Description of the degree program

Environmental Sciences (Master)
PO 3

Date: 09.02.2026

Table of contents

Specialisation Applied Hydrology and Water Management

Title	Hydrology and Water Resources Management		
Number	3321200000	**Module version**	
Shorttext		**Language**	german
Frequency of offer		**Teaching unit**	
Module duration	1	**Institution**	Abteilung Hydrologie und Flussgebietsmanagement
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Kai Schröter
Workload (h)			
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (approx. 60 Min.)		
Course achievement			

Contents

[Hydrology and water management (VÜ)]
Hydrological processes and process models for precipitation, evaporation, snow, soil moisture, runoff generation, runoff concentration and flood routing; integration of processes in catchment models for event and long-term continuous systems and determination of design values. Model applications using the PC for catchment modeling, flood protection planning and water balance studies; evaluation of the results.

Objective qualification

Students will gain knowledge of the processes of runoff formation, runoff concentration, and flood-routing and their implementation in simulation models. They will be able to apply a mesoscale rainfall-runoff model to a catchment area, to evaluate results and to carry out flood prevention planning. They acquire the basics to perform an economic evaluation of flood protection measures in terms of benefits and costs.

Literature

- Baumgartner, A., Liebscher, H.-J., & Benecke, P. (2011, February 25). Allgemeine Hydrologie. Schweizerbart'sche Verlagsbuchhandlung. https://www.schweizerbart.de/publications/detail/isbn/9783443300029
- Dyck, S., & Peschke, G. (1995). Grundlagen der Hydrologie (3., stark bearb. Aufl.). Verlag für Bauwesen.
- Maniak, U. (2016). Hydrologie und Wasserwirtschaft: Eine Einführung für Ingenieure (7., neu bearbeitete Auflage). Springer Vieweg. https://doi.org/10.1007/978-3-662-49087-7
- Fohrer, N. (Hrsg.), Bormann, H., Miegel, K., Casper, M., Bronstert, A., Schumann, A., Weiler, M. (2016): Hydrologie. utb.basics, Haupt Verlag, Bern.
- Patt, H., & Jüpner, R. (Eds.). (2020). Hochwasser-Handbuch: Auswirkungen und Schutz. Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-26743-8
- Shaw, E. M., Beven, K. J., Chappell, N. A., & Lamb, R. (2011). Hydrology in Practice, Fourth Edition. Spon Press. http://www.crcpress.com/product/isbn/9780415370417

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Hydrology and Water Resources Management		
Number	4310260	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Hydrologie und Flussgebietsmanagement
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Kai Schröter
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (approx. 60 Min.)		
Course achievement			

Contents

[Hydrology and water management (VÜ)]
Hydrological processes and process models for precipitation, evaporation, snow, soil moisture, runoff generation, runoff concentration and flood routing; integration of processes in catchment models for event and long-term continuous systems and determination of design values. Model applications using the PC for catchment modeling, flood protection planning and water balance studies; evaluation of the results.

Objective qualification

Students will gain knowledge of the processes of runoff formation, runoff concentration, and flood-routing and their implementation in simulation models. They will be able to apply a mesoscale rainfall-runoff model to a catchment area, to evaluate results and to carry out flood prevention planning. They acquire the basics to perform an economic evaluation of flood protection measures in terms of benefits and costs.

Literature

- Baumgartner, A., Liebscher, H.-J., & Benecke, P. (2011, February 25). Allgemeine Hydrologie. Schweizerbart'sche Verlagsbuchhandlung. https://www.schweizerbart.de/publications/detail/isbn/9783443300029
- Dyck, S., & Peschke, G. (1995). Grundlagen der Hydrologie (3., stark bearb. Aufl.). Verlag für Bauwesen.
- Maniak, U. (2016). Hydrologie und Wasserwirtschaft: Eine Einführung für Ingenieure (7., neu bearbeitete Auflage). Springer Vieweg. https://doi.org/10.1007/978-3-662-49087-7
- Fohrer, N. (Hrsg.), Bormann, H., Miegel, K., Casper, M., Bronstert, A., Schumann, A., Weiler, M. (2016): Hydrologie. utb.basics, Haupt Verlag, Bern.
- Patt, H., & Jüpner, R. (Eds.). (2020). Hochwasser-Handbuch: Auswirkungen und Schutz. Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-26743-8
- Shaw, E. M., Beven, K. J., Chappell, N. A., & Lamb, R. (2011). Hydrology in Practice, Fourth Edition. Spon Press. http://www.crcpress.com/product/isbn/9780415370417

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Hydrogeology and Groundwater Management		
Number	4310270	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Hydrologie und Flussgebietsmanagement
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Matthias Schöniger
Workload (h)			
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (60 Min.)		
Course achievement			

Contents

[Hydrogeology and Groundwater Management (VÜ)]
Basics of hydrogeology and groundwater management, knowledge of the tasks of hydrogeology and groundwater management for sustainable resource use, management objectives according to § 47 of WHG (national water resources act).

Presented are: numerical groundwater software for the calculation of regional groundwater movements, transport processes with simple reaction kinetics, model-based evaluation of quantitative and chemical groundwater conditions.

Objective qualification

Students will gain knowledge about the structure of regional groundwater bodies, the flow and transport processes in aquifer systems and in the vadose zone and the groundwater balance.
They acquire practical skills in the use of computer programs to simulate groundwater movement and transport processes. After successful completion of this module, students will be able to gain an overview of evaluating water management projects according to benefit-cost criteria and other criteria. Another central aspect is learn about complex hydrogeologic processes and the modeling techniques used to model these processes.

Literature

Hill, M.C. & Tiedeman, C.T. (2006): Effecvtive Groundwater Model Calibration. With Analysis of Data, Sensitivities,
Predictions, and Uncertainty.- Wiley- Interscience

Rausch, R., Schäfer, W. & Wagner, C. (2002): Einführung in die Transportmodellierung im Grundwasser.- Gebr.
Borntraeger

Mattheß, G. & Ubell, K. (2003): Allgemeine Hydrogeologie Grundwasserhaushalt.- Gebr. Borntraeger

Skriptum und Simulationsprogramme

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	River Basin Management		
Number	4320090	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Hydrologie und Flussgebietsmanagement
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Kai Schröter
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (approx. 60 Min.)		
Course achievement	2 Term papers		

Contents

River Basin Management (VÜ).
River basin management (RBM) for the implementation of the EU Water Framework Directive and the EU Floods Directive; International RBM; Model applications for reservoir management; Flood risk management.
[GIS - Applications in River Basin Management (RBM).
Geographic information for hydrologic and hydraulic modeling; digital maps, vector and raster data; intersection techniques; georeferencing; macro languages and programming.

Objective qualification

The students will acquire the ability to perform river basin management according to the requirements of the EU directives. Students will be familiarized with computer-based model applications for river basin management with a focus on reservoir management.
They will be able to process and analyze geographical data in raster and vector form.
They will be able to solve spatial problems and present the results in thematic maps.

Literature

Scripts and Simulation programs

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture/Exercise	german
	2,0	Lecture/Exercise	german

Title	Water Protection - Measurement Technologies and Data analyses		
Number	4310970	**Module version**	V1
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Hydrologie und Flussgebietsmanagement
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Kai Schröter
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Term paper		
Course achievement			

Contents

[Measuring Techniques for Water Quantity and Water Quality (P)]
Measuring techniques for meteorological and hydrological data and their processing (surface water and groundwater); measuring of water quality parameters (physical-chemical variables, biological indicators); sampling from the water body (river, lake) and laboratory analysis; online measuring networks; analysis of measurement data

[Data Processing for Hydrologic and Hydraulic simulations (V)]
Testing, processing and analyzing of data to answer application-related questions and for subsequent usage as input data for hydrologic and hydraulic models. The relevant processes of precipitation, evapotranspiration, soil water movement and runoff transformation are covered in the lecture. Teaching content are universal applicable methods as time series analysis (homogeneity, consistency), regionalisation and extreme value analysis, as well as process-specific methods as correction of measurement errors and the usage of alternative precipitation data sets.

Objective qualification

The students gain varied and interdisciplinary knowledge in data processing and the development of own algorithms for data analysis. An understanding of data structures, data amounts and data plausibility is established. The gained knowledge can be transferred to other disciplines and model software.

Literature

Scripts and simulation programs

Remark

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Related courses			
Rules for the choice of courses			
maximum 12 participants			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Internship	german
	2,0	Lecture/Exercise	german

Title	Water Protection - Water Quality Modeling		
Number	4310730	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Hydrologie und Flussgebietsmanagement
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Kai Schröter
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) or oral exam (approx. 60 Min.)		
Course achievement	Term paper		

Contents

[Water quality modeling (VÜ)]

water quality parameters and processes; methods for the analysis of measurement data; differential equations for the simulation of completely and incompletely mixed systems; analytical and numerical methods; heat balance; transport and transformation processes of pollutants (e.g. sediment, nitrogen, phosphorus) in water bodies, solving model equations in R programming

Objective qualification

The students gain in-depth knowledge of the interaction of water quantity and water quality in standing and flowing waters at the reach scale. The students will be qualified to quantify the pollution scientifically and technically and to describe it using model algorithms. Using model applications, the students get to know solutions for the improvement of water quality.

Literature

Steven C. Chapra, Surface Water-Quality Modeling, Waveland Press 2008 James L. Martin & Steven C. McCutcheon, Hydrodynamics and Transport for Water Quality Modeling, CRC Press, 1998

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Related courses

Rules for the choice of courses

Basic knowledge of water quality parameters and processes is required.

Compulsory attendance

Name of the course	SWS	Eventtype	Language

	4,0	Lecture/Exercise	german

Title	Ecohydrological Modelling of Catchments		
Number	4398800	**Module version**	V1
Shorttext		**Language**	english
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration	1	**Institution**	Abteilung Hydrologie und Flussgebietsmanagement
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Kai Schröter
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam+ (120min) or oral exam+ (30min)		
Course achievement			

Contents

Components of an ecohydrological model system
- Modeling of the water balance (precipitation, evapotranspiration, soil water, runoff formation, runoff concentration, flood-routing)
- Modeling of plant growth
- Modeling of transport and transformation processes of substances (e.g. sediment, nitrogen, phosphorus) in the landscape and in water bodies
- Application of an ecohydrological model on a PC to a mesoscale catchment area
- Influence of different forms of land use, land cultivation and land management on the landscape water regime and nutrient budget
- Modeling and evaluation of management measures for the reduction of emissions from the landscape (technical and nature-based)
- Solving model equations in R programming

Objective qualification

Students will gain in-depth knowledge of the transport and transformation processes of substances in a catchment that occur in the landscape and in a water body, as well as their mathematical description in an eco-hydrological model system. They will be able to set-up an ecohydrological model for a mesoscale catchment, prepare and analyze the model outputs, and evaluate the simulation results. They will acquire fundamental knowledge in modeling and evaluating management measures to reduce substance emissions within and from the catchment.

Literature

Harper, D.M., Zalewski, M., Pacini, N., 2008. Ecohydrology: Processes, Models and Case Studies: an Approach to the Sustainable Management of Water Resources. CABL
Haygarth, P.M., Jarvis, S.C., 2002. Agriculture, hydrology and water quality.
Pers, C. 2007. HBV-NP Model Manual

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	english

Title	Eco-Hydraulics		
Number	4320020	**Module version**	V1
Shorttext		**Language**	german
Frequency of offer		**Teaching unit**	
Module duration	1	**Institution**	Abteilung Wasserbau und Gewässermorphologie
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Jochen Aberle
Workload (h)	180		
Class attendance (h)	66	**Self studying (h)**	114
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) and oral exam (approx. 30 Min.)		
Course achievement			

Contents

[Near-to-Nature Hydraulic Engineering (Master) (VÜ)]
European Water Framework Directive, River Morphology, Hydraulics of nature-like rivers; Flow resistance of plain river beds composed of different bed material and form resistance of morphological structures; Roughness and resistance coefficients, Sediment transport, Morphological development of rivers, River maintenance and development measures
[Open Channel Hydraulics – Near-to-Nature (Master) (Ü)]
Practical exercises in the field are carried out so that the students learn about the effect of hydraulic, morphological and morphodynamic factors on the flow characteristics of rivers.

[Flow Resistance of Vegetation (Master) (V)]
Approaches are introduced for the determination of parameters to describe riverine vegetation characteristics (rigid, flexible, emergent, submerged) and to determine flow resistance due to vegetation. This is an elective subject serving as an in-depth supplement to the compulsory course "Near-to-Nature Hydraulic Engineering”
[Stream Ecology (Master) (V)]
Introduction into the field of stream ecology and presentation of methods for the determination of water and structural quality of streams.
[Dynamics of Cohesive Sediments (V)]
Introduction into the physical processes governing the dynamics of cohesive sediments in rivers, streams, and estuaries.

Objective qualification

The students learn the basics of essential aspects that are important for near-to-nature hydraulic engineering applications. They will have a basic understanding of flow characteristics, flow resistance and sediment transport in natural rivers and how these are interrelated, also considering the effect of further roughness such as vegetation. The students will be able to define the goals of near-natural revitalization measures, to develop appropriate measures and to evaluate the success of planned and existing revitalization measures. The practical training is underlined by exercises in the field. In addition to hydraulic engineering and environmental hydraulics applications, ecological considerations are also part of the contents to prepare the stu-

dents for the interdisciplinary cooperation with the scientific field of natural sciences that is required in professional life to implement nature-based solutions.
Literature
Literaturhinweise, Fachbücher, und Vorlesungsumdrucke

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Related courses
Rules for the choice of courses
Compulsory: [Near-to-Nature Hydraulic Engineering] (3 LP), [Open Channel Hydraulics – Near-to-Nature] (2 LP) One of the elective courses: [Flow Resistance of Vegetation] (1 LP) [Dynamics of Cohesive Sediments] (1 LP) [Stream Ecology] (1 LP) must be chosen.
Compulsory attendance

Name of the course	**SWS**	**Eventtype**	**Language**
	3,0	Lecture/Exercise	german
	2,0	Exercise	german
	1,0	Lecture	german
	1,0	Lecture	german

Title	Eco-Hydraulics		
Number	4320020	**Module version**	V2
Shorttext		**Language**	german
Frequency of offer		**Teaching unit**	
Module duration	1	**Institution**	Abteilung Wasserbau und Gewässermorphologie
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Jochen Aberle
Workload (h)			
Class attendance (h)	66	**Self studying (h)**	114
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) and oral exam (approx. 30 Min.)		
Course achievement			

Contents

[Near-to-Nature Hydraulic Engineering (Master) (VÜ)]
European Water Framework Directive, River Morphology, Hydraulics of nature-like rivers; Flow resistance of plain river beds composed of different bed material and form resistance of morphological structures; Roughness and resistance coefficients, Sediment transport, Morphological development of rivers, River maintenance and development measures
[Open Channel Hydraulics – Near-to-Nature (Master) (Ü)]
Practical exercises in the field are carried out so that the students learn about the effect of hydraulic, morphological and morphodynamic factors on the flow characteristics of rivers.

[Flow Resistance of Vegetation (Master) (V)]
Approaches are introduced for the determination of parameters to describe riverine vegetation characteristics (rigid, flexible, emergent, submerged) and to determine flow resistance due to vegetation. This is an elective subject serving as an in-depth supplement to the compulsory course "Near-to-Nature Hydraulic Engineering”
[Stream Ecology (Master) (V)]
Introduction into the field of stream ecology and presentation of methods for the determination of water and structural quality of streams.
[Dynamics of Cohesive Sediments (V)]
Introduction into the physical processes governing the dynamics of cohesive sediments in rivers, streams, and estuaries.

Objective qualification

The students learn the basics of essential aspects that are important for near-to-nature hydraulic engineering applications. They will have a basic understanding of flow characteristics, flow resistance and sediment transport in natural rivers and how these are interrelated, also considering the effect of further roughness such as vegetation. The students will be able to define the goals of near-natural revitalization measures, to develop appropriate measures and to evaluate the success of planned and existing revitalization measures. The practical training is underlined by exercises in the field. In addition to hydraulic engineering and environmental hydraulics applications, ecological considerations are also part of the contents to prepare the stu-

dents for the interdisciplinary cooperation with the scientific field of natural sciences that is required in professional life to implement nature-based solutions.
Literature
Literaturhinweise, Fachbücher, und Vorlesungsumdrucke

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Related courses
Rules for the choice of courses
Compulsory: [Near-to-Nature Hydraulic Engineering] (3 LP), [Open Channel Hydraulics – Near-to-Nature] (2 LP) One of the elective courses: [Flow Resistance of Vegetation] (1 LP) [Dynamics of Cohesive Sediments] (1 LP) [Stream Ecology] (1 LP) must be chosen.
Compulsory attendance

Name of the course	**SWS**	**Eventtype**	**Language**
	3,0	Lecture/Exercise	german
	2,0	Exercise	german
	1,0	Lecture	german
	1,0	Lecture	german

Specialisation Atmosphere and Boundary Layer Processes

Title	Atmospheric Boundary Layer Processes		
Number	1112040	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung für Klimatologie und Umweltmeteorologie
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Stephan Weber
Workload (h)			
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (30 Min.)		
Course achievement			

Contents

[Boundary Layer Processes and Boundary Layer Climates (V)]
- Elementary Boundary Layer Processes
- Exchange processes in the near-surface boundary layer
- Basic climatological measurement techniques
- Quantification of boundary layer processes

[Quantification of Processes in the Atmospheric Boundary Layer (S)]
- Exchange processes in the atmospheric boundary layer
- Radiation and heat balances of different surfaces
- Climatological measurement instruments

Objective qualification

Students gain a basic understanding of elementary boundary layer and exchange processes in the near-surface air layer. They will be able to interpret the characteristics of different boundary layerclimates. In the course, the quantification of boundary layer processes with the help of parameterisation models is learned.

Literature

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	german
Literature			
Geiger, R., 1961. Das Klima der bodennahen Luftschicht. Vieweg & Sohn, Braunschweig, 646 pp. Oke, T.R., 1987. Boundary layer climates. Methuen, London, 435 pp. Arya, P.S., 2001. Introduction to micrometeorology. International Geophysics Series, 42. Academic Press Inc., San Diego, 415 pp.			
	2,0	Seminar	german
Literature			
Geiger, R., 1961. Das Klima der bodennahen Luftschicht. Vieweg & Sohn, Braunschweig, 646 pp. Oke, T.R., 1987. Boundary layer climates. Methuen, London, 435 pp. Arya, P.S., 2001. Introduction to micrometeorology. International Geophysics Series, 42. Academic Press Inc., San Diego, 415 pp.			

Title	Climate Change		
Number	1112060	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung für Klimatologie und Umweltmeteorologie
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Stephan Weber
Workload (h)			
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (30 Min.)		
Course achievement			

Contents

[Climate System and Climate Variability (V)]
- The Climate System
- Palaeoclimate - Methods of data acquisition from climate archives
- Natural Climate Variability

[Climate Change: Physical Basics, Consequences, Perspectives (S)]
- Physical Basics of Climate Change
- Impacts of Climate Change - Climate Impact Management
- Adaptation and mitigation strategies
- Special aspects of regional climate change
- Special issues of climate change (e.g. geopolitical impacts)

Objective qualification

The students acquire a basic understanding of elementary processes in the climate system and are enabled to apply this to questions of climate variability and paleoclimate as well as to the assessment of changes in the climate system. They will learn to classify current research questions and results on climate change research in the overall context of climate development in order to be able to assess the effects of processes of mitigation and adaptation research.

Literature

Remark

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	german
	2,0	Seminar	german

Literature

Houghton, J., 2009. Global Warming - the complete briefing. Cambridge University Press, Cambridge, 438 pp. Latif, M., 2009. Klimawandel und Klimadynamik. UTB 3178. Eugen Ulmer, Suttgart, 219 pp. Rahmstorf, S.; Schellnhuber, H.J., 2006. Der Klimawandel - Diagnose, Prognose, Therapie. Beck, München, 144 pp. Endlicher, W. und Gerstengarbe, F.-W. (Hrsg.) Der Klimawandel - Einblicke, Rückblicke und Ausblicke. Potsdam Institut für Klimafolgenforschung e.V. (http://edoc.hu-berlin.de) Hupfer, P.; Kuttler, W. (Hrsg.) (2006) Witterung und Klima. 12. Aufl., Teubner, Wiesbaden, 554 S. Kuttler, W. (2009) Klimatologie. Schönigh, Paderborn, 260 S. IPCC. (2007). Climate Change 2007 - The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the IPCC. New York: Cambridge University Press (www.ipcc.ch)

Title	Air Quality and Air Pollution Control		
Number	1112340	**Module version**	
Shorttext		**Language**	german
Frequency of offer		**Teaching unit**	
Module duration	1	**Institution**	Abteilung für Klimatologie und Umweltmeteorologie
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Stephan Weber
Workload (h)			
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (30 Min.)		
Course achievement	Portfolio		

Contents

[Air Quality in the Near-Surface Boundary Layer (S)]
- Basics of atmospheric chemistry of the near-surface boundary layer
- Principles and characteristics of urban air quality
- Procedures for the measurement and characterisation of aerosol-analysis of data sets

[Air Quality and Air Pollution Control (V)]
- Understanding of the basics of atmospheric chemistry in the near-surface boundary layer
- Knowledge of the most important impacts of tropospheric pollutants
- Legislative requirements for air pollution control
- Trends in ground-level air quality under climate change
- Understanding of the handling of air pollution data sets

Objective qualification

Students will gain a basic understanding of the fundamentals of (urban) air quality in the near-surface boundary layer as well as knowledge of the most important tropospheric pollutants. The students will be able to understand current trends air pollution research. They are trained in the handling,analysis and interpretation of air pollution data sets.

Literature

Finlayson-Pitts, B.J. and Pitts, J.N., 2000. Chemistry of the upper and lower atmosphere. Acamedic Press, San Diego,
969 pp.

Möller, D., 2003. Luft - Chemie, Physik, Biologie, Reinhaltung, Recht. de Gruyter, Berlin, NewYork, 750 pp.
Hinds, W.C., 1999. Aerosol technology - Properties, Behavior and Measurement of Airborne Particles. Wiley Interscience, New York, 483 pp.

Remark

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	german
Literature			
Finlayson-Pitts, B.J. and Pitts, J.N., 2000. Chemistry of the upper and lower atmosphere. Acamedic Press, San Diego, 969 pp. Möller, D., 2003. Luft - Chemie, Physik, Biologie, Reinhaltung, Recht. de Gruyter, Berlin, NewYork, 750 pp. Hinds, W.C., 1999. Aerosol technology - Properties, Behavior and Measurement of Air-borne Particles. Wiley Interscience, New York, 483 pp.			
	2,0	Seminar	german

Title	Micrometeorology		
Number	1112200	**Module version**	
Shorttext	GEA-STD2-2	**Language**	german
Frequency of offer		**Teaching unit**	
Module duration	1	**Institution**	Abteilung für Klimatologie und Umweltmeteorologie
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Stephan Weber
Workload (h)			
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Term paper or oral exam (30 Min.)		
Course achievement			

Contents

Methodical Fundamentals of Micrometeorology (V)]
- Elementary boundary layer processes
- Micrometeorological concepts for quantification of surface-atmosphere exchange
- Micrometeorological measurement techniques, data evaluation and presentation

[Field Exercise Micrometeorology (PRÜ)]
- Exchange processes in the near-surface boundary layer
- Quantification of surface-atmosphere exchange by different methods
- Gradient approaches, eddy-covariance technique
- QA/QC in the quantification of energy balance components
- Evaluation and discussion of uncertainties

Objective qualification

Students will gain a basic understanding of micrometeorological concepts for quantifying surface-atmosphere exchange. In the course, state-of-the-art micrometeorological measurement instrumentation will be used to collect measurement data in the field. In addition, students will be able to analyse and present the data using established approaches.

Literature

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	1,0	Lecture	german
	3,0	Practical exercise	german

Title	Urban Climatology		
Number	1112070	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung für Klimatologie und Umweltmeteorologie
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Stephan Weber
Workload (h)			
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (30 Min.)		
Course achievement			

Contents

- The urban surface
- Definition and characteristics of the urban climate
- The urban wind field
- Urban radiation and heat balance
- Thermal and hydrological properties of urban surfaces
- Human biometeorology
- Applied questions of urban climatology
- Urban climate and climate change

Objective qualification

Students will gain a basic understanding of elementary boundary layer processes and their modification by citiesa. Students will be able to discuss and understand fundamental and applied issues in urban climate research. They will also be trained in the application of urban climate models.

Literature

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**

	2,0	Seminar	german
Literature			
Helbig, A., Baumüller, J., Kerschgens, M. (1999). Stadtklima und Luftreinhaltung. 2. Aufl. Springer, 467 S. Hupfer, P. Kuttler, W. (Hrsg.) (2006) Witterung und Klima. 12. Aufl., Teubner, Wiesbaden, 554 S. Kuttler, W. (2009) Klimatologie. Schönigh, Paderborn, 260 S. Oke, T. R. (1987) Boundary Layer Climates (2nd Edition). Routledge, London, New York, 435 S. sowie themenspezielle Primärliteratur (wird beim ersten Termin besprochen)			

Urban Climatology	2,0	Lecture	german
Literature			
Oke, T.R., 1987. Boundary layer climates. Methuen, London, 435 pp. Kuttler, W., 1998. Stadtklima. In: H. Sukopp and R. Wittig (Editors), Stadtökologie. G. Fischer Verlag, Stuttgart, pp. 113-153. Helbig, A., Baumüller, J. and Kerschgens, M.J.H., 1999. Stadtklima und Luftreinhaltung. Springer-Verlag, Berlin, Heidelberg, New York, 467 pp. Kuttler, W., 2009. Klimatologie. Schöningh, UTB, Paderborn, 260 pp.			

Specialisation Biodiversity

Title	Fundamentals of Biodiversity		
Number	1116070	**Module version**	V1
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung für Landschaftsökologie und Umweltsystemanalyse
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Frank Suhling
Workload (h)			
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.)		
Course achievement			

Contents

Biodiversity, biogeography and ecosystem services: This lecture explains the basic terms, concepts, and theories used to understand species richness and its distribution, and introduces the concepts of ecosystem functions and ecosystem services. Lecture topics:
- Biodiversity research history, concepts and terms.
- Origin and natural history of biodiversity
- Patterns and mechanisms of species richness
- Collection and assessment of distribution data
- Biodiversity and ecosystem functions
- Consequences of human activities and protection of biological diversity
- Value of nature: ecosystem services
- Biodiversity and human well-being: Services and disservices

Biodiversity Data Management: In biodiversity research, large amounts of data are collected. How are these data stored transparently and in the sense of Open Data, how can such data be used? What problems do we have to expect when using such data? This lecture deals with these questions. Contents are in particular:
- Open Science and Open Data
- Data management
- quality management
- Metadata
- Repositories and databases
- Natural History Collections

Objective qualification

Students know the basic concepts of biodiversity and biogeography and can interpret them. They have a deeper understanding of the relevant processes that influence species richness locally, regionally and globally. They can explain and interpret biogeographic patterns and know approaches to describe and analyze these patterns. They know the relationships between ecosystem functions and species richness. They are

able to apply the concept of ecosystem services and have a good understanding of the relationship to biodiversity. They have a deeper understanding of the importance of biodiversity and ecosystem services. Students will know how to collect, document and maintain biodiversity data. They will learn about databases such as GBIF, Movebank, eBird, etc., as well as natural history collections. In exercises, they gain knowledge on how to evaluate and map biodiversity data from databases.
Literature
Wird in Vorlesung bekannt gegeben.

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	german
	2,0	Course	german

Title	Agricultural Biodiversity		
Number	1112370	**Module version**	V1
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Geoökologie
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Jens Dauber
Workload (h)			
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.)		
Course achievement	Presentation		

Contents

[Biodiversity of Agricultural Landscapes
Biodiversity as an interdisciplinary concept
Importance of biodiversity for agriculture and food ecosystem services in agroecosystems
Monitoring and indicators of biodiversity agricultural landscape monitoring
Concepts and strategies for the protection and use of biodiversity in agricultural landscapes

[Agricultural systems of the future].
Challenges for sustainable agriculture
Target images for agricultural systems of the future
Development of a research project and project proposal on the topic of agricultural systems of the future

Objective qualification

The students know the different definitions of biodiversity and know the emergence and politicisation of the concept of biodiversity. They understand the importance of the concept for its application in agriculture to resolve the apparent conflict between agriculture and biodiversity. The students know the importance of ecosystem services as functional components of biodiversity for agroecosystems and agricultural production. They have a deeper understanding of issues relating to the protection and use of biodiversity in agricultural landscapes and are aware of the associated conflicts of objectives. They know different strategies for the protection and use of biodiversity in agricultural landscapes and are trained in the critical use of biodiversity indicators and monitoring programmes.

The students can develop visions of future agricultural systems that are adapted to the challenges of sustainable agricultural development. They can present these visions and transfer them into the format of a research proposal. They know the formal structure of a research proposal and can defend their research ideas to a panel of experts. They have a deeper understanding of inter- and transdisciplinary working in research projects and know which project partners necessarily have to work together for such a research project. They can critically deal with possible risks for the implementation of a research project.

Literature

Reynolds et al. (2016) Environ Monit Assess 188: 399

DOI 10.1007/s10661-016-5397-x
EU-Biodiversitätsstrategie für 2030
La Notte A, Vallecillo S, Polce C, Zulian G, Maes J. 2017. Implementing an EU system of accounting for ecosystems and
their services. Initial proposals for the implementation of ecosystem services accounts, EUR 28681 EN; Publications
Office of the European Union, Luxembourg, doi:10.2760/214137, JRC107150
Lindenmeyer & Likens Biological Conservation 143 (2010) 13171328
Convention on Biological Diversity https://www.cbd.int/convention/

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	german
	2,0	Exercise	german

Title	Bioindication and Biodiversity Change in Aquatic Ecosystems		
Number	1111140	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Geosysteme und Bioindikation
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Antje Schwalb
Workload (h)			
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) Attendance in exercises and seminars is compulsory.		
Course achievement			

Contents

Aquatic Biodiversity (S)]
- Effects of climate change on communities in aquatic ecosystems
- Communities as bioindicators
- Human influence on biodiversity
- Methodological approaches such as organism-related assessment methods for water quality, long-term monitoring for early detection of changes in (palaeo) ecological conditions

[Bioindication and analysis of archives (V/Ü)]
- Archives and proxies
- Chronological methods
- Bioindication: basics and systems
- Biological indicators in the sediment
- Preparation and analysis of biological indicators
- Stable isotopes
- Lake sediments as memories of ecosystems
- Multivariate analysis (CCA, DCA) and transfer functions
- Bioindication for solving scientific questions (examples from research projects)
-Stochastic processes
- Decomposition and spectra of time series

Objective qualification

The students learn to research and present topics of particularly high topical relevance for the function and future of aquatic ecosystems in urban and semi-natural continental areas as well as in the marine realm. Students gain an understanding of the formation, analysis and use of geoarchives as a tool for long-term monitoring of climate and environment. Students will work out the characteristics and the significance of bioindication as well as important indicator organisms. Students train methodological competence in geoscientific and biological analytics as well as in statistical methods such as time series analysis. They learn to derive long-term environmental and climate changes from the geo-ecosystem, to design future scenarios and better understand the interaction between humans and the environment.

Literature

Die notwendige und empfohlene Literatur, überwiegend aktuelle Forschungsergebnisse, veröffentlicht in internationalen Zeitschriften, wird in den jeweiligen Veranstaltungen bekanntgegeben.

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Seminar	german
	2,0	Lecture/Exercise	german

Title	Landscape Epidemiology		
Number	1116100	**Module version**	V1
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	2	**Institution**	Abteilung für Landschaftsökologie und Umweltsystemanalyse
Hours per Week / ECTS	5 / 6,0	**Module owner**	Prof. Dr. Boris Schröder-Esselbach
Workload (h)			
Class attendance (h)	80	**Self studying (h)**	100
Compulsory requirements			
Expected performance/ Type of examination	Prüfungsleistung Landschaftsepidemiologie: Presentation(1/3) Prüfungsleistung Geländepraktikum: Term paper (2/3)		
Course achievement			

Contents

[Landschaftsepidemiologie (V+Ü+S)]
[Landscape Epidemiology]
Landscape-associated pathogens
Direct and indirect transmission, reservoir hosts and vectors
Prevalence, incidence, basic reproduction number
Transmission dynamics and habitat association
Influence of biotic and abiotic environmental factors
Spatio-temporal distribution patterns
Risk evaluation and mitigation
Strategies of prevention and intervention
Habitat modelling of landscape-associated pathogens

Objective qualification

Lecture Landscape Epidemiology (WS)
The students acquire a basic understanding of landscape-associated pathogens and are able to recognize direct and indirect transmission routes, hosts and vectors in temperate and tropical zones. They are able to derive epidemiological indices such as prevalence, incidence and basic reproduction number. They understand how biotic and abiotic parameters of the environment and other habitat-specific factors affect the transmission dynamics of landscape-associated pathogens. They are able to explain spatio-temporal distribution patterns of these pathogens. They have gained an overview of various methods to estimate and mitigate risk and are able to evaluate the applicability of strategies for prevention and intervention. They know approaches for habitat modelling of landscape-associated pathogens.

Seminar Landscape Epidemiology (WS)
The students learn about current foci of research in landscape epidemiology and know to critically evaluate them. Original publications will be read in English as homework assignments, presented and critically discussed during the seminar.

Exercise Landscape Epidemiology (SS, Blockveranstaltung)

The students learn methods of sampling vectors in the field in order to compare their relative activity and describe their spatial pattern of distribution. They learn simple modelling approaches on the basis of their own data sets.
Literature

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	1,0	Lecture	german
	2,5	Exercise	german
	1,5	Seminar	german

Title	Ecological Modeling		
Number	1116130	**Module version**	
Shorttext		**Language**	english german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung für Landschaftsökologie und Umweltsystemanalyse
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Frank Suhling
Workload (h)			
Class attendance (h)	60	**Self studying (h)**	120
Compulsory requirements			
Expected performance/ Type of examination	Examination: Generation and documentation of computer programs		
Course achievement			

Contents

[Distribution and population models(VÜ)]
Approaches to and methods of ecological modelling
Theoretical basics for the generation of ecological models (instructed in the exercises)
Application examples of models in ecology and conservation biology
Approaches to species distribution models in statistics and machine learning (parametric, semi-parametric and nonparametric
techniques) Individual-based (agent-based) modelling
Progamming of species distribution models in R (or comparable software)
Progamming of individual-based population models with NetLogo (or comparable software)

Objective qualification

After successful completion of the module, students have knowledge of the key - statistical and machine learning -
methods of species distribution modelling. They also have knowledge of the most important approaches to population dynamic modelling. The students are able to apply both modelling methods for dealing with geoecological and conservation biological questions and they know the advantages and disadvantages of these methods. They are capable to visualise and interpret data and models and to check underlying assumptions as well as to evaluate parameter
sensitivities.

Literature

- Franklin J 2010: Mapping Species Distributions - Spatial Inference and Prediction.

- Railsback SF, Grimm V 2011: Agent-based and individual-based modeling: A practical introduction.
Additional literature will be provided online.

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Related courses			
Rules for the choice of courses			
In the exercises, we use R (statistical software) and NetLogo. Previous knowledge in programming (preferentially in R) is preconditioned. NetLogo will be newly introduced (no previous knowledge required).			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Specialisation Soil and Land Use Management

Title	Advanced Soil Science		
Number	3328200000	**Module version**	
Shorttext	Modulbeschreibungen Englisch fehlen	**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung für Bodenwissenschaften
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Magdalena Sut-Lohmann
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements	Basic knowledge corresponding to the lecture "Bodenkunde - Einführung" is mandatory		
Recommended requirements	Basic knowledge of geology, soil science and biology		
Expected performance/ Type of examination	Written examination (120 min) or oral examination (30 min)		
Course achievement			

Contents

[Regional Soil Science of Northern Germany (VÜ)]

- Factors and processes of soil formation
- Geology and geomorphology of Northern Germany
- Division of Northern Germany - Soil regions
- Soil region: Loess and sand loess landscapes
- Soil region: Young moraine landscapes
- Soil region: Old moraine landscapes (Geest)
- Moors - Origin, properties, soils
- Soil region: Coastal Holocene (from North Sea islands to marshes)
- Soil region: River landscapes - Floodplains, colluvium

As part of the soil science field exercise, an excursion to important terrestrial soils, such as Chernozem, Luvisol, Leptosol, Cambisol, and Podsol, is organized. On-site, soil profile descriptions and mapping exercises are con-ducted.

[Soil-Plant-Interactions (VÜ)]

- Nutrient cycles in terrestrial ecosystems (vegetation, soils)
- Interactions between the soil solid phase and soil solution, water uptake by plants
- Organic soil matter, degradation, and transformation reactions in soils
- Pollutants and pathways in soils, phytoremediation

Practical exercises in the laboratory and, if necessary, in the field are conducted as part of the course.

Objective qualification

The students acquire knowledge about the occurrence and distribution of soils in Northern Germany. The students will be able to explain the factors and processes of landform development. The students are familiar with soil clas-sification, mapping, and the association of soils. As part of the field exercises, they learn to identify, describe soil types, horizons, and horizon sequences, and to map the soils of Northern Germany. The students gain in-depth knowledge of physical parameters and processes with a focus on the interactions between vegetation and soils and understand the practical implications thereof.

Literature

Regional Soils of Northern Germany:
- Scheffer, F. und Schachtschabel, P., 2018, Lehrbuch der Bodenkunde. 17.Aufl., Spektrum, Heidelberg.
- Bundesanstalt für Geowissenschaften und Rohstoffe, 2016, Bodenatlas Deutschland, Böden in thematischen Karten, Schweizerbart, Stuttgart.
- Don., A., Prietz, R. 2019, Unsere Böden Entdecken, Springer
- Joisten, H. et . al., 2023, Böden Deutschlands, Österreichs und der Schweiz, Springer
- Wagenbreth, O., Steiner, W., 2015, Geologische Streifzüge, 4. Auflage,Springer Spektrum
- AG Boden, 2005, Bodenkundliche Kartieranleitung. Schweizerbart, Stuttgart.

Boden-Pflanze-Interaktionen:
- Scheffer, F. und Schachtschabel, P., 2018, Lehrbuch der Bodenkunde. 17.Aufl., Spektrum, Heidelberg
- Monika Sobotik, Roland K. Eberwein, Gernot Bodner, Rosemarie Stangl, Willibald Loiskandl, 2020, Pflan-zenwurzeln
- Peter Schopfer, Axel Brennicke, 2006, Pflanzenphysiologie

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Related courses

Rules for the choice of courses

Compulsory attendance

Mandatory attendance for the exercise part

Name of the course	SWS	Eventtype	Language
	2,0	Lecture/Exercise	german
	2,0	Lecture/Exercise	german

Literature

- Scheffer, F. und Schachtschabel, P., 2002, Lehrbuch der Bodenkunde. 15.Aufl., Spektrum, Heidelberg.
- Bundesanstalt für Geowissenschaften und Rohstoffe, 2016, Bodenatlas Deutschland, Böden in thematischen Karten, Schweizerbart, Stuttgart.

Title	Anthropogenic Soils		
Number	3328200030	**Module version**	
Shorttext		**Language**	english
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung für Bodenwissenschaften
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Magdalena Sut-Lohmann
Workload (h)	180		
Class attendance (h)	49	**Self studying (h)**	131
Compulsory requirements	Basic knowledge regarding the Modules: "Bodenkunde - Einführung" and "Erweiterte Bodenkunde" are necessary.		
Expected performance/ Type of examination	Soil Degradation and Conservation: Oral Presentation (45min+ 20min discussion; 50%) Urban Soils: Term Paper (20 pages; 50%)		
Course achievement			

Contents

Soil Degradation and Conservation (S):
- Need for Soil Conservation and Legal Foundations
- Main Causes of Soil Degradation:
  - Soil Erosion
  - Sealing
  - Tillage and Compaction
  - Irrigation and Drainage
  - Fertilization
  - Soil Salinization
  - Pollution
  - Utilization and Disposal of Waste

Urban Soils (V):
- Ecosystem Services (key properties and functions)
- Classification of Urban Soils according to WRB
- Urban Soils Challenges (Heat Islands, Sealing, Contamination)
- Remediation and sustainable management approaches (Sponge City, Remote Sensing, Urban Gardening, Soil Amendments)

Urban Soils (Ü):
- study design/problem formulation
- soil sampling in the city
- laboratory analysis
- writing a technical report

Objective qualification

In this module students understand the central role of soils in the landscape. One of the specific aims is to expand basic knowledge in soil science regarding soil protection. The students are familiar with the legal and technical foundations of soil conservation and can evaluate measures for the use of soils with regard to soil protection. Selected issues in soil science and applied soil protection, as well as associated ecologi-

cal problems, are reflected upon. In addition, students acquire knowledge about the necessary soil measurement techniques and basic understanding of remediation strategies for degraded soils.
Students receive an overview of the specific characteristics of urban soils, various parent materials, technogenic substrates, soil formation processes, and resulting physical, chemical, and biological properties. Topics such as sealing,
contamination, parent substrates, and soil functions including urban agriculture, among others, are discussed in more detail.
The practical part offers a hands-on approach essential for understanding the fundamentals of geoecological research. Students learn research design and planning, sampling, laboratory techniques, and the preparation of a technical report.

Literature

W. Amelung, H. Blume, H. Fleige et al. (2016) Scheffer/Schachtschabel Soil Science, Springer Spektrum, Berlin, Heidelberg.
H.-P. Blume, R. Horn, S. Thiele-Bruhn (2011) Handbuch des Bodenschutzes. 4th Edition, Wiley-VCH, Weinheim.
A. K. Braimoh, P. L. G. Vlek (2008) Land Use and Soil Resources, Springer Netherlands
R.C.P. Morgan (2005) Soil Erosion and Conservation, 3rd Edition, Blackwell Science Ltd
H. Blanco-Canqui, R. Lal (2008) Principles of Soil Conservation and Management, Springer Netherlands
W. Endlicher et al. (2011) Perspectives in Urban Ecology, Springer
Rakshit et al. (2022) Soils in Urban Ecosystem, Springer
D. A. Hiller, H. Meuser (1998) Urbane Boden, Springer

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Related courses

Rules for the choice of courses

Compulsory attendance

mandatory attendence for the practical part

Name of the course	SWS	Eventtype	Language
	2,0	Seminar	english
	2,0	Lecture/Exercise	english

Title	Soil as an Ecosystem		
Number	3328200010	**Module version**	
Shorttext		**Language**	english german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung für Bodenwissenschaften
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Magdalena Sut-Lohmann
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements	Basic knowledge of the lecture "Bodenkunde - Einführung" is mandatory.		
Recommended requirements	Basic knowledge of soil science and biology		
Expected performance/ Type of examination	Written examination (120 min)		
Course achievement			

Contents

[Soil Ecology and Soil Use (V)]
The course focuses on the role and performance of soil fauna in regulating soil processes under different land use types
- Soil ecology and ecological classification systems of soil organisms
- Recognizing and evaluating the role and performance of soil fauna
- Habitat function of soil and adaptation mechanisms of soil organisms
- Production function of soil as an ecological stress situation with potential for regeneration

[Isotopes for Quantifying Biogeochemical Cycles (VÜ)]
- Isotope Analysis and Measurement Techniques
- Carbon (C) and Nitrogen (N) Cycles in Terrestrial Ecosystems (Vegetation, Soils)
- Organic Soil Matter and Its Transformation and Stabilization
- Isotopes as Tracers in Soil Hydrology
- Soil-Plant-Atmosphere Interactions and Global Change

[Microbial Ecosystem Processes (VÜ)]
This course covers the following themes:
- Microbial physiology, behaviour, evolution and biodiversity
- Global elemental cycles from the perspective of microbial biotransformations
- Key factors that control microbial activity in aquatic, terrestrial, engineered and host-associated environments
- Computer lab practical for investigating microbial community composition and function from environmental DNA sequencing data

Objective qualification

Students acquire knowledge about soil ecological relationships in the context of soil use, the application of isotopes in biogeochemical research, and microbial ecosystem processes. The focus is initially on teaching the fundamentals of soil ecology, the habitat function of soil, adaptation mechanisms of soil organisms, and the production function of soil. Students gain the ability to analyze and evaluate feedback mechanisms between habitat function and soil use using indicator systems for soil invertebrates. Isotopes are important tracers in soil ecological research, enabling the tracking of the transformation and fate of substances in the environment. Students learn the basics and applications of stable isotopes for researching C and N cycles through current research examples.
In the course "Microbial Ecosystem Processes" (lectures combined with exercises), students acquire knowledge about microbial activities in ecosystems, with a focus on terrestrial systems (soils, rhizospheres) but also with reference to aquatic and constructed systems. Students become familiar with important microorganisms and microbial functional groups. They gain an understanding of the interactions between environmental factors and microbial processes, leading to insights into how microbial activities can be controlled, utilized, and managed. "Microbial Ecosystem Processes" is conducted in English.

Literature

Soil Ecology and Soil Use:

- Skript zur Vorlesung wird gestellt.
- W. Amelung, H. Blume, H. Fleige et al. (2018) Scheffer/Schachtschabel Lehrbuch der Bodenkunde. 17. Aufl., Springer Spektrum, Berlin, Heidelberg.
- H.-P. Blume, R. Horn, S. Thiele-Bruhn (2011) Handbuch des Bodenschutzes. 4. Aufl., Wiley-VCH, Weinheim.
- J.K. Whalen, L. Sampedro (2010) Soil Ecology and Management. CABI International, Wallingford.
- D.H. Wall, R.D. Bardgett, V. Behan-Pelletier, J.E. Herrick, T.H. Jones, K. Ritz, J. Six, D.R. Strong, W.H. van der Putten (2012) Soil Ecology and Ecosystem Services. Oxford University Press, Oxford.
- Isotopes for Quantifying Biogeochemical Cycles:
- Krüger, N., Finn, D. R., & Don, A. (2024). Soil depth gradients of organic carbon-13–A review on drivers and processes. Plant and Soil, 495(1), 113-136.
- J.R. Ehleringer, A.E. Hall, G.D. Farquhar (1993) Stable Isotope in Plant Carbon-Water Relations, Academic Press
- Deb, S., Lewicka-Szczebak, D., & Rohe, L. (2024). Microbial nitrogen transformations tracked by natural abundance isotope studies and microbiological methods: A review. Science of The Total Environment, 172073.
- Nieder, R. and Benbi, D.K., 2008, Carbon and nitrogen in the terrestrial environment. Springer, Dordrecht.

Microbial Ecosystem Processes:

- M.T. Madigan, K.S. Bender, D.H. Buckley, W.M. Sattley, D.A. Stahl (2022) Brock Biology of Microorganisms 16th edition. Pearson Education Ltd., Harlow, UK
- E.A. Paul (ed.) (2015) Soil microbiology, ecology, and biochemistry. Elsevier, Amsterdam, NL.

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Related courses

Rules for the choice of courses

Compulsory attendance

Mandatory attendance for the exercise part.

Name of the course	SWS	Eventtype	Language

	1,0	Lecture/Exercise	german
Literature			
Skript zur Vorlesung als Lerngrundlage wird gestellt. Folgende Lehrbücher zum Nachschlagen und Vertiefen sind in der UB vorhanden: F. Scheffer, P. Schachtschabel (2002) Lehrbuch der Bodenkunde. 15.Aufl., Spektrum, Heidelberg. U. Gisi (1997) Bodenökologie. 2. Aufl., Thieme, Stuttgart. H.-P. Blume (2004) Handbuch des Bodenschutzes. 3. Aufl., Ecomed, Landsberg am Lech. D.C. Coleman, D.A. Crossley, P.F. Hendrix (2004) Fundamentals of Soil Ecology. 2. Aufl., Elsevier, Amsterdam. P. Lavelle, A.V. Spain (2005) Soil Ecology. Springer, Dordrecht.			

	1,0	Lecture/Exercise	german
Literature			
Isotope in der bodenökologischen Forschung: - Skript wird zur Verfügung gestellt - J.R. Ehleringer, A.E. Hall, G.D. Farquahar, Stabe Isotope in Plant Carbon-Water Relations, Academic Press 1993 R. Nieder, D.K. Benbi (2008): Carbon and Nitrogen in the Terrestrial Environment. Springer, Dordrecht			

	2,0	Lecture/Exercise	english
Literature			
Vorlesungsskript			

Title	Soil Management		
Number	3328200020	**Module version**	
Shorttext	Modulbeschreibungen Englisch fehlen	**Language**	
Frequency of offer	every term	**Teaching unit**	
Module duration	2	**Institution**	Abteilung für Bodenwissenschaften
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Magdalena Sut-Lohmann
Workload (h)	180		
Class attendance (h)	77	**Self studying (h)**	103
Compulsory requirements			
Recommended requirements	Basic knowledge in soil science		
Expected performance/ Type of examination	Agriculture: written examination (45 min) Forest Management: written examination (45 min)		
Course achievement			

Contents

[Agriculture (VÜ)]:
The lecture provides an overview of the history and development of agriculture from its earliest beginnings to modern production. It explores the diversity of cultivated plants and their various uses, as well as the biological foundations and factors influencing yield formation. Different cropping systems and types of cultivation are introduced and discussed. Within the lecture, adaptation of agriculture to the consequences of climate change, stress tolerance of various crops and cropping systems, as well as the possibilities and limitations of climate protection in agriculture are presented and discussed. Furthermore, local and global environmental issues caused by agriculture, as well as approaches to monitoring and assessing environmental impacts, are addressed. Finally, various instruments and strategies of sustainable land management for agriculture are presented to ensure sustainable use of natural resources.
As part of the one-day practical exercise at the Julius Kühn Institute's experimental fields, the content of the lecture is deepened through practical exercises. Different crop types, their challenges, and utilization possibilities are presented based on current experimental field trials around Braunschweig. Scientists from the JKI are also involved, presenting the background and objectives of their current research activities and their experimental work.

[Forest Management in Central Europe (VÜ)]:
Knowledge about the economic, ecological, and social significance of Central European forests is imparted. This includes presenting key parameters, metrics, and inventory methods. In addition to nature conservation and forestry methods for describing and classifying forests, legal definitions, forest functions, organizational structures, management principles, and management systems are explained. Furthermore, students gain an overview of forest history, material cycles, and wildlife management within the forest ecosystem.
As part of two full-day excursions in Lower Saxony, the content of the lecture "Forest Management in Central Europe" is deepened through practical exercises. Various forests are economically and ecologically classified through vegetation surveys, description of soil profiles, and recording of silvicultural parameters. Building on this, various development options will be discussed taking into account climate change.

Objective qualification

Literature

Agriculture:
- Diepenbrock, W., Elmer, F. Und Léon, J., 2005, Ackerbau, Pflanzenbau und Pflanzenzüchtung, Grundwissen Bachelor. Verlag Eugen Ulmer, Stuttgart.
- Lütke-Entrup, N., Oehmichen, J., 2006, Lehrbuch des Pflanzenbaus, Band 1: Grundlagen. Verlag Agro-Concept
- Lütke-Entrup, N., Schäfer, B.C.,2006, Lehrbuch des Pflanzenbaus, Band 2: Kulturpflanzen. Verlag Agro-Concept
- Martin, K., Sauerborn, J., 2006, Agrarökologie. Verlag Eugen Ulmer, Stuttgart.
- Sadras, V.O., Calderini D.F., 2021, Crop Physiology: Case Histories for Major Crops, Academic Press

Forest Management in Central Europe:
- Arbeitskreis Standortskartierung, 6. Aufl. 2003, Forstliche Standortsaufnahme. IHW-Verlag.
- Dengler, A., 1980, Waldbau, Band 1 und 2. Verlag Paul Parey.
- Drachenfels, O., 2021, Kartierschlüssel für Biotoptypen in Niedersachsen unter besonderer Berücksichtigung der gesetzlich geschützten Biotope sowie der Lebensraumtypen von Anhang I der FFH-Richtlinie. NLWKN
- Fischer, A., 2002, Forstliche Vegetationskunde. Eine Einführung in die Geobotanik. Verlag Eugen Ulmer, Stuttgart.
- Kramer, H., 1988, Waldwachstumslehre. Verlag Paul Parey.
- Kramer, H. u. Akca. A., 1995; Leitfaden zur Waldmesslehre. J. D. Sauerländer's Verlag.
- Kremser, W., 1990, Niedersächsische Forstgeschichte: Eine integrierte Kulturgeschichte des nordwestdeutschen Forstwesens. Heimatbund Rotenburg/Wümme.
- Larcher, W., 1994, Ökophysiologie der Pflanzen. Leben, Leistung und Stressbewältigung der Pflanzen in ihrer Umwelt, Verlag Eugen Ulmer, Stuttgart.
- Niedersächsische Landesforsten, 2019; Aus dem Walde Schriftenreihe Waldentwicklung in Niedersachsen, Heft 61, Klimaangepasste Baumartenwahl in den Niedersächsischen Landesforsten. NLF.
- Otto, H.-J., 1994, Waldökologie. Verlag Eugen Ulmer, Stuttgart.

Remark

The different parts of the module will be offered in different semesters. To distribute the workload, each part will be assessed separately.

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Related courses

Rules for the choice of courses

Compulsory attendance

Mandatory attendance for the excursions.

Name of the course	SWS	Eventtype	Language
	2,0	Lecture	german
	2,0	Lecture	german

Literature

- Otto, H.-J., 1994, Waldökologie. Verlag Eugen Ulmer, Stuttgart. - Arbeitskreis Standortskartierung, 6. Aufl. 2003, Forstliche Standortsaufnahme. IHW-Verlag. - Niedersächsische Landesforsten, 2019; Klimaangepasste Baumartenwahl in den Niedersächsischen Landesforsten. Aus dem Walde, Heft 61.

Title	Practice-Oriented Seminars in Soil Science		
Number	3328000010	**Module version**	
Shorttext		**Language**	
Frequency of offer		**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration		**Institution**	Abteilung für Bodenwissenschaften
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Magdalena Sut-Lohmann
Workload (h)	180 h		
Class attendance (h)	30	**Self studying (h)**	150
Compulsory requirements	Basic knowledge corresponding to the lecture “Soil Science – Introduction” (PHY-IGÖ-086) is mandatory.		
Recommended requirements	Prior completion of the module “Advanced Soil Science” is recommended.		
Expected performance/ Type of examination	Portfolio		
Course achievement			
Contents			
Conceptualization and planning of an internship project in the field of soil science. Various project-related topics will be addressed. As part of the course, practical exercises will be conducted in the laboratory and, if applicable, in the field.			
Objective qualification			
Students acquire the ability to independently conduct a scientific project in the field of soil science, as well as to analyze and critically discuss the data obtained. In addition, they will gain theoretical knowledge and practical skills in fundamental laboratory and fieldwork techniques relevant to project-based approaches			
Literature			
Literature will be announced during the lectures.			
Remark			
Participation is limited to 6 persons.			

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**

Project Work and Methods in Soil Science Lecture	4,0	Lecture/Exercise	german

Specialisation Modelling Flow and Transport in the Critical Zone

Title	Transport Processes in the Environment: Fundamentals and Modelling		
Number	3328200040	**Module version**	
Shorttext	Modulbeschreibungen Englisch fehlen	**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung für Bodenwissenschaften
Hours per Week / ECTS	4 / 6,0	**Module owner**	Dr. Sascha Iden
Workload (h)	180		
Class attendance (h)	40	**Self studying (h)**	140
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			

Imboden & Koch (2003): Systemanalyse – Eine Einführung in die mathematische Modellierung natürlicher Systeme, Springer.

Jury & Horton (2004): Soil Physics, John Wiley & Sons, 384 Seiten. [Lehrbuchsammlung]

Munz & Westermann (2019): Numerische Behandlung gewöhnlicher und partieller Differenzialgleichungen, ein anwendungsorientiertes Lehrbuch für Ingenieure, Springer.

Press, Flannery, Teukolsky & Vetterling (1992): Numerical Recipes, Cambrige University Press.

D. E. Radcliffe und J. Simunek (2010): Soil Physics with Hydrus. Modeling and Applications. CRC Press

Richter, Diekkrüger und Nörteshäuser (2007): Environmental Fate of Pesticides: From the Laboratory to the Field Scale. Wiley Interscience und VCH, Weinheim.

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Inverse Modelling and Model Calibration		
Number	3328200050	**Module version**	
Shorttext	Modulbeschreibungen Englisch fehlen	**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung für Bodenwissenschaften
Hours per Week / ECTS	4 / 6,0	**Module owner**	Dr. Sascha Iden
Workload (h)	180		
Class attendance (h)	40	**Self studying (h)**	140
Compulsory requirements			
Expected performance/ Type of examination	Written examination (120 min) or oral examination (30 min)		
Course achievement			

Contents

Linear regression in matrix notation
- Residual analysis, goodness-of-fit measures and model selection
- Calculation and interpretation of confidence and prediction intervals
- Collinearity analysis and parameter correlation
- Weighting of data points with different error variance
- Non-linear minimization in one and more dimensions
- Identifiability, stability and uniqueness of inverse problems
- Optimization of experimental designs
- Application of the methods to the following problems: Determination of sorption isotherms, degradation parame-ters and sorption kinetics, estimation of soil hydraulic properties, estimation of transport parameters from transport experiments in the laboratory and in the field

Objective qualification

The students...
- are able to independently apply methods of linear and non-linear regression to estimate parameters of water and mass transport and to implement them in the programming language PYTHON
- know the most important methods of iterative minimization of functions of several variables and are able to use them to solve practical problems, taking into account their advantages and disadvantages.
- are able to formulate and solve inverse problems for arbitrary problems and model types (linear and non-linear compartment models, transport models in the form of partial differential equations).
- can quantify the uncertainties of model parameters and model predictions in the form of confidence and predic-tion intervals, present them appropriately and interpret them statistically.
- are able to plan experiments to investigate the behavior of substances in the environment and optimize them with regard to their information content.
- can present, explain and interpret the results of independently conducted projects.

Literature

Draper und Smith (1998): Applied Regression Analysis, 3rd Ed., Wiley.
Fahrmeir, Kneib und Lang (2009): Regression. Modelle, Methoden und Anwendungen, Springer Verlag.

Hill und Tiedemann (2007): Effective groundwater model calibration. With analysis of data, sensitivities, predictions and uncertainty. Wiley-Interscience.
Press, Teukolsky, Vetterling und Flannery (1992): Numerical Recipes. The Art of Scientific Computing, Cambridge University Press.
Richter, Diekkrüger und Nörteshäuser (1996): Environmental Fate of Pesticides: From the Laboratory to the Field Scale. Wiley Interscience und VCH, Weinheim.

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Modelling of Water and Energy Fluxes in the Critical Zone		
Number	3328200060	**Module version**	
Shorttext		**Language**	english
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung für Bodenwissenschaften
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Ilhan Özgen
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90min) or oral exam (20min)		
Course achievement			

Contents

- Soil water budget
- Richardson-Richards equation
- Root water uptake
- Plant physiology, photosynthesis
- Plant hydraulics, van den Honert equation
- Evapotranspiration
- Water stress, vulnerability curves, hydraulic redistribution

Objective qualification

Upon completing this module, students will be able to quantitatively describe and predict the water flow through the soil-plant-atmosphere continuum and to model research questions in the field of plant hydraulics.

Literature

Baird & Wilby (2000) Eco-Hydrology, Routledge, Oxfordshire, UK.
Yin & Porporato (2021) Ecohydrology: Dynamics of Life and Water in the Critical Zone, Cambridge University Press, Cambridge, UK.

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**

	4,0	Lecture/Exercise	english

Title	Soil Water Assessment in the Field		
Number	3328200070	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung für Bodenwissenschaften
Hours per Week / ECTS	4 / 6,0	**Module owner**	Dr. Sascha Iden
Workload (h)	180		
Class attendance (h)	60	**Self studying (h)**	120
Compulsory requirements			
Expected performance/ Type of examination	Portfolio		
Course achievement			

Contents

1 Soil hydrology: basics, measurement techniques, modeling (V)
- The soil as a three-phase system, phase saturations, phase relationships
- Solid phase: mineralogy. Grain size distribution
- Water in the soil: Water content, water potential
- Measurement technology for recording water content and water potential
- Modeling water flow in the soil with the Richards equation
- Atmospheric boundary conditions and calculation of evapotranspiration

2 Soil hydrology field exercise (exercise)

Design and construction of a soil hydrological measuring station to record water dynamics in the unsaturated zone (tensiometry, water content sensors, soil temperature, soil water sampling devices, automatic data recording and data transmission).

Objective qualification

The students ...
- know the most important hydrological processes in soils and their model-based description using the laws of Buckingham-Darcy and Richards.
- know the physical principles of measuring water potential and water content in soil.
- are able to operate a meteorological measuring station and process the resulting data and convert it into atmos-pheric boundary condition for modeling and assessing the soil water balance.
- are able to independently design a measurement campaign in the field to record the soil water balance in the unsaturated soil zone and use suitable measuring instruments for the problem.
- are able to record and present the measurement results in the field, check the plausibility of the data and evalu-ate them using numerical simulation.
- can apply important soil hydrological measurement techniques in the laboratory and field and evaluate the result-ing data appropriately, e.g. HYPROP, PARIO, KSAT, infiltration measurements in the field, penetrometer meas-urements in the field, root analysis
- can compile and present the results of a measurement campaign in the field in the form of a presentation and a report.

Literature
Jury & Horton (2004): Soil Physics, John Wiley & Sons, 384 Seiten. [Lehrbuchsammlung] J.L. Monteith, M. Unsworth (2013): Principles of environmental Physics, 2nd Ed., Academic Press D. E. Radcliffe und J. Simunek (2010): Soil Physics with Hydrus. Modeling and Applications. CRC Press J.A. Tindall, J.R. Kunkel (1999): Unsaturated Zone Hydrology for Scientists and Engineers. Prentice-Hall Wessel-Bothe & Weihermüller (2020): Field Measurement Methods in Soil Science, Borntraeger

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	3,0	Exercise	german
	1,0	Lecture	german

Title	Urban Ecohydrology		
Number	1514300	**Module version**	
Shorttext		**Language**	english
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration	1	**Institution**	Abteilung für Bodenwissenschaften
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Ilhan Özgen
Workload (h)	180 h		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) or oral exam (20 Min.)		
Course achievement			

Contents

[Urban Ecohydrology (V)]
The lecture presents topics of ecohydrology in the urban area: urban groundwater, measurement and modelling techniques, decentralised stormwater management and green-blue infrastructure

[Urban Ecohydrology (Ü)]
The exercise consists of calculation exercises that are based on the lecture's topics. Part of the exercise is carried out using the programming language "R".

Objective qualification

Upon completing this module, students will be able to:

- apply theoretical knowledge of the effect of ecosystem services on the urban water cycle
- quantitatively solve ecohydrological problems in the urban area
- apply urban ecohydrological methods

Literature

Baird & Wilby (2000) Eco-Hydrology, Routledge, Oxfordshire, UK.

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**

	4,0	Lecture/Exercise	english
Literature			
Baird & Wilby (2000) Eco-Hydrology, Routledge, Oxfordshire, UK			

Specialisation Environmental (Geo-)Chemistry and Ecotoxicology

Title	Pollutants in the Environment		
Number	1112120	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Geochemie
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Harald Biester
Workload (h)			
Class attendance (h)	60	**Self studying (h)**	120
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (60 Min.)		
Course achievement			

Contents

[Inorganic Pollutants in the Environment (V)]
The focus of the lecture Inorganic Pollutants in the Environment is the behaviour of toxic heavy metals and nutrients in the environment. In addition to the essential physical-chemical basic parameters of this group of pollutants, the binding and transport behaviour of various heavy metals in soils, aquatic systems and the atmosphere is demonstrated on the basis of case studies. The focus is on contaminated industrial sites, deposits and ore processing plants that have caused contamination of soils, groundwater, surface waters or the atmosphere on different scales. Further topics are the assessment of contaminated sites on the basis of administrative regulations and existing threshold values, considerations of the natural background of toxic heavy metals as well as strategies for remediation or risk limitation of contaminated soils and waters. In addition to heavy metals, the contamination of surface waters and groundwater by macronutrients is also addressed.

[Organic Pollutants in the Environment (V)]
The lecture Organic Pollutants in the Environment deals with the occurrence and behaviour of organic chemicals in the environment. At the beginning the principles of chemical plant protection from synthesis to application are presented. The basic prerequisite for this is the legally regulated authorisation procedure, in which, among other things, investigation strategies are used starting from laboratory and lysimeter experiments to field studies in order to assess the residue behaviour of these organic chemicals in the various environmental compartments of air, soil and water. This authorisation procedure is based on test methods that are also used as a basis for investigations under the Chemicals Act, the Biocides Directive and the authorisation of human and veterinary pharmaceuticals. In addition to the presentation of these test systems, the application of residue and radiotracer analysis is also discussed. In this methodically designed concept, direct practical relevance is achieved by including current results from research activities in the individual sub-disciplines.

Objective qualification

Knowledge of the most important inorganic pollutants and the processes and controls that govern their behaviour in the environment on different scales (local, regional, global). Learn evaluation criteria of conta-

minated sites (soils, groundwater and water bodies). Overview of the most important remediation concepts of contaminated soil and groundwater.

In the lecture Organic Pollutants in the Environment, students are enabled to plan and apply investigation strategies for the prospective evaluation of the behaviour of organic chemicals and their metabolites in different environmental compartments (air, water, sediment, soil, plant, waste) in order to be able to carry out and evaluate laboratory, lysimeter and field studies including basic methods of residue and radiotracer analyses.

Literature

Merian, E. et al. (2004): Elements and their Compounds in the Environment. Vol. I-III. Wiley-VCH.
Appelo and Postma (2005),Geochemistry, Groundwater and Pollution
Van Loon and Duffy (2005), Environmental Chemistry, a global perspective.
Baird and Cann (2005), Environmental Chemistry.
Förstner (2004), Umweltschutztechnik.
Bahadir, M., Klein, W., Lay, J.P., Parlar, H. und Scheunert, I. (1992): Lehrbuch der Ökologischen Chemie. Georg Thieme Verlag, Stuttgart, New York.
Haider, I. und Schäffer, A. (2000): Umwandlung und Abbau von Pflanzenschutzmitteln in Böden. Enke im Georg Thieme Verlag, Stuttgart, New York.
Kreuzig, R. (1998): Entwicklung analytischer Methoden zur Differenzierung von Abbau und Sorption als konzentrationsbestimmenden Prozessen für Pflanzenschutzmittel-Wirkstoffe in Böden. Habilitati-onsschrift, TU
Braunschweig, ISBN 3-89720-291.
Kümmerer, K. (2004): Pharmaceuticals in the Environment. Springer.

Merian, E. et al. (2004): Elements and their Compounds in the Environment. Vol. I-III. Wiley-VCH.
Appelo and Postma (2005),Geochemistry, Groundwater and Pollution
Van Loon and Duffy (2005), Environmental Chemistry, a global perspective.
Baird and Cann (2005), Environmental Chemistry.
Förstner (2004), Umweltschutztechnik.

Publikationen zur Vorlesung.

Remark

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Related courses

Rules for the choice of courses

Compulsory attendance

Name of the course	SWS	Eventtype	Language
	2,0	Lecture	german

Literature

Merian, E. et al. (2004): Elements and their Compounds in the Environment. Vol. I-III. Wiley-VCH. Appelo and Postma (2005),Geochemistry, Groundwater and Pollution Van Loon and Duffy (2005), Environmental Chemistry, a global perspective. Baird and Cann (2005), Environmental Chemistry. Förstner (2004), Umweltschutztechnik. Publikationen und Folien zur Vorlesung.

		Lecture	german

Title	Ecological Chemistry		
Number	1112150	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	2	**Institution**	Abteilung Geochemie
Hours per Week / ECTS	4 / 6,0	**Module owner**	Dr. Marit Kolb
Workload (h)			
Class attendance (h)	60	**Self studying (h)**	120
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			

Korte, F (Hrsg). (1992): Lehrbuch der Ökologischen Chemie, Thieme Verlag.
Parlar, H. Angerhöfer, D. (1995): Chemische Ökotoxikologie. Springer-Verlag.
Bliefert, C. (2002): Umweltchemie, Wiley-VCH.
Fent, K. (2003): Ökotoxikologie, Georg Thieme Verlag.
Schwedt, G. (2007):Taschenatlas der Analytik, Georg Thieme Verlag.
Schwedt, G. (1996):Taschenatlas der Umweltchemie, GeorgThieme Verlag.
Bahadir,M. Parlar, H. Spiteller M. (Hrsg) (2000): Springer Umweltlexikon, Springer Verlag.
Hites, R.A. Raff, J.D. (2017), Umweltchemie: Eine Einführung mit Aufgaben und Lösungen, Wiley VCH Verlag.
Klöpffer, W (2012), Verhalten und Abbau von Umweltchemikalien. Physikalisch-chemische Grundlagen; Wiley VCH Verlag.
Hites, R.A. Raff, J.D. (2017), Umweltchemie: Eine Einführung mit Aufgaben und Lösungen, Wiley VCH Verlag
Klöpffer, W (2012), Verhalten und Abbau von Umweltchemikalien. Physikalisch-chemische Grundlagen; Wiley VCH Verlag

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	german
	2,0	Lecture	german

Title	Ecotoxicology		
Number	1112160	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Geochemie
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Harald Biester
Workload (h)			
Class attendance (h)	60	**Self studying (h)**	120
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			
Fent, K. (2013): Ökotoxikologie. Thieme.			

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
		Lecture	german
		Exercise	german
		Internship	german

Title	Environmental Geochemistry - Biogeochemical Cycles: Introduction and Data Interpretation		
Number	1514230	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Geochemie
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Harald Biester
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			
W.G. Ernst, Earth Systems M. Jacobson et al., Earth System Science W.H. Schlesinger, Biogeochemistry V.N. Baskin, Modern Biogeochemistry J. Hoefs, Stable Isotope Geochemistry Verschiedene wissenschaftliche Artikel aus Fachzeitschriften Skript/Foliensammlung zur Veranstaltung			

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Ecological Chemistry Geochemical Modeling and Case Studies		
Number	1112350	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Geochemie
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Harald Biester
Workload (h)			
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Portfolio		
Course achievement			

Contents

[Introduction to Geochemical Modelling of Aquatic Systems (VÜ)]
Physicochemical properties of water, solution equilibria, acids and bases, composition of natural waters, redox chemistry, trace metals, pollutants, processes at the mineral-water boundary, thermodynamics, determination of cation exchange capacity, preparation of pH-Eh diagrams.

Objective qualification

Building on the basics of aquatic geochemistry, skills are to be learned that allow independent processing of geochemical tasks using geochemical models. The students are enabled to approach physical-geochemical processes in the environment by expanding the basics of mathematical formulation. They also gain an understanding of the structure and concept of geochemical models, as well as their possibilities and limitations. They acquire the ability to independently parameterisation of simple geochemical processes in the environment.

Literature

- Geochemistry, Groundwater and Pollution Appelo, C.A.J und Postma, D. 2 Edition (2005), A.A. Balkema.
- Aquatische Chemie. Sigg, L. und Stumm, W.. Vdf Hochschulverlag AG, 1996.
- Chemical Fate and Transport in the Environment. Hemond, H.F., Fechner-Levy, E., Academic Press Inc.,U.S.1999.
- Dokumentationen: PREEQC

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Supplement Area

Title	Waste and Resource Management		
Number	4398320	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration	1	**Institution**	Abteilung Abfall- und Ressourcenwirtschaft
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Julia Gebert
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) or oral exam (approx. 30 Min.) (in the Master's programme in Social Sciences as a course achievement)		
Course achievement			

Contents
Waste management concepts; acquisition logistics; plant and process technology (with focus on biological processes; methods for process control and monitoring; emission control; product development; secondary raw materials; methods for quality control of secondary raw materials; design principles, plant planning and design, and waste analytics.
Objective qualification
Students acquire in-depth knowledge of tasks and solution methods of municipal and industrial waste and resource management as well as material flow-related recycling management. The special focus is on biological treatment and recycling processes for municipal waste. Here, required work steps and methods for the implementation of management measures and plant technologies are learned. Evaluation methods for describing and assessing economic, ecological and social impacts are taught and applied. Special knowledge in the field of the use of regenerative energies from municipal waste is acquired. In this lecture, students will be able to use their acquired knowledge to evaluate waste management concepts and to perform rough measurements of selected process steps/aggregates
Literature
Detailed script, Powerpoint slides,

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Wastewater and Sludge Treatment		
Number	4398270	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Siedlungswasserwirtschaft
Hours per Week / ECTS	5 / 6,0	**Module owner**	Prof. Dr. Thomas Dockhorn
Workload (h)	180		
Class attendance (h)	70	**Self studying (h)**	110
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (approx. 60 Min.)		
Course achievement			

Contents

[Processes of Wastewater Treatment (VÜ)]
The class gives a comprehensive overview of wastewater treatment an introduces wastewater parameters (organic carbon compounds, nitrogen, phosphorus compounds, relevant toxic substances) and all major processes of wastewater treatment (mechanical wastewater treatment, biological wastewater treatment, activated sludge process, special treatment procedures e.g. biofiltration, membrane processes, SBR-reactors, chemical treatment processes e.g. precipitation and flocculation as well as aeration and gas exchange).
An additional tutorial discusses special topics in detail and presents calculation and dimensioning examples.

[Sewage Sludge Treatment and Disposal (VÜ)]
The class presents the entire process of sewage sludge treatment, starting with sludge production, sludge characteristics (physical, chemical, biological), various types of sludge stabilisation (aerobic/anaerobic), biogas utilization and sludge disinfection up to sludge disposal options, legal regulations and disposal costs. Special importance is given to questions of sludge reuse and nutrient recovery

Objective qualification

Students will gain detailed and comprehensive understanding of processes and objectives of municipal wastewater and sludge treatment. On the basis of their fundamental knowledge in sanitary engineering from prior studies, students acquire advanced engineering qualifications and scientific skills to understand, design and operate wastewater and sludge treatment plants. They will be able to dimension all treatment processes independently and will be able to carry out research and practical projects in the field of wastewater and sludge treatment. They will be able to critically discuss various process options and find adequate solutions taking into consideration environmental, social, scientific and ethical concerns

Literature

Lecture notes for both classes are available.

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture/Exercise	german
	3,0	Lecture/Exercise	german

Title	Applied Limnology and Modelling of Lakes and Reservoirs		
Number	1112280	**Module version**	
Shorttext	GEA-STD2-1	**Language**	german
Frequency of offer		**Teaching unit**	
Module duration	2	**Institution**	Abteilung Geochemie
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Harald Biester
Workload (h)			
Class attendance (h)	80	**Self studying (h)**	100
Compulsory requirements			
Expected performance/ Type of examination	Lecture: Written exam (90 Min.) or oral exam (30 Min.) [50%] Excursion: Term paper/ Report about the excursion [50%]		
Course achievement			

Contents

[Introduction to the Function and Modelling of Standing Waters (V/Ü)].
The participants get an introduction to the structure and functioning of limnic ecosystems. This includes the following aspects: Physical structure, food chains, biogeochemical processes and trophic dynamics. In the second part of the course, these different components are abstracted to a conceptual lake model and realised in an implemented lake model. On the last day, applied problems of lake management and reservoir management are discussed and analysed in selected examples by means of the model (e.g. eutrophication, oxygen depletion).

[Ecological Condition and Use of Dams and Lakes (Exk)].
The focus of the excursion week is on taking samples and measurements in the field and evaluating the data collected. Furthermore, different types of water bodies are visited and characteristic differences are worked out (e.g. deep lake vs. shallow lake, dam vs. natural lake, oligotrophic water body vs. eutrophic water body). Finally, important water management infrastructures are learned about and visited. The analysis of certain water samples takes place in the laboratory.

Objective qualification

The students learn the most important concepts for assessing the water quality of reservoirs and lakes and to characterise the relevant influencing variables. They will acquire skills for the use of lake models for water quality management, for the development of management concepts for standing waters as well as for the ecosystem analysis of lake ecosystems. Finally, during the excursion week, practical experience will be gained in sampling, sample analysis and water management practice

Literature

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
		Lecture/Exercise	german
	2,0	Excursion	german

Title	Inorganic Environmental Analysis		
Number	1112170	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Geochemie
Hours per Week / ECTS	5 / 6,0	**Module owner**	Dr. Hubertus Wichmann
Workload (h)			
Class attendance (h)	60	**Self studying (h)**	120
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			

Contents
Objective qualification
Literature
Fent, K.(2007): Ökotoxikologie, Thieme Verlag, 3. Auflage Merian, E. et al. (2004): Elements and their Compounds in the Environment. Vol. I-III. Wiley-VCH. Publikationen und Folien zur Vorlesung.

↑

Related courses
Rules for the choice of courses
Compulsory attendance

Name of the course	SWS	Eventtype	Language
	2,0	Lecture	german
		Internship	german

Title	Landfill Technology and Remediation of Contaminated Sites		
Number	4398330	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Abfall- und Ressourcenwirtschaft
Hours per Week / ECTS	4 / 6,0	**Module owner**	Dr. Kai Münnich
Workload (h)			
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (approx. 30 Min.)		
Course achievement			

Contents

[Landfill Mining, Landfill Construction and Geotechnique of Wastes (VÜ)}
Fundamentals of waste mechanics und the hydarulic behaviour of wastes; interaction between the different parameters; constructive elements of landfills; emissions from landfills and their monitoring; longterm behaviour of landfills; position and after-use of landfills; Landfills in emerging and developing countries; legal basis.

[Investigation and Remediation of Contaminated Sites (VÜ)]
Contaminants in soil and groundwater; procedures for exploration; control of soil air; sampling of soil, soil air and groundwater; evaluation and assessment of analytical results; techniques for in-site and on-/off-sites remediation; procedures for groundwater treatment; biological, thermal and physical treatment of soils; after-use of contaminated sites; landfill mining.

Objective qualification

Students acquire in-depth knowledge of the construction and operation of landfills for municipal solid waste (MSW). The aspects of the position of the landfill in the waste management, the legal framework, the site search, the technical installations up to the aftercare, the monitoring and the landfill mining are considered. Furthermore, they gain detailed knowledge about the mechanical properties of waste as well as the long-term behavior in terms of water and gas emissions. Overall, there is a focus on the situation in emerging and developing countries. This will enable students to understand and evaluate the major dynamic processes of a landfill and to size the required structural components.

Students gain in-depth knowledge of the identification and remediation of contaminated sites. The basic aspects concerning possible pollutants, sources of input and exploration of the soil and groundwater are considered. The possible techniques for remediation of contaminated sites (biological, chemical and physical) are learned. The special case of remediation of old MSW dumps is elaborated in detail. This will enable students to assess a suspected contaminated site and select an appropriate remediation technique for the specific case.

Literature

Powerpoint slides
Remark

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture/Exercise	german
	2,0	Lecture/Exercise	german

Title			
Number	1514330	**Module version**	
Shorttext		**Language**	english german
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration		**Institution**	Abteilung für Bodenwissenschaften
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Ilhan Özgen
Workload (h)			
Class attendance (h)		**Self studying (h)**	
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Project	english german

Title	Remote Sensing		
Number	3324000000	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Geodäsie und Photogrammetrie
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Markus Gerke
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Portfolio		
Course achievement			

Contents

-physical principles
-selected sensors of multispectral remote sensing
-backscatter values and indices
-Classification methods
-Change detection
-Terrestrial microwave interferometry
-Radar remote sensing and SAR interferometry
-Intensity and coherence analysis of radar data
-Multi-temporal evaluation processing of radar interferometry

Objective qualification

Students are taught basic theoretical knowledge, acquisition and analysis methods of multispectral and radar remote sensing. Through the combination of lectures and application-related exercises in the PC pool, students acquire the competence to independently derive selected questions regarding the determination of basic states and changes of the earth's surface on the basis of multispectral satellite data. The evaluation and analysis of radar data extends their skills to the area of geometric monitoring of changes in the earth's surface and infra-structural objects.

Literature

Wird während der Vorlesung bekanntgegeben.

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Field Course Biodiversity		
Number	1116150	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung für Landschaftsökologie und Umweltsystemanalyse
Hours per Week / ECTS	5 / 6,0	**Module owner**	Prof. Dr. Frank Suhling
Workload (h)			
Class attendance (h)	70	**Self studying (h)**	110
Compulsory requirements			
Expected performance/ Type of examination	Presentation		
Course achievement			

Contents

The course will be conducted by changing instructors and will take place in changing ecosystems. It can also be held at several different locations each year, depending on demand. Therefore, in some cases there is also the possibility to take the exercise in the winter semester.
Overview of relevant components of the selected ecosystem Sampling in the field to collect biodiversity data Application of assessment procedures using proxies.
Introduction to ecosystem-specific challenges to biodiversity conservation.
Potential topics:
- Aquatic ecology
- Ecology of arid landscapes
- Laboratory and field studies on biotic interactions
- etc.

Objective qualification

The students acquire practical knowledge in the recording and investigation of the biodiversity of a selected ecosystem. