
## Department of

## Water, Environment, Construction and Safety

# Module Handbook

For the

# Masters Programme in “Water Engineering“

According to the Study and Examination Regulation dated 20.11.2023, published in the official Announcements No. 21/2023

Version / last update: April 2026

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**Department of Water, Environment, Construction and Safety**

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| **Study programme:** | Water Engineering | | | |
| **Module level:** | Master | | | |
| **Module Nr.:** | 1. | | | |
| **Module name:** | Global Water Resources Management | | | |
| **Module components:** | Global water resources (GWR); Water Pollution Management (WPM); Water management planning and projects (WMPP) | | | |
| **Semester:** | 1 | | | |
| **Module responsible:** | Prof. Dr. rer. nat. Petra Schneider | | | |
| **Lecturers:** | Prof. Dr. rer. nat. Petra Schneider, Prof. Dr. rer. nat. Kilian Smith | | | |
| **Language:** | English | | | |
| **Correlation to Curriculum:** | ***Study programme:*** | Water Engineering | | |
| | ***Compulsory:*** | | | |
| | ***Elective:*** | X | | |
| **Teaching form/ SWH/ Workload/ Credits:** | ***Teaching form*** | ***SWH*** | ***Credits*** | ***180 h Workload*** 84 h…Attendance time 56 h…Self study 40 h…Exam preparation |
| | ***L:*** | 4 | | |
| | ***Tu:*** | 2 | | |
| | ***Sum:*** | 6 | 6 | |
| **Prerequisites according to examination regulations:** | Bachelor degree | | | |
| **Recommended prerequisites:** | | | | |
| **Module objectives / intended learning outcomes:** | **Global water resources (GWR)**<br>Students will be able to identify global water resources and related transboundary water resources conflicts. They will become familiar with conflict mitigation and resolution approaches.<br><br>**Water Pollution Management (WPM)**<br>Students will understand water pollution causes and pressures, can identify and assess water depollution methdodologies and strategies and will be able to apply them to real cases.<br><br>**Water management planning and projects (WMPP)**<br>Students will understand project management and project organisation approaches. They will be able to identy the water engineering tasks in the role of the a) supervising engineer, b) competent authority, and c) planning engineer. The students will understand the international procurement and tendering rules in engineering. | | | |
| **Content:** | **Global water resources management (GWRM)**<br>• Overview on Global Water Resources<br>• Global Institutions and Policies on Water<br>• Transboundary Water Management<br>• Global and EU Law on Water<br>• Water Reuse and Recycling<br>• Resource Efficiency and Industrial Symbiosis<br>• Water-Resilient Cities: Critical, Social and Green Infrastructure | | | |

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| | • Climate Change Mitigation and Adaptation<br>• Nature-based Solutions<br>• Natural Hazards and Mitigation<br><br>**Water Pollution Management (WPM)**<br>• River Basin Management<br>• Basics on water management and water quality legislation<br>• Water Pollution Management, Isotope hydrology<br>• Environmental Remediation Strategies – Isolation, Incapsulation<br>• Environmental Remediation Strategies – Extraction, Treatment, Immobilisation<br>• Environmental Remediation Strategies – Hydraulic Treatment<br>• Environmental Remediation Strategies – Pneumatic and Biological Treatment<br>• Environmental Remediation Strategies – Bioremediation, Phytoremediation<br><br>**Water management planning and projects (WMPP)**<br>• Introduction to Project Conception and Planning<br>• Environmental Engineering<br>• Supporting Design Documents<br>• Environmental Impact Assessment<br>• International Procurement and Tendering (FIDIC)<br>• Cost-Benefit Analysis<br>• Hydrogeological Aspects<br>• Geotechnical Aspects<br>• Project Implementation and Supervision |
| **Examination prerequisites:** | B.Eng. or B.Sc. |
| **Study/examination tasks/forms of examination:** | GWR: Term paper, WPM: Group presentation, WMPP: Tender project (Term paper) |
| **Applicability of the module:** | |
| **Media forms/ Learning method:** | Seminar / lecture / group presentation |
| **Literature:** | **Global water resources (GWR)**<br>• Agarwal, A., M.S. de los Angeles, R. Bhatia, I. Cheret, S. Davila-Poblete, M. Falkenmark, F.G. Villarreal, T. Jonch-Clausen, M.A. Kadi, J. Kindler, J. Rees, P. Roberts, P. Rogers, M. Solanes and A. Wright (2000). Integrated water resources management, TAC Background Paper No. 4, Stockholm, Sweden, Global Water Partnership.<br>• Avellan, T.; Roidt, M.; Emmer, A.; von Koerber, J.; Schneider, P.; Raber, W. (2017): Making the Water-Soil-Waste Nexus work: Framing the boundaries of resource flows; Sustainability 2017, 9, 1881; doi:10.3390/su9101881.<br>• Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds. (2008): Climate Change and Water. Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, 1.3.1<br>• Belinskij A (2015) Water-Energy-Food Nexus within the Framework of International Water Law, Water 7, 5396-5415; doi:10.3390/w7105396<br>• de Strasser, L.; Lipponen, A.; Howells, M.; Stec, S.; Bréthaut, C. (2016). A Methodology to Assess the Wa-ter Energy Food Ecosystems Nexus in Transboundary River Basins, Water, 8, 59, doi:10.3390/w8020059<br>• Dombrowsky I (2007) Conflict, Cooperation and Institutions in |

International Water Management: an economic analysis. Edward Elgar editions, Great Britain, 2007, ISBN 978-1-84720-341-0
- Food and Agriculture Organization of the United Nations (FAO) (2011). Climate change, water and food security, FAO Water Reports 36, available online http://www.fao.org/docrep/014/i2096e/i2096e00.htm,
- Food and Agriculture Organization of the United Nations (FAO) (2012). Coping with water scarcity. An action framework for agriculture and food security, available online www.fao.org/3/a-i3015e.pdf,
- Grigg NS (2008) Integrated water resources management: balancing views and improving practice, Water International, 33:3, 279-292, DOI: 10.1080/02508060802272820GWP. Catalyzing Change: A Handbook for Developing Integrated Water Resources Management (IWRM) and Water Efficiency Strategies. Available online: http://www.un.org/esa/sustdev/csd/csd13/documents/bground_5.pdf
- Global Water Partnership GWP (2000). Integrated Water Resources Management, TAC Background Papers No. 4, Stockholm, Sweden, ISBN: 91-630-9229-8
- Hoff, H. (2011) Understanding the Nexus. Background Paper for the Bonn2011 Conference: The Water, Energy and Food Security Nexus. Stockholm Environment Institute, Stockholm. http://sei-international.org/publications?pid=1977.
- Huelsmann S, Ardakanian R (ed.) (2014). Advancing a Nexus Approach to the Sustainable Management of Water, Soil and Waste (White Book). Dresden: UNU-FLORES.

**Water Pollution Management (WPM)**

- Hostmann, M., Truffer, B., Reichert, P. (2003): Decision Support Systems for River Rehabilitation – Swiss experiences. - In: A.D. Buijse, R.S.E.W. Leuven & M. Greijdanus-Klaas (eds.): Lowland River Rehabilitation 2003. Wageningen, September 2003. Programme, abstracts & participants. Institute for Inland Water Management and Waste Water Treatment RIZA. - NCR-publication 22-2003.
- Matthies, M., Koormann, F., Schulze, C.; Wagner, J.-O. (1999): GREAT-ER a geography-referenced regional exposure assessment tool for European rivers. - In: River Basin Management - Challenge to Research (Ed. W. Geller). - UFZ-Bericht Nr. 31/1999, P. 109-112.
- Simonovich, S. P. (1996): Decision Support Systems for Sustainable Management of Water Resources. – General Principles. - In: Water International, Vol. 21, No. 4, pp 223-232. A decision support system (DSS) for river-basin management in the Elbe catchment
- Reichenauer TG, Germida JJ (2008). "Phytoremediation of organic contaminants in soil and groundwater". ChemSusChem. 1 (8–9): 708–17. doi:10.1002/cssc.200800125. PMID 18698569.
- Das, Pratyush Kumar (April 2018). "Phytoremediation and Nanoremediation : Emerging Techniques for Treatment of Acid Mine Drainage Water". Defence Life Science Journal. 3 (2): 190–196. doi:10.14429/dlsj.3.11346.
- Zhong, Jiawen; Liu, Yeqing; Chen, Xinheng; Ye, Zihao; Li, Yongtao; Li, Wenyan (2024-01-01). "The impact of acid rain on cadmium phytoremediation in sunflower (Helianthus annuus L.)". Environmental Pollution. 340: 122778. doi:10.1016/j.envpol.2023.122778. ISSN 0269-7491.
- Salt DE, Smith RD, Raskin I (1998). "PHYTOREMEDIATION". Annual Review of Plant Physiology and Plant Molecular Biology. 49: 643–668. doi:10.1146/annurev.arplant.49.1.643. PMID 15012249. S2CID 241195507.

- Mendez MO, Maier RM (2008), "Phytostabilization of Mine Tailings in Arid and Semiarid Environments—An Emerging Remediation Technology", Environ Health Perspect, 116 (3): 278–83, doi:10.1289/ehp.10608, PMC 2265025, PMID 18335091, archived from the original on 2008-10-24.


**Water management planning and projects (WMPP)**


- Ertas, A. & Jones, J. (1996). The Engineering Design Process. 2nd ed. New York, N.Y., John Wiley & Sons, Inc.
- Dym, C.L. & Little, P. (2009). Engineering Design. 3rd ed. New York, N.Y., John Wiley & Sons, Inc.
- Pahl, G. & Beitz, W. (1988). Engineering Design: a systematic approach. London, UK, The Design Council.
- A.Eide, R.Jenison, L.Mashaw, L.Northup. Engineering: Fundamentals and Problem Solving. New York City: McGraw-Hill Companies Inc.,2002
- Ralph, P., and Wand, Y. A Proposal for a Formal Definition of the Design Concept. In, Lyytinen, K., Loucopoulos, P., Mylopoulos, J., and Robinson, W., (eds.), Design Requirements Engineering: A Ten-Year Perspective: Springer-Verlag, 2009, pp. 103–136.
- Urizar, Mark (24 July 2013). The Project Manager's Checklist for Building Projects: Delivery Strategies & Processes. Xlibris Corporation (published 2013). p. 236. ISBN 9781483662954. Retrieved 2015-12-03.
- Compare: Herbst, Douglas; Edmondson, Samuel A. (2012). "Design-Build Procurement Approaches". In Shorney-Darby, Holly (ed.). Design-build for Water and Wastewater Projects. American Water Works Association. p. 73. ISBN 9781583218181.
- Bosio, Erica; Djankov, Simeon; Glaeser, Edward; Shleifer, Andrei (2022). "Public Procurement in Law and Practice". American Economic Review. 112 (4). AEA: 1091–1117. doi:10.1257/aer.20200738
- Hysell, Helen (1922). The Science of Purchasing. New York: Appleton.


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|---|---|---|---|---|
| **Study programme:** | Water Engineering | | | |
| **Module level:** | Master | | | |
| **Module Nr.:** | 2. | | | |
| **Module name:** | Water Supply | | | |
| **Module components:** | Drinking water distribution; Design of water supply pipelines | | | |
| **Semester:** | 1 | | | |
| **Module responsible:** | Prof. Dr.-Ing. Irene Slavik; | | | |
| **Lecturers:** | Prof. Dr.-Ing. Irene Slavik; Prof. Dr.-Ing. Torsten Schmidt | | | |
| **Language:** | English | | | |
| **Correlation to Curriculum:** | ***Study programme:*** | Water Engineering | | |
| | ***Compulsory:*** | | | |
| | ***Elective:*** | X | | |
| **Teaching form/ SWH/ Workload/ Credits:** | ***Teaching form*** | ***SWH*** | ***Credits*** | ***Workload*** 5 SWH…Attendance time 5 SWH…Self study Exam preparation is included |
| | ***L:*** | | | |
| | ***Tu:*** | | | |
| | ***Summe:*** | 6 | 6 | |
| **Prerequisites according to examination regulations:** | Bachelor's degree | | | |
| **Recommended prerequisites:** | Fluid mechanics, hydro mechanics | | | |
| **Module objectives / intended learning outcomes:** | Knowledge and abilities in dimensioning, design and planning of water transport and distribution systems including pumping stations and storage facilities as well as rehabilitation strategies | | | |
| **Content:** | • Water demand calculation<br>• Planning of water transport and distribution systems<br>• Dimensioning of water transport pipes<br>• Pipe network calculation<br>• Pressure area zoning<br>• Rehabilitation<br>• Dimensioning and design of water pumping systems<br>• Dimensioning and planning aspects for water storage facilities | | | |
| **Examination prerequisites:** | Semester project | | | |
| **Study/examination tasks/forms of examination:** | Written examination | | | |
| **Applicability of the module:** | Modern teaching method that allows unrestricted participation and successful graduation even without participation in in-class events. The only prerequisite is access to the Moodle course by a university account (email address) | | | |
| Media forms/ Learning method: | Inverted/flipped classroom, tutorials, exercises & worksheets, slide sets, exam training, in-class events for practice & application | | | |
| Literature: | | | | |
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| **Study programme:** | Water Engineering | | | |
| **Module level:** | Master | | | |
| **Module Nr.:** | 3. | | | |
| **Module name:** | Environmental Statistics and Artificial Intelligence | | | |
| **Module components:** | Statistical Methods; Machine Learning and Artificial Intelligence | | | |
| **Semester:** | 1 | | | |
| **Module responsible:** | Prof. Dr. rer. nat. Reik Donner | | | |
| **Lecturer:** | Prof. Dr. rer. nat. Reik Donner | | | |
| **Language:** | English | | | |
| **Correlation to Curriculum:** | ***Study programme:*** | Water Engineering | | |
| | ***Compulsory:*** | | | |
| | ***Elective:*** | X | | |
| **Teaching form/ SWH/ Workload/ Credits:** | ***Teaching form*** | ***SWH*** | ***Credits*** | ***Workload*** 42 hours…attendance time 42 hours…self study 42 hours…exam preparation |
| | ***L/Tu:*** | 2 | 3 | |
| | ***LP:*** | 2 | 3 | |
| | ***Summe:*** | 4 | 6 | |
| **Prerequisites according to examination regulations:** | Bachelor degree | | | |
| **Recommended prerequisites:** | Basic knowledge of descriptive statistics, familiarity with basic programming concepts | | | |
| **Module objectives / intended learning outcomes:** | After completion of the module, the students will have profound working knowledge on different types of environmental data (discrete and continuous, univariate and multivariate, time series) and how these can be analyzed using standard statistical techniques as well as more modern machine learning approaches. They will be able to formulate research hypotheses and select specific statistical methods for testing them according to the specific aims of analysis, develop necessary code snippets for applying these methods to given environmental data sets using a state-of-the-art scientific programming environment (Python), and interpret the obtained results correctly. | | | |
| **Content:** | • Fundamental concepts of probability theory and applied statistics: discrete and continuous random variables, distribution functions, statistical descriptors, extreme value statistics<br>• Assessing dependency among bivariate data graphically and numerically<br>• Multivariate statistics: regression and classification problems, linear models, dimensionality reduction, supervised and unsupervised classification<br>• Time series analysis: stationarity, trend assessment, correlation functions, power spectral density<br>• Machine learning: neural networks, loss function and training process, common network architectures for different types of regression and classification problems<br><br>While the lectures will provide the necessary theoretical foundations for understanding different types of traditional statistical as well as modern machine learning methods, the practical part of the course will provide the | | | |

