habil. Volker Lüderitz
Dozent(in)/ lecturer	Prof. Dr. rer. nat. habil. Volker Lüderitz Dr. Martin Schultze (Helmholtz Center for Environmental Research) Prof. Dr. José Ramón Arévalo (University of La Laguna, Canary Islands)
Sprache/ language	english
Zuordnung zum Curriculum/ correlation to curriculum	Compulsory module
Lehrform/SWS/ teaching form/contact hours	6 SWS lecture and excursion
Arbeitsaufwand/ amount of work	180 h
Kreditpunkte/ credit points	6
Voraussetzungen nach Prüfungsordnung/ requirements	Bachelor degree
Empfohlene Voraussetzungen/ recommended requirements	Hydraulics, Hydrology, Environmental Engineering
Form der Prüfung/ form of exam	homework
Angestrebte Lernergebnisse/ target educational objective	Students are able to identify main processes in ecological and restauration projects of rivers and lakes. They learn the practice of ecological analysis and basics in ecological planning
10.1: Ecology and restoration of rivers (Lüderitz)	Ecology and restauration of rivers. Using makrozoobenthos as indicator.
10.2: Ecology and restoration of lakes (Schultze, Arevalo)	Basics in lake ecology and lake restauration. Ecology and restauration aspects in international projects. Projectmanagement and strategies.
10.3: Project in river restoration (Lüderitz)	River restauration project with application of theretical methods in practice. Identification of macrozoobenthos as idicator for restauration quality
Medienformen/ used media	Script, Powerpoint presentation, White board

Literatur/ literature	-Journals: Ecological Engineering Journal of Applied Ecology Limnoligica Restoration Ecology Water Research -DIRECTIVE 2000/60/EC. Water framework directive. -DIRECTIVE 2000/60/EC. GUIDANCE DOCUMENT No 10 - Reference Conditions Inland Waters. -Volker Lüderitz; Robert Jüpner; Stefan Müller; Christian K. Feld. Renaturalization of streams and rivers- the special importance of integrated ecological methods in measurement of success. An example from Saxony-Anhalt (Germany). 2004 -Volker Lüderitz; Thomas Speierl; Uta Langheinrich; Wolfgang Völkl; Richard M.Gersberg. Restoration of the Upper Main and Rodach rivers - The success and its measurement. 2011 -T. Pottgiesser & M. Sommerhäuser. Profiles of German Stream Types. 2004 -Piet Verdonschot, Christian Feld, Armin Lorenz, Veronica Dahm, Anahita Marzin, Didier Pont, Maxime Logez, Gerome Belliard, Andreas Melcher, Helga Kremser & Martin Seebacher: Deliverable D5.1-4: Guidance on management options and measures of pressure reduction to improve the ecological status of rivers with emphasis on the implications of global/climate change; Water bodies in Europe: Integrative Systems to assess Ecological Status and Recovery. ALTERRA Green World Research. (2012).

Modulbezeichnung/ module notation	**11. Experimental Hydraulics II**
Modulniveau/ module level	Master
Studiensemester/ semester	2
Kürzel/ abbreviation	EH II
Lehrveranstaltungen/ courses	11.1 Scale models II
	11.2 Morphological flume experiments
	11.3 Scouring at hydraulic structures
Modulverantwortlicher/ module responsible	Prof. Dr.-Ing. Bernd Ettmer
Dozent(in)/ lecturer	Prof. Dr.-Ing. Bernd Ettmer Stefan Orlik, M.Eng. Franciska Müller, M.Eng.
Sprache/ language	english
Zuordnung zum Curriculum/ correlation to curriculum	Optional course
Lehrform/SWS/ teaching form/contact hours	6 SWS lecture, laboratory work and excursion
Arbeitsaufwand/ amount of work	180 h
Kreditpunkte/ credit points	6
Voraussetzungen nach Prüfungsordnung/ requirements	Bachelor degree
Empfohlene Voraussetzungen/ recommended requirements	Hydraulics, Fluid Mechanics and Physics
Form der Prüfung/ form of exam	homework
Angestrebte Lernergebnisse/ target educational objective	The students are able to use and interpretate experimental tests as an instrument for the prediction of hydraulic and morphological processes.
11.1: Scale models II (Ettmer)	Review to Froude and Reynolds similarity laws and basics in model scaling. Morphological similarity laws and application on physical models. Physical models as an instrument of prediction for hydraulic and morphological processes. Basic research and applied research experments.
11.2: Morphological flume experiments (Orlik)	Morphological flume experiments with experimental tests. Autonomous measurement of settling velocity and critical velocity for the initiation of motion of sediment particles as most important parameters for morphological processes. Flume experiments in a sediment recirculating flume with a high resolution detection of sediment transport.
11:3: Scouring at hydraulic structures (Müller)	Erosion processes and scouring at hydraulic structures like piers, abutments, wiers etc. Experimental tests under clear-water, bed-load and suspension load conditions. Prediction of morphological processes.
Medienformen/ used media	Script, Powerpoint presentation, White board

Literatur/ literature	-Arneson, L.A Zevenbergen, L.W. Lagasse P.F Clopper P.E, (2012). Evaluating Scour at Bridges. Hydraulic Engineering Circular 18, Fifth Edition, Section 7.2, FHWA HIF 12 003 HEC-18, Federal Highway Administration, U.S. Department of Transportation, Washington, D.C., USA. -Department of Transport and Main Roads (Australia), 2013, Bridge Scour Manual -Zanke, U.C.E., Hsu, T.-W., Roland, A., Link, O., Diab, R., 2011. Equilibrium scour depth around piles in non-cohesive sediments under currents and waves. Coastal Engineering 58, 986-991. -Gao, D., Posada, G. Nordin, C.F., 1993. Pier scour equations used in the People's Republic of China – Review and summary. Department of Civil Engineering, Colorado State University, Fort Collins, Colorado, USA. -Melville, B.W., Coleman, S.E., 2000. Bridge Scour. Water Resources Publication, LLC, Colorado, USA. -José A. Jiménez and Ole S. Madsen (2003). "A Simple Formula to Estimate Settling Velocity of Natural Sediments" Journal of waterway, port, coastal and ocean engineering. Vol. 129, No. 2. ASCE. -Schmidt, J.C. Rubin, D.M. Ikada, H. "Flume simulation of recirculating flow and sedimentation". Water Resources Research Vol. 29, Nº8 (1993) -Van Rijn (1993): "Principles of sediment transport in rivers, estuaries and coastal seas", Aqua Publications, ISBN 90800356-2-9. -Van Rijn, L.C. "Unified view of sediment transport by currents and waves. Graded beds." Journal of Hydraulic Engineering, ASCE (2007). -River Weirs – Good Practice Guide Guide - Section A Charles Rickard, Rodney Day, Jeremy Purseglove R&D Publication W5B-023/HQP Research Contractor: Mott MacDonald Ltd and University of Hertfordshire

Modulbezeichnung/ module notation	**12. Computational Fluid Dynamics II**
Modulniveau/ module level	Master
Studiensemester/ semester	2
Kürzel/ abbreviation	CFD II
Lehrveranstaltungen/ courses	12.1. Mathematics II
	12.2. 1D/2D-Models
	12.3. Modeling of dike stability
Modulverantwortlicher/ module responsible	Prof. Dr.-Ing. Daniel Bachmann
Dozent(in)/ lecturer	Prof. Dr.-Ing. Daniel Bachmann Dr. rer. nat. Alraune Zech (University of Utrecht, The Netherlands) Daniel Hesse, M.Eng. Dr.-Ing. Peter Grubert (Local industry partner GGU)
Sprache/ language	english
Zuordnung zum Curriculum/ correlation to curriculum	Optional course
Lehrform/SWS/ teaching form/contact hours	6 SWS lecture and exercises
Arbeitsaufwand/ amount of work	180 h
Kreditpunkte/ credit points	6
Voraussetzungen nach Prüfungsordnung/ requirements	Bachelor degree
Empfohlene Voraussetzungen/ recommended requirements	Hydraulics, Fluid Mechanics and Physics, Mathematics for Engineers
Form der Prüfung/ form of exam	homework
Angestrebte Lernergebnisse/ target educational objective	The students are able to use computational models as an instrument for the prediction of hydraulic processes.
12.1: Mathematics II (Zech)	Within the scope of this module the students engage a range of advanced topics from CFD. This comprises solution techniquies for unsteady flow problems, i.e. different Euler and Runge-Kutta methods as well as classification schemes for Partial Differential Equations, i.e. elliptic, parabolic and hyperbolic PDE's. The latter issue will be connected to different flow regimes and the numerical solution techniques applicable for each type (Finite-Difference, Finite-Volume, Finite-Elements). The course itself contains both lectures and exercises, which are fully integrated into each other. The exercises themselves are both analytical and numerical, with the latter using the technical language Matlab.
12.2: 1 D/2D-Models (Bachmann, Hesse)	Theoretical background of 1D- models using BernoulliEquation. Using of 1D- HEC-Ras software in a pratical application. Theoretical background of Double-Averaged-ReynoldsEquation, Differentiation of 1D- and 2D-numerical model, Grid construction using SMS and RMA, Practical application.

12.3: Modeling of dike stability (Grubert)	Application of an geohydraulic model under seepage aspects of dikes and dam structures. Calculation of dambreak situation.
Medienformen/ used media	Powerpoint presentation, White board, Computer
Literatur/ literature	-Prentice-Hall, A. Chadwick (1986). Hydraulics in Civil Engineering. -Matlab tutorial -Hec-Ras Tutorial -GGU MiniCAD manual -GGU software tutorials

Modulbezeichnung/ module notation	**13. River Morphology**
Modulniveau/ module level	Master
Studiensemester/ semester	2
Kürzel/ abbreviation	RM
Lehrveranstaltungen/ courses	13.1 River Morphology
	13.2 Sediment transport
	13.3 Sedimentation and Erosion
Modulverantwortlicher/ module responsible	Prof. Dr.-Ing. Bernd Ettmer
Dozent(in)/ lecturer	Dr.-Ing. Francisco Nuñez-Gonzalez (TU Braunschweig) Dr.-Ing. Carles Ferrer (UPC Barcelona /Spain) Prof. Dr.-Ing. Oscar Link (University of Concepcion / Chile) Prof. Dr.-Ing. Jochen Aberle (NTNU Trondheim/Norway) Prof. Dr.-Ing. Bernd Ettmer
Sprache/ language	english
Zuordnung zum Curriculum/ correlation to curriculum	Optional course
Lehrform/SWS/ teaching form/contact hours	6 SWS lecture
Arbeitsaufwand/ amount of work	180 h
Kreditpunkte/ credit points	6
Voraussetzungen nach Prüfungsordnung/ requirements	Bachelor degree
Empfohlene Voraussetzungen/ recommended requirements	Hydraulics, Hydrology, Fluid Mechanics and Physics
Form der Prüfung/ form of exam	Homework or written examination
Angestrebte Lernergebnisse/ target educational objective	Students are able to describe and analyse morphological processes in rivers and reservoirs. They are able to calculate and predict morphological processes.
13.1: River Morphology (Nuñez, Ferrer)	Basics in river morphology. Definition of sediment particles, Calculation of initiation of motion of sediment particles, calculation of settling velocities, Erosion and sedimentation basics, sharp bents, scouring and deposition.
13.2: Sediment transport (Link)	Sediment transport processes in rivers and reservoirs, Calculation and prediction of sediment transport by using typical approaches and eqautions. Diferentiation between bed load and suspension load calculations.
13.3: Sedimentation and Erosion (Ettmer/ Aberle)	Understanding of sediment transport mechanisms and basic concepts for gravel bed rivers, Classification of sediment transport processes, Critical shear stress concept and incipient motion for granular material, Armour layer development, Examples of Bed load and Suspended sediment transport and Reservoir sedimentation.
Medienformen/ used media	Script, Powerpoint presentation, White board

Literatur/ literature	-Annette SCHULTE-RENTROP, Katinka KOLL, Jochen ABERLE and Andreas DITTRICH (2005). SEDIMENT BUDGET OF A HEATHLAND SAND-BED RIVER. Acta Geophysica Polonica Vol. 53, no. 4, pp. 553-565 -Aberle, J., Nikora, V., Henning, M, Ettmer, B., Hentschel, B. (2010). "Statistical characterization of bed roughness due to bed forms: 3 A field study in the Elbe River at Aken, Germany." Water Resour. Res. -Ackers, P., White, W. (1973). "Sediment transport: new approach and analyses." J. Hydraul. Div. ASCE, 99(11), 2041-2060 -Bagnold, R. A. (1966). "An approach to the sediment transport problem for general physics." Geological Survey Prof. Paper 422-I, Washington, D.C. -Callander, R. A. (1978). "River meandering." Annu. Rev. Fluid Mech., 10, 129-158 -Chabert, J., Chauvin, J.L. (1963). "Formation des dunes et des rides dans les models fluviaux. Bull." Du CREC Nr. 4. Chatou. -Chanson, H. (2004). Environmental Hydraulics for Open Channel Flows. Butterworth Heinemann -Garcia, M. H. (edt.) (2007). Sedimentation engineering, ASCE press, Virginia, USA -Laursen, E.M. (1958). "The total sediment load of streams." J. Hydraul. Div., ASCE, 84(1) 1958,1-36 -Nikora, V. (2009). "Hydrodamics of aquatic ecosystems: An interface between Ecology, Biomechanics and Environmental Fluid Mechanics." River Res. Appl., DOI: 10.1002/rra.1291. -Shields, F.D., Copeland, R.R., Klingeman, P.C., Doyle, M.W., and Simon, A. (2003). "Design for stream restoration." J. Hydraul. Eng., 129(8), 575–584.
	-van Rijn, L.C. (1984). "Sediment transport, part II: suspended load transport." Journal of Hydraulic Engineering, 110(11), 1613-1641. -van Riijn, L.C. (2007). "Unified view of sediment transport by currents and waves. II: Suspended transport." J. Hydraul. Eng., 133(6), 668-689. -Yalin, M.S. (1965). "Similarity in sediment transport by currents." Hydraulic Research Paper Nr. 6, Hydraulics Research Station, London. -Yalin, M.S. (1992). River Mechanics. Pergamon Press, Oxford. -Yalin, M.S., da Silva, A.M. (2001). Fluvial Processes, IAHR, Monograph

Modulbezeichnung/ module notation	**14. Water and Waste**
Modulniveau/ module level	Master
Studiensemester/ semester	2
Kürzel/ abbreviation	EBH
Lehrveranstaltungen/ courses	14.1 Waste Treatment
	14.2 Waste and Ocean
	14.3 Anaerobic technologies
	14.4 Water Chemistry
Modulverantwortlicher/ module responsible	Prof. Dr.-Ing. habil. Jürgen Wiese
Dozent(in)/ lecturer	Prof. Dr.-Ing. habil. Jürgen Wiese Prof. Dr.-Ing. Carsten Cuhls Prof. Dr.-Ing. Gilian Gerke Monica Vergara Araya, M.Sc. Prof. Dr. Kilian Smith
Sprache/ language	english
Zuordnung zum Curriculum/ correlation to curriculum	Optional course
Lehrform/SWS/ teaching form/contact hours	6 SWS lecture, practical training and fieldwork
Arbeitsaufwand/ amount of work	180 h
Kreditpunkte/ credit points	6
Voraussetzungen nach Prüfungsordnung/ requirements	Bachelor degree
Empfohlene Voraussetzungen/ recommended requirements	high school graduation in biology, knowledge in microbiology
Form der Prüfung/ form of exam	homework
Angestrebte Lernergebnisse/ target educational objective	Students are able to use biological and hydrochemical methods for the assessment of water bodies
14.1: Waste Treatment (Cuhls)	Biological and chemical basics of waste treatment. Biological and chemical processes in waste plants
14.2: Waste and ocean (Gerke)	Entrance paths of plastics in lakes and ocean. Biological and chemical pollution
14.3: Anaerobic technologies (Wiese/Vergara)	Anaerobic technologies of sludge treatment and mud structures
14.4: Water Chemistry (Smith)	Methods and processes for detection and assessment of different environmental pollutants
Medienformen/ used media	Script, Powerpoint presentation, White board
Literatur/ literature	G. Biiton: Wastewater microbiology. WILEY 2005

Modulbezeichnung/ module notation	**15. Practicum as Enterprise Traineeship or University Practicum**
Modulniveau/ module level	Master
Studiensemester/ semester	3
Kürzel/ abbreviation	
Lehrveranstaltungen/ courses	Practicum
Modulverantwortlicher/ module responsible	Prof. Dr.-Ing. Bernd Ettmer
Dozent(in)/ lecturer	Workplace supervisor and university professor of hosting faculty
Sprache/ language	english
Zuordnung zum Curriculum/ correlation to curriculum	Compulsory module
Lehrform/SWS/ teaching form/contact hours	practica term of 10 weeks
Arbeitsaufwand/ amount of work	10 weeks
Kreditpunkte/ credit points	15
Voraussetzungen nach Prüfungsordnung/ requirements	A minimum of 54 credits from modules 1-14
Empfohlene Voraussetzungen/ recommended requirements	
Form der Prüfung/ form of exam	Homework as Internship report
Angestrebte Lernergebnisse/ target educational objective	In case of successful completion of this module students are able to edit projects independently and produce a direct practical reference.

Modulbezeichnung/ module notation	**16. Master's Thesis**
Modulniveau/ module level	Master
Studiensemester/ semester	3
Kürzel/ abbreviation	
Lehrveranstaltungen/ courses	
Modulverantwortlicher/ module responsible	Mentoring professor of the hosting faculty
Dozent(in)/ lecturer	Mentoring professor of the hostig faculty
Sprache/ language	english
Zuordnung zum Curriculum/ correlation to curriculum	Compulsory module
Lehrform/SWS/ teaching form/contact hours	
Arbeitsaufwand/ amount of work	10 weeks
Kreditpunkte/ credit points	15
Voraussetzungen nach Prüfungsordnung/ requirements	Successful completion of all modules 1-15, 75 Credits
Empfohlene Voraussetzungen/ recommended requirements	
Form der Prüfung/ form of exam	Colloquium
Angestrebte Lernergebnisse/ target educational objective	Through the Master's thesis students acquire the ability of independent scientific work and their presentation. They show that they are able to work on a task from the field of Water Engineering within a specified time period independently and scientificly. They learn to define a theme, to work it up analytical, to identify and evaluate scientific literature, to develop the conception of an empirical study, to apply scientific methods concretely and perform an investigation. They also learn to represent the results in a scientific text as well as to evaluate them with respect to their theoretical importance and practical relevance. Students present their work in a colloquium to demonstrate that they are able to defend their work results in a technical discussion with the advisory board.