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| | students with hands-on experience on working with examples of environmental datasets, partially originating from past or ongoing research projects. |
| **Examination prerequisites:** | Participation in lectures and practical sessions |
| **Study/examination tasks/forms of examination:** | Term paper or Term project with oral presentation/colloquium |
| **Applicability of the module:** | |
| **Media forms/ Learning method:** | Presentations (board, PPT), demonstration of practical examples (with statistical software), introduction and guided hands-on training in using scientific programming environments (Python/Jupyter notebooks or similar) |
| **Literature:** | To be provided in the course as needed |
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| **Study programme:** | Water Engineering | | | |
| **Module level:** | Master | | | |
| **Module Nr.:** | 4. | | | |
| **Module name:** | Waste technologies | | | |
| **Module components:** | Waste treatment; Waste and ocean | | | |
| **Semester:** | 1 | | | |
| **Module responsible:** | Prof. Dr.-Ing. Carsten Cuhls | | | |
| **Lecturers:** | Prof. Dr.-Ing. Gilian Gerke; Prof. Dr.-Ing. Carsten Cuhls | | | |
| **Language:** | English | | | |
| **Correlation to Curriculum:** | ***Study programme:*** | Water Engineering | | |
| | ***Compulsory:*** | | | |
| | ***Elective:*** | X | | |
| **Teaching form/ SWH/ Workload/ Credits:** | ***Teaching form*** | ***SWS*** | ***Credits*** | ***Gerke: 90 h (3 Cr) Workload*** 21 h Attendance, 20 h Self study 49 h Exam preparation ***Cuhls: 90 h (3 Cr) Workload*** 28 h Attendance, 22 h Self study 40 h Exam preparation |
| | ***L:*** | | 3 (Gerke) 3 (Cuhls) | |
| | ***Tu:*** | | | |
| | ***Summe:*** | 4 | 6 | |
| **Prerequisites according to examination regulations:** | Bachelor degree | | | |
| **Recommended prerequisites:** | Gerke: none Cuhls: chemical and biological basics | | | |
| **Module objectives / intended learning outcomes:** | An understanding for sustainability due waste in general, recycling technologies, material recovery, biological and thermal processes, exhaust gas treatment technologies, disposal and impacts for the ecosystem ocean. | | | |
| **Content:** | *Gerke: General overview sustainability*<br>- *Different sources for waste into the ocean*<br>- *Reasins and Solutions, status quo, technology*<br>- *International waste management int.*<br>*Cuhls: General overview into waste hierarchy a. solid waste management*<br>- *Recycling technologies (glass, paper, metal, plastic, construction)*<br>- *Biological treatment: composting, anaerobic digestion, biogas*<br>- *Thermal treatment, energy recovery, CO2-removal*<br>- *Slag and ash, exhaust gas treatment and emission control*<br>- *Waste disposal and landfill design, environmental problems, GHG* | | | |
| **Examination prerequisites:** | Lecture or equal documents | | | |
| **Study/examination tasks/forms of examination:** | Term paper, Design project, Written examination | | | |
| **Applicability of the module:** | *Content out of praxis for praxis* | | | |
| **Media forms/ Learning method:** | Slides ppt, Moodle platform, in presence and possibility for hybrid synchronised, seminar lecture | | | |
| **Literature:** | Script on Moodle platform and actual suggested material in lecture | | | |
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| **Study programme:** | Water Engineering | | | |
| **Module level:** | Master | | | |
| **Module Nr.:** | 5. | | | |
| **Module name:** | Restoration Ecology | | | |
| **Module components:** | Ecology and restoration of rivers; Ecology and restoration of lakes; Ecology in arid terrestrial systems | | | |
| **Semester:** | 1 | | | |
| **Module responsible:** | Prof. Dr. rer.nat. habil. Volker Lüderitz | | | |
| **Lecturers:** | Prof. Dr. rer.nat. habil. Volker Lüderitz; Dr. Martin Schultze;<br>Prof. Dr. José Ramón Arévalo | | | |
| **Language:** | English | | | |
| **Correlation to Curriculum:** | ***Study programme:*** | Water Engineering | | |
| | ***Compulsory:*** | | | |
| | ***Elective:*** | X | | |
| **Teaching form/ SWH/ Workload/ Credits:** | ***Teaching form*** | ***SWH*** | ***Credits*** | ***180 h Workload*** |
| | ***L/S:*** | 4 | 4 | |
| | ***Tr:*** | 2 | 2 | |
| | ***Summe:*** | 6 | 6 | |
| **Prerequisites according to examination regulations:** | Bachelor degree | | | |
| **Recommended prerequisites:** | Basic knowledge in ecology and limnology | | | |
| **Module objectives / intended learning outcomes:** | Students are able to assign surface water bodies to specific water types and carry out a type-specific ecological and hydromorphological assessment. On the basis of these assessments, they are able to design, plan, provide technical support and evaluate the success of these measures for renaturation, restoration and remediation measures for flowing and standing water. | | | |
| **Content:** | • Requirements of the EC WFD for the protection and management of water bodies<br>• Typology of streams, rivers and lakes in Germany<br>• Biological assessment of running waters with the components diatoms/phytobenthos, macrophytes, macroinvertebrates and fish<br>• Hydromorphological assessment of rivers<br>• Restoration of rivers<br>• Monitoring the success of restoration measures<br>• Artificial and Significantly Modified Waters – the Good Ecological Potential<br><br>Ecology of lakes:<br>Basics in lake ecology and lake restauration. Ecology and restauration aspects in international projects. Project management and strategies. | | | |
| **Examination prerequisites:** | Participation in lessons, seminars, fieldwork and labwork | | | |
| **Study/examination tasks/forms of examination:** | Term paper, research project, | | | |

| **Applicability of the module:** | |
|---|---|
| Media forms/<br>Learning method: | ppt presentations, textbooks, original papers, field trips<br>Self-study, topic work, field work, laboratory studies |
| Literature: | • DOKULIL/HAMM/KOHL: Ökologie und Schutz von Seen, Facultas-Verlag<br>• FREDE/DABBERT: Handbuch zum Gewässerschutz in der Landwirtschaft, Ecomed-Verlag<br>• GUNKEL: Renaturierung kleiner Fließgewässer, Gustav-Fischer-Verlag<br>• HÜTTE: Ökologie und Wasserbau, Parey-Verlag<br>• KLAPPER: Eutrophierung und Gewässerschutz, Gustav-Fischer-Verlag<br>• LÜDERITZ/LANGHEINRICH/KUNZ: Flussaltwässer. Ökologie und Sanierung.<br>• POTT/REMY: Gewässer des Binnenlandes, Ulmer-Verlag.<br>• SCHÖNBORN: Lehrbuch der Limnologie, Schweizerbartsche Verlagsbuchhandlung.<br>• SUCCOW/JOOSTEN: Landschaftsökologische Moorkunde, Schweizerbartsche Verlagsbuchhandlung.<br>• UHLMANN/HORN: Hydrobiologie der Binnengewässer, Ulmer-Verlag |
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| **Study programme:** | Water Engineering | | | |
| **Module level:** | Master | | | |
| **Module Nr.:** | 7. | | | |
| **Module name:** | Environmental Chemistry of Waters | | | |
| **Module components:** | Aquatic environmental chemistry; Analysis of water constituents and pollutants; Water quality and pollution | | | |
| **Semester:** | 1 | | | |
| **Module responsible:** | Prof. Kilian Smith Ph.D | | | |
| **Lecturer:** | Prof. Kilian Smith Ph.D | | | |
| **Language:** | English | | | |
| **Correlation to Curriculum:** | ***Study programme:*** | Water Engineering | | |
| | ***Compulsory:*** | | | |
| | ***Elective:*** | X | | |
| **Teaching form/ SWH/ Workload/ Credits:** | ***Teaching form*** | ***SWH*** | ***Credits*** | ***Workload*** |
| | ***L/Tu:*** | 2 | 2 | 63 hours…Attendance time |
| | ***LP:*** | 4 | 4 | 77 hours…Self study |
| | ***Summe:*** | 6 | 6 | 30 hours….Exam preparation |
| **Prerequisites according to examination regulations:** | Bachelor degree | | | |
| **Recommended prerequisites:** | Basic knowledge of general and environmental chemistry | | | |
| **Module objectives / intended learning outcomes:** | After completion of the module the students should have knowledge about how water quality is affected by different classes of aquatic contaminants. These include inorganic pollutants (e.g., nutrients, heavy metals, acidity) but also organic micropollutants (e.g., pesticides, pharmaceuticals, industrial chemicals). The focus is on the sources on these contaminants, their fate and impact in aquatic ecosystems but also technologies for their removal.<br><br>The practical component of the course covers the sampling and anaylsis of samples taken from aquatic ecosystems. This includes hand-on experience with the different analytical approaches that are typically applied including photometric methods but also more advanced methods such as liquid and gas chromatography coupled with various detectors (e.g., DAD, fluorescent and mass spectrometric detectors). A particular focus is on analytical quality assurance and control to ensure the reliability of the data and how these can then be used to determine water quality. | | | |
| **Content:** | • Contaminants of aquatic ecosystems and their impacts: nutrients and eutrophication, acid deposition, heavy metals and organic micropollutants<br>• Sampling and analysis of inorganic and organic pollutants in water samples using different methods<br>• Application of pollutant measurements for the determination of water quality | | | |
| **Examination prerequisites:** | Participation in lectures, seminars, field and lab work | | | |
| **Study/examination** | Term paper or Design project or Written examination | | | |

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| **tasks/forms of examination:** | |
| **Applicability of the module:** | |
| **Media forms/<br>Learning method:** | Multimedia tools (presentations, videos etc.), whiteboard, printed material, laboratory practicals |
| **Literature:** | T. Brown, H. LeMay, B. Bursten, C. Murphy, P. Woodward and M. Stoltzfus, Chemistry: The Central Science, 14th ed. Harlow, Essex, UK: Pearsons Education Limited, 2007.<br><br>Eds. R. P. Schwarzenbach, P. M. Gschwend and D. M. Imboden, Environmental Organic Chemistry, 3rd ed. USA: John Wiley & Sons Inc, 2016.<br><br>P. L. Brezonik, W. A. A. Arnold, Water chemistry: an introduction to the chemistry of natural and engineered aquatic. Oxford, England: Oxford University Press, 2011.<br><br>A. Manz, P. S. Dittrich, N. Pamme and D. Lossifidis, Bioanalytical Chemistry, 2nd ed. London, UK: Imperial College Press, 2015. |
| **Status:** | SoSe 2026 |

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| **Study programme:** | Water Engineering | | | |
| **Module level:** | Master | | | |
| **Module Nr.:** | 8. | | | |
| **Module name:** | Groundwater | | | |
| **Module components:** | Groundwater modelling of dams; Groundwater models | | | |
| **Semester:** | 1 | | | |
| **Module responsible:** | Prof. Dr. rer.nat. habil. Reinstorf | | | |
| **Lecturer:** | Prof. Dr. rer.nat. habil. Reinstorf; Dr.-Ing Peter Grubert | | | |
| **Language:** | English | | | |
| **Correlation to Curriculum:** | ***Study programme:*** | Water Engineering | | |
| | ***Compulsory:*** | | | |
| | ***Elective:*** | X | | |
| **Teaching form/ SWH/ Workload/ Credits:** | ***Teaching form*** | ***SWH*** | ***Credits*** | ***180 h Workload***<br>62 h…Attendance time<br>46 h…Self study<br>72 h….Exam preparation |
| | ***L/Tu:*** | 4 | | |
| | | | | |
| | ***Sum:*** | 4 | 6 | |
| **Prerequisites according to examination regulations:** | Bachelor degree | | | |
| **Recommended prerequisites:** | | | | |
| **Module objectives / intended learning outcomes:** | The aim is to get students familiar with basic skills and knowledge of groundwater transport/flow and to enable them to set up groundwater models for various issues and to analyze and evaluate the issues through scenario calculations. | | | |
| **Content:** | ***1 Aim & Definition of terms***<br>***2 Types of groundwater***<br>***3 Parameters***<br>*3.1 Storage coefficient*<br>*3.2 Hydraulic conductivity*<br>***4 Physical Laws***<br>*4.1 Darcy's Law*<br>*4.2 Balance*<br>***5 Determination of geohydraulic parameters***<br>*5.1 Pumping tests*<br>*5.2 Theoretical basic to assess pumping tests*<br>***6 Functions of groundwater***<br>*6.1 Groundwater as reservoir*<br>*6.2 Interaction between ground- and surface waters*<br>*6.2.1 Storage at high floods (bank storage)*<br>*6.2.2 Feeding the base flow*<br>*6.2.3 Groundwater dynamics - Quality*<br>*6.2.4 Ecological aspects*<br>*6.3 Functions of groundwater systems*<br>***7 Groundwater models***<br>*7.1 Aims*<br>*7.2 Model building*<br>*7.2.1 Model types* | | | |

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| | *7.3 Data*<br>*7.3.1 Parameters and boundary conditions*<br>*7.4 Groundwater models as elements of an decision support system*<br>*7.5 Model application*<br>*7.5.1 Groundwater extractions*<br>*7.5.2 Effects of building of power stations*<br>*7.5.3 Modeling the Substance transport (see Chap.8)*<br>***8 Substance transport***<br>*8.1 Substance characteristics*<br>*8.2 Transport mechanism*<br>*8.2.1 Advective substance transport*<br>*8.2.2 Diffusive substance transport*<br>*8.2.3 Dispersive substance transport*<br>*8.2.4 Advection-Dispersion-Equation (ADE)*<br>*8.2.5 Transport reactive substance*<br>*8.3 Calculation of the substance transport in groundwasser*<br>*8.3.1 Analytical models (continuous solution procedures)*<br>*8.3.2 Numerical models (discrete solution procedures)*<br>*8.3.3 Stochastical models*<br>*8.4 Hydrological remediation technologies for groundwater contamination cases*<br>***9 Geohydraulic issues***<br>*9.1 Groundwater and dam stability issues*<br>*9.2 Seepage quantities and drainage issues*<br>*9.3. Excavations and groundwater drawdown issues*<br>*9.4 .Groundwater flow and influence on structures* |
| **Examination prerequisites:** | B.Eng. or B.Sc. |
| **Study/examination tasks/forms of examination:** | Design project (Scientific project) |
| **Applicability of the module:** | |
| **Media forms/ Learning method:** | Seminar / Lecture |
| **Literature:** | R. Allan Freeze, 1979: Groundwater, Pearson, ISBN-100133653129<br>Mary P. Anderson , William W. Woessner, et al., 2015: Applied Groundwater Modeling: Simulation of Flow and Advective Transport, Academic Press, ISBN-100120581035,<br>Jacob Bear, 2012: Hydraulics of Groundwater (Dover Books on Engineering) (English Edition), ISBN-13978-0486453552<br>Charles R. Fitts, 2023: Groundwater Science, Academic Press, ISBN-10 012811455X |
| **Status:** | SuSe 2026 |

**Department of Water, Environment, Construction and Safety**

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| **Study programme:** | Water Engineering | | | |
| **Module level:** | Master | | | |
| **Module Nr.:** | 9. | | | |
| **Module name:** | Hydraulic Engineering | | | |
| **Module components:** | Design of hydraulic structures; Risk management; Flood protection | | | |
| **Semester:** | 2 | | | |
| **Module responsible:** | Prof. Dr. Ing. Bernd Ettmer | | | |
| **Lecturer:** | Prof. Dr. Ing. Bernd Ettmer; Dr. Annika Schüttrumpf; Prof. Dr.Ing. Daniel Bachmann | | | |
| **Language:** | English | | | |
| **Correlation to Curriculum:** | ***Study programme:*** | Water Engineering | | |
| | ***Compulsory:*** | | | |
| | ***Elective:*** | X | | |
| **Teaching form/ SWH/ Workload/ Credits:** | ***Teaching form*** | ***SWH*** | ***Credits*** | ***Workload*** h…Attendance time h…Self study h….Exam preparation |
| | ***L:*** | | | |
| | ***Tu:*** | | | |
| | ***Summe:*** | 6 | 6 | |
| **Prerequisites according to examination regulations:** | Bachelor degree | | | |
| **Recommended prerequisites:** | | | | |
| **Module objectives / intended learning outcomes:** | After successfully completing the module, students will have in-depth knowledge and skills of the physical processes on the coast (tides, currents, waves and storm surges) and the functionality and planning of coastal protection structures. The special features of estuary areas are discussed and various case studies on flood protection structures (coast and rivers) are presented.<br><br>The lectures are focused on hydraulic engineering planning and development of projects which are part of civil engineering and is primarily concerned with the construction of hydraulic engineering facilities as well as the development and maintenance of water bodies. This applies to both standing and flowing bodies of water, from inland to coastal waters<br><br>The student will learn the planning and implementation of diverse complex projects worldwide on flood risk management, river engineering, flood defenses, hydropower plants and dams, pumped storage hydropower plants, river diversion and water transfer tunnel systems, sustainable storm urban drainage and sponge city, each topic applied to the country and region reality and its applicability, considering perennial and non perennial river basins; green and arid river basins; mountain and alluvial rivers; wadis, gullies and torrents; lakes and estuaries: and under an integrated river basin and coastal management consideration, and taking anthropogenic and non-anthropogenic changes into account.<br><br>Other topics as for instance hydrology, sedimentology, geology, geotechnics, environment and social aspects are also discussed as the | | | |

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| | basis of a project definition to understand the variables of a project including the cost benefit analysis methodology. |
| **Content:** | Flood Protection:<br>Different types of coasts<br>Tides<br>Currents and sediment transport<br>Wave theories<br>Storm surges<br>Planning and dimensioning of structures<br>Influence of tides in estuaries<br>Case studies on flood protection (coastal and river areas) |
| **Examination prerequisites:** | |
| **Study/examination tasks/forms of examination:** | Term paper, Design project, Written examination |
| **Applicability of the module:** | |
| **Media forms/ Learning method:** | |
| **Literature:** | |
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| **Study programme:** | Water Engineering | | | |
| **Module level:** | Master | | | |
| **Module Nr.:** | 10. | | | |
| **Module name:** | Hydrology and GIS | | | |
| **Module components:** | GIS and Hydrology; Advanced Hydrology | | | |
| **Semester:** | 2 | | | |
| **Module responsible:** | Prof. Dr. rer. nat. habil. Frido Reinstorf | | | |
| **Lecturer:** | Prof. Dr. rer. nat. habil. Frido Reinstorf; Dr. Alejandra Stehr | | | |
| **Language:** | English | | | |
| **Correlation to Curriculum:** | ***Study programme:*** | Water Engineering | | |
| | ***Compulsory:*** | | | |
| | ***Elective:*** | X | | |
| **Teaching form/ SWH/ Workload/ Credits:** | ***Teaching form*** | ***SWH*** | ***Credits*** | ***180 h Workload*** 62 h…Attendance time 46 h…Self study 72 h…Exam preparation |
| | ***L:*** | 4 | | |
| | ***Tu:*** | 1 | | |
| | ***Sum:*** | 5 | 6 | |
| **Prerequisites according to examination regulations:** | Bachelor degree | | | |
| **Recommended prerequisites:** | | | | |
| **Module objectives / intended learning outcomes:** | The aim is to enable students to use a geoinformation system and to solve hydrological and other professional issues on the basis of digital databases. | | | |
| **Content:** | • *Quick start tutorial to refresh the ability to work with GIS or to learn basic skills for using GIS*<br>• *1. Exercise: ArcCatalog*<br>• *2. Exercise: ArcMap*<br>• *3. Exercise: Working with attribute tables*<br>• *4. Exercise: Selection of features*<br>• *5. Exercise: Geodatabase*<br>• *6. Exercise: Coordinate systems, projections and grids*<br>• *7. Exercise: Layouting of maps*<br>• *8. Exercise: Editing and Geoverarbeitung*<br>• *9. Exercise: Georeferencing of raster datasets*<br>• *10. Exercise: Kriging*<br>• *11. Exercise: Hydrological analysis using the GIS toolbox*<br>• *Scientific project: Endanger and damage potential maps for the precautionary high flood protection* | | | |
| **Examination prerequisites:** | B.Eng. or B.Sc. | | | |
| **Study/examination tasks/forms of examination:** | Design project (Scientific project) | | | |
| **Applicability of the module:** | | | | |
| **Media forms:** | Seminar / Lecture | | | |

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| **Learning method:** | |
| **Literature:** | Michael N. DeMers, 2009: GIS For Dummies, ISBN 100470236825<br>Bill, R., 2023: Grundlagen der Geo-Informationssysteme, Herbert Wichmann Verlag, Heidelberg.<br>Dawn J. Wright , Christian Harder, et al., 2020: GIS for Science: Applying Mapping and Spatial Analytics (GIS for Science, 2)<br>Wilpen L. Gorr und Kristen S. Kurland, 2023: GIS Tutorial for ArcGIS Pro 3.1ISBN- 10 1589487397 |
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| **Study programme:** | Water Engineering | | | |
| **Module level:** | Master | | | |
| **Module Nr.:** | 11. | | | |
| **Module name:** | Experimental Hydraulics | | | |
| **Module components:** | Model theory; Hydraulic and morphological experiments; Measurements techniques | | | |
| **Semester:** | 2 | | | |
| **Module responsible:** | Prof. Dr. Ing. Bernd Ettmer | | | |
| **Lecturer:** | Prof. Dr. Ing. Bernd Ettmer; M.Eng. Stefan Orlik | | | |
| **Language:** | English | | | |
| **Correlation to Curriculum:** | ***Study programme:*** | Water Engineering | | |
| | ***Compulsory:*** | | | |
| | ***Elective:*** | X | | |
| **Teaching form/ SWH/ Workload/ Credits:** | ***Teaching form*** | ***SWH*** | ***Credits*** | ***180 h Workload*** |
| | ***L:*** | | | |
| | ***Tu:*** | | | |
| | ***Summe:*** | 5 | 6 | |
| **Prerequisites according to examination regulations:** | Bachelor degree | | | |
| **Recommended prerequisites:** | Basics of hydrostatics and hydrodynamics, e.g. continuity equation, super- and subcritical flow, pressure to water depth relation, calculus of flow velocity, classification of flow patterns: steady/unsteady uniform/non-uniform, conservation laws: mass, momentum, energy, relation of temperature to viscosity | | | |
| **Module objectives / intended learning outcomes:** | Basic principles of experimental hydraulics, basics of sediment behavior in flumes (laboratory) and rivers (nature), scaling laws, sedimentation engineering | | | |
| **Content:** | Physical modelling of sediments, (1) dam break experiment, (2) Detection of critical velocity and fall velocity (3) Scouring at hydraulic structures Insights into laboratory halls and use of measurement techniques | | | |
| **Examination prerequisites:** | - | | | |
| **Study/examination tasks/forms of examination:** | Experimental coursework, Written examination or homework | | | |
| **Applicability of the module:** | Model theory, measurements techniques, practical approaches to get basic information of flow, rivers and sediment, e.g. properties of flow, important sediment properties, measurement of flow and sediment properties | | | |
| **Media forms/ Learning method:** | Laboratory experiments, physical model tests | | | |
| **Literature:** | Script<br>Van Rijn (1993): “Principles of sediment transport in rivers, estuaries and coastal seas”, Aqua Publications, ISBN 90-800356-2-9.<br><br>Jimenez & Madsen (2003): “A Simple Formula to Estimate Settling Velocity of Natural Sediments”, Journal of Waterway, Port, Coastal, and Ocean | | | |

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| | Engineering, Vol. 129-2, March 1, 2003, ISSN 0733-950X/2003/2-70–78 |
| **Status:** | SuSe 2026 |

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| **Study programme:** | Water Engineering | | | |
| **Module level:** | Master | | | |
| **Module Nr.:** | 12. | | | |
| **Module name:** | River Morphology | | | |
| **Module components:** | River Morphology; Sediment transport; Sedimentation and Erosion | | | |
| **Semester:** | 2 | | | |
| **Module responsible:** | Prof. Dr. Ing. Bernd Ettmer | | | |
| **Lecturer**: | Dr.-Ing. Francisco Nuñez-Gonzalez; Dr.-Ing. Carles Ferrer; Prof. Dr.-Ing. Oscar Link | | | |
| **Language:** | English | | | |
| **Correlation to Curriculum:** | ***Study programme:*** | Water Engineering | | |
| | ***Compulsory:*** | | | |
| | ***Elective:*** | X | | |
| **Teaching form/ SWH/ Workload/ Credits:** | ***Teaching form*** | ***SWH*** | ***Credits*** | ***180 h Workload*** |
| | ***L:*** | | | |
| | ***Tu:*** | | | |
| | ***Summe:*** | 6 | 6 | |
| **Prerequisites according to examination regulations:** | Bachelor degree | | | |
| **Recommended prerequisites:** | Hydraulics, Hydrology, Fluid Mechanics, Physics | | | |
| **Module objectives / intended learning outcomes:** | Understanding of River Morphology, Topography of riverbanks, design of bed forms. Sediment transport and erosion processes. Interaction between hydraulics and sediment. | | | |
| **Content:** | *River Morphology*<br>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.<br><br>*Sediment transport*<br>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.<br><br>*Sedimentation and Erosion*<br>Understanding of Sediment transport mechanisms and basics concepts for gravel bed rivers, Classification of sediment transport processes, Critical shear stress concept and incipient motion for granular, Armour layer deveplopment, Examples of Bed load and Suspended sediment transport and Reservoir sedimentation. | | | |
| **Examination prerequisites:** | | | | |
| **Study/examination** | Design project; Written examination | | | |

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| **tasks/forms of examination:** | |
| **Applicability of the module:** | |
| **Media forms/ Learning method:** | |
| **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<br>-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.<br>-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<br>-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<br>-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<br>-Nikora, V. (2009). "Hydrodamics of aquatic ecosystems: An interface between Ecology, Biomechanics and Environmental Fluid Mechanics." River Res. Appl., DOI: 10.1002/rra.1291.<br>-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.<br>-van Rijn, L.C. (1984). "Sediment transport, part II: suspended load transport." Journal of Hydraulic Engineering, 110(11), 1613-1641.<br>-van Riijn, L.C. (2007). "Unified view of sediment transport by currents and waves. II: Suspended transport." J. Hydraul. Eng., 133(6), 668-689.<br>-Yalin, M.S. (1965). "Similarity in sediment transport by currents." Hydraulic Research Paper Nr. 6, Hydraulics Research Station, London.<br>-Yalin, M.S. (1992). River Mechanics. Pergamon Press, Oxford. -Yalin, M.S., da Silva, A.M. (2001). Fluvial Processes, IAHR, Monograph |
| **Status:** | SuSe 2026 |

**Department of Water, Environment, Construction and Safety**

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| **Study programme:** | Water Engineering | | | |
| **Module level:** | Master | | | |
| **Module Nr.:** | 13. | | | |
| **Module name:** | Computational Fluid Dynamics | | | |
| **Module components:** | 1 dhn-modelling ; 2 dhn-modelling | | | |
| **Semester:** | 2 | | | |
| **Module responsible:** | Prof. Dr.-Ing. Daniel Bachmann | | | |
| **Lecturer:** | Prof. Dr.-Ing. Daniel Bachmann; Prof. Dr.-Ing. Bernd Ettmer; Dr.-Ing. Daniel Hesse; Linda Bromberg, M. Eng. | | | |
| **Language:** | English | | | |
| **Correlation to Curriculum:** | ***Study programme:*** | Water Engineering | | |
| | ***Compulsory:*** | | | |
| | ***Elective:*** | X | | |
| **Teaching form/ SWH/ Workload/ Credits:** | ***Teaching form*** | ***SWH*** | ***Credits*** | ***Workload*** 60 h…Attendance time 120 h…Self study & Exam preparation |
| | ***L:*** | 2 | 3 | |
| | ***Tu:*** | 2 | 3 | |
| | ***Sum:*** | 4 | 6 | |
| **Prerequisites according to examination regulations:** | Bachelor degree | | | |
| **Recommended prerequisites:** | Mathematics, hydromechanics, hydrology | | | |
| **Module objectives / intended learning outcomes:** | After successfully completing the module, students will have the necessary knowledge and skills to independently solve practical water management problems with the help of numerical modelling as a direct preparation for their professional work. | | | |
| **Content:** | The module is divided into three sections.<br><br>The main topics of the section *1 dhn-modelling* are:<br>- Introduction to modelling<br>- Methods and tools of water management<br>- The modelling process: from problem definition to a project report<br>- Mathematical-physical description of the flow in surface waters<br>- Numerical methods<br>- Introduction and practical application of software for 1d modelling of surface water<br><br>Additional topic on *1 dhn-modelling* with a focus on *case study* for a river:<br>- Introduction to the project area<br>- Model calibration, hydraulic calculations, analysis of the results<br><br>The main topics of the section *2 dhn-modelling* are:<br>- Introduction to 2dhn-modelling<br>- Mathematical-physical description of the flow in surface waters<br>- Introduction and practical application of software for *2 dhn-modelling* of surface water<br>- Practical application example with a focus on *2 dh-modelling* | | | |

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| **Examination prerequisites:** | No |
| **Study/examination tasks/forms of examination:** | Project work (*1 dhn-modelling*); Project work (*Case study);* Project work (*2 dhn-modelling*) |
| **Applicability of the module:** | |
| **Media forms/ Learning method:** | Presentation, video material, Moodle learning platform, blackboard, software application |
| **Literature:** | Will be announced during the course. |
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| **Study programme:** | Water Engineering | | | |
| **Module level:** | Master | | | |
| **Module Nr.:** | 14. | | | |
| **Module name:** | Waste Water | | | |
| **Module components:** | Waste water technology; Slugde treatment and anaerobic treatment; Design of sewer networks | | | |
| **Semester:** | 2 | | | |
| **Module responsible:** | Prof. Dr. Ing. Jürgen Wiese | | | |
| **Lecturer**: | Prof. Dr.-Ing. Jürgen Wiese; Prof. Dr.-Ing. Torsten Schmidt | | | |
| **Language:** | English | | | |
| **Correlation to Curriculum:** | ***Study programme:*** | Water Engineering | | |
| | ***Compulsory:*** | | | |
| | ***Elective:*** | X | | |
| **Teaching form/ SWH/ Workload/ Credits:** | ***Teaching form*** | ***SWH*** | ***Credits*** | ***Workload*** h…Attendance time h…Self study h…Exam preparation |
| | ***L:*** | | | |
| | ***Tu:*** | | | |
| | ***Summe:*** | 5 | 6 | |
| **Prerequisites according to examination regulations:** | Bachelor degree | | | |
| **Recommended prerequisites:** | Knowledge of ecology, hydrobiology, hydro- and waste chemistry, hydrology, limnology, water protection and hydromechanics | | | |
| **Module objectives / intended learning outcomes:** | Completing the module enables students to independent systems for wastewater and sludge treatment to design and evaluate. The students can take a leading role in the operation of such systems. | | | |
| **Content:** | *Waste water and sludge treatment*<br>*• Mechanical wastewater treatment (e.g. screens, primary clarifiers)*<br>*• Chemical wastewater treatment (e.g. precipitation)*<br>*• Biological wastewater treatment (e.g. activated sludge systems)*<br>*• Natural wastewater treatment processes (e.g. pond systems)*<br>*• Small wastewater treatment plants*<br>*• Sludge stabilization process*<br>*• Sludge dewatering process*<br>*• Energy and raw materials from wastewater and sludge* | | | |
| **Examination prerequisites:** | | | | |
| **Study/examination tasks/forms of examination:** | Design project; Term paper | | | |
| **Applicability of the module:** | | | | |
| **Media forms/ Learning method:** | | | | |
| **Literature:** | | | | |
| **Status:** | SuSe 2026 | | | |

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| **Study programme:** | Water Engineering | | | |
| **Module level:** | Master | | | |
| **Module Nr.:** | 15. | | | |
| **Module name:** | Drinking Water Treatment | | | |
| **Module components:** | Drinking water treatment, Treatment plant design | | | |
| **Semester:** | 2 | | | |
| **Module responsible:** | Prof. Dr.-Ing. Irene Slavik | | | |
| **Lecturer:** | Prof. Dr.-Ing. Irene Slavik | | | |
| **Language:** | English | | | |
| **Correlation to Curriculum:** | | Water Engineering | | |
| | | | | |
| | | X | | |
| **Teaching form/ SWH/ Workload/ Credits:** | ***Teaching form*** | ***SWH*** | ***Credits*** | ***Workload*** 4 SWS…Attendance time 6 SWS…Self study Exam preparation is included |
| | ***L:*** | | | |
| | ***Tu:*** | | | |
| | ***Sum:*** | 6 | 6 | |
| **Prerequisites according to examination regulations:** | Bachelor's degree | | | |
| **Recommended prerequisites:** | Basic knowledge in water quality, water chemistry and process engineering | | | |
| **Module objectives / intended learning outcomes:** | Acquisition of specific basic knowledge<br>• chemical reactions<br>• mass balance analyses<br>• modelling of reactions in ideal reactors<br>• modelling of hydraulic conditions in reactors<br>Acquisition of knowledge and skills in water treatment and for the design/planning of the associated treatment plants | | | |
| **Content:** | • Basics of chemical reactions<br>• Basics of reactor analyses and modelling of reactions in ideal reactors<br>• Basics of hydraulic conditions in reactors and mixing<br>• Principle and design/planning of selected processes for water treatment and waste treatment<br>• Quality of water (characteristics and key quality indicators)<br>• Objectives of water treatment<br>• Air stripping and aeration<br>• Coagulation and flocculation<br>• Gravity separation<br>• Granular filtration<br>• Oxidation and advanced oxidation processes<br>• Adsorption<br>• Disinfection<br>• Removal of selected constituents<br><br>Design of<br>• Dosing and mixing systems<br>• Flocculation systems<br>• Advanced oxidation processes | | | |

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| | • Ozonation & biofiltration<br>• Activated carbon adsorption<br>• Water treatment processes in advanced wastewater treatment |
| **Examination prerequisites:** | |
| **Study/examination tasks/forms of examination:** | Written examination |
| **Applicability of the module:** | Modern teaching method that allows unrestricted participation and successful graduation even without participation in in-class events. The only prerequisite is access to the Moodle course by a university account (email address) |
| **Media forms/ Learning method:** | Inverted/flipped classroom, tutorials, exercises & worksheets, slide sets, exam training, in-class events for practice & application |
| **Literature:** | Mainly WHs Water Treatment - Principles and Design by Crittenden et al. |
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| **Study programme:** | Water Engineering | | | |
| **Module level:** | Master | | | |
| **Module Nr.:** | 16. | | | |
| **Module name:** | Social Aspects | | | |
| **Module components:** | Environmental laws and policies, Approval processes and Impact Assessment; Social-ecological systems | | | |
| **Semester:** | 2 | | | |
| **Module responsible:** | Prof. Dr. rer. nat. Petra Schneider | | | |
| **Lecturer:** | Prof. Dr. rer. nat. Petra Schneider; Prof. Dr. Lydia Bittner | | | |
| **Language:** | English | | | |
| **Correlation to Curriculum:** | ***Study programme:*** | Water Engineering | | |
| | ***Compulsory:*** | | | |
| | ***Elective:*** | X | | |
| **Teaching form/ SWH/ Workload/ Credits:** | ***Teaching form*** | ***SWH*** | ***Credits*** | ***Workload*** h…Attendance time h…Self study h….Exam preparation |
| | ***L:*** | | | |
| | ***Tu:*** | | | |
| | ***Sum:*** | 6 | 6 | |
| **Prerequisites according to examination regulations:** | Bachelor degree | | | |
| **Recommended prerequisites:** | | | | |
| **Module objectives / intended learning outcomes:** | **Environmental Law and Policies (ELP)**<br>Students will receive an overview of key global and EU environmental conventions and policies. The course covers legal frameworks on resources, water, biodiversity, energy, climate protection, and the circular economy. Students gain foundational insight into how environmental law shapes sustainable development and guides policy strategies at international and EU levels.<br><br>**Approval Processes and Impact Assessment (APIA)**<br>Students will understand key approval procedures and various impact assessments as well as the role oft he competent authority, including environmental, health, and sustainability. It provides essential knowledge on management systems and regulatory compliance for responsible project development..<br><br>**Social-Ecological Systems (SES)**<br>Students will explore the interaction between social and ecological systems, covering fundamentals and practical applications. Key topics include ecosystem services, stakeholder engagement, socio-economic aspects, and urban resilience. Students learn methods like DPSIR and synthesis techniques to assess sustainability challenges. | | | |
| **Content:** | **Environmental Law and Policies (ELP)**<br>• Overview on Global Conventions and Policies<br>• Global Resources Status and Resources Strategy<br>• EU Environmental Law | | | |

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| | • Global / EU Law and Policies on Mineral Resources and Waste Management<br>• Global / EU and Policies on Water<br>• Global / EU and Policies on Biodiversity, Biomass and Food<br>• Global / EU and Policies on Energy<br>• Global / EU and Policies on Waste Management and Circular Economy<br>• Green Deal and Green Economy<br>• Climate Protection Legislation<br><br>**Approval Processes and Impact Assessment (APIA)**<br>• Basics of Project Permitting Procedures<br>• Authorization Procedures in Spatial Planning<br>• Fundamentals of Impact Assessment<br>• Environmental Impact Assessment / Strategic Impact Assessment<br>• Health Impact Assessment / Gender Impact Assessment<br>• NATURA2000 Impact Assessment<br>• Quality Management / Occupational Health and Safety Management<br>• Environmental Management Systems<br>• Life Cycle Assessment<br>• Sustainability Assessment and Managemen<br><br>**Social-Ecological Systems (SES)**<br>• Socio-Ecohydrology<br>• Socio-Ecological Systems: Fundamentals<br>• Socio-Ecological Systems: Practicals<br>• Ecosystem Services<br>• DPSIR and Overview of Synthesis Methods<br>• Stakeholder Engagement<br>• Social and Environmental Economics<br>• Resilient Cities / Urban Metabolism<br>• Aquaculture<br>• Agriculture and Agroecology |
| **Examination prerequisites:** | B.Eng. or B.Sc. |
| **Study/examination tasks/forms of examination:** | ELP: Written exam, APIA: Group term paper, SES: single presentation |
| **Applicability of the module:** | |
| **Media forms/ Learning method:** | Seminar / lecture / group presentation |
| **Literature:** | **Environmental Law and Policies (ELP)**<br>• Birnie, P.; Boyle, A.; Redgwell, C. (2009). International Law and the Environment, 3. Aufl. 2009<br>• Bodansky, D.; Brunnée, J.; Hey, E. (Hrsg., 2007). The Oxford Handbook of International Environmental Law.<br>• Kiss, A.C. (2000). International Environmental Law, 2. Aufl.<br>• Krämer, K. (2006). EC Environmental Law, 6. Aufl. 2006<br>• Sands, P. (2003). Principles of International Environmental Law, 2. Aufl.<br>• Verschuuren, J. (2003). Principles of Environmental Law.<br>• WanaGopa - NyawakanMiller, G.T. & S. Spoolman (2011). Living in the Environment: Principles, Connections, and Solutions (17th ed.). Belmont, CA: Brooks-Cole. ISBN 978-0-538-73534-6.<br>• Ricklefs, R.E. (2005). The Economy of Nature (6th ed.). New York, NY: WH Freeman. ISBN 0-7167-8697-4.<br>• Morley, D. 2010. Understanding Computers: Today and Tomorrow, 13th ed. Course Technology, Stamford, CT. ISBN 0-538-74810-9. |

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**Approval Processes and Impact Assessment (APIA)**

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- Van Assche, K., & Verschraegen, G. (2008). The limits of planning: Niklas Luhmann's systems theory and the analysis of planning and planning ambitions. Planning theory, 7(3), 263-283.
- Gunder, M., & Hillier, J. (2009). Planning in ten words or less: A Lacanian entanglement with spatial planning. Ashgate Pub., Ltd.
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**Social-Ecological Systems (SES)**

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| | Canet-Marti, A.; Eder, M.; Flödl, P.; Kearney, K.; Ondiek, R.; Pucher, B:, Pucher, M:, Simperler, L.; Tschikof, M.; Wang, C. (2021). The coupled socio-ecohydrological evolution of river systems: Towards an integrative perspective of river systems in the 21st century, Science of The Total Environment, Volume 801, 2021, 149619, ISSN 0048-9697, https://doi.org/10.1016/j.scitotenv.2021.149619.<br>• Murugesu Sivapalan, Hubert H. G. Savenije, and Günter Blöschl, "Socio-hydrology: A new science of people and water," Hydrological Processes 26 (2012): 1270–6, https://doi.org/10.1002/hyp.8426.<br>• Kaveh Madani and Majid Shafiee- Jood, "Socio-Hydrology: A New Understanding to Unite or a New Science to Divide?" Water 12, no. 7 (2020): 1941, https://doi-org.proxy-um.researchport.umd.edu/10.3390/w12071941.<br>• Ahlborg H., I. Ruiz-Mercado, S. Molander, and O. Masera. 2019. Bringing technology into social-ecological systems research—motivations for a socio-technical-ecological systems approach. Sustainability 11(7). https://doi.org/10.3390/su11072009<br>• Anderies, J. M., M. A. Janssen, and E. Ostrom. 2004. A framework to analyze the robustness of social-ecological systems from an institutional perspective. Ecology and Society 9(1):18. https://doi.org/10.5751/ES-00610-090118<br>• Berkes, F. 1989. Common property resources. Ecology and community-based sustainable development. Belhaven Press, London, UK.<br>• Berkes, F. 2009. Evolution of co-management: role of knowledge generation, bridging organizations and social learning. Journal of Environmental Management 90(5):1692-1702. https://doi.org/10.1016/j.jenvman.2008.12.001<br>• Berkes, F., J. Colding, and C. Folke, editors. 2003. Navigating social-ecological systems: building resilience for complexity and change. Cambridge University Press, Cambridge, UK. https://doi.org/10.1017/CBO9780511541957<br>• Ostrom, E. (1990). Governing the Commons: The Evolution of Institutions for Collective Action. Cambridge University Press. |
| **Status:** | SuSe 2026 |

**Department of Water, Environment, Construction and Safety**

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| **Study programme:** | Water Engineering | | | |
| **Module level:** | Master | | | |
| **Module Nr.:** | 17. | | | |
| **Module name:** | Master Thesis | | | |
| **Module components:** | | | | |
| **Semester:** | 3 | | | |
| **Module responsible:** | Thesis Supervisior | | | |
| **Lecturer**: | Thesis Supervisior | | | |
| **Language:** | English | | | |
| **Correlation to Curriculum:** | ***Study programme:*** | Water Engineering | | |
| | ***Compulsory:*** | X | | |
| | ***Elective:*** | | | |
| **Teaching form/ SWH/ Workload/ Credits:** | ***Teaching form*** | ***SWH*** | ***Credits*** | ***Completion period of 20 weeks*** |
| | | | | |
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| | ***Sum:*** | | 30 | |
| **Prerequisites according to examination regulations:** | Bachelor degree | | | |
| **Recommended prerequisites:** | | | | |
| **Module objectives / intended learning outcomes:** | 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. | | | |
| **Content:** | Students can choose a topic according to their interests. The assignment of the topic, along with the names of the examiners, must be officially recorded in the Examination Office. In the colloquium, students must demonstrate that they are able to defend the results of their independent scientific work in a subject-specific discussion. To this end, the results must be presented in a presentation and related questions must be answered. | | | |
| **Examination prerequisites:** | Successful completion of 60 Credits | | | |
| **Study/examination tasks/forms of examination:** | | | | |

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| **Applicability of the module:** | |
| **Media forms/<br>Learning method:** | |
| **Literature:** | |
| **Status:** | SuSe 2026 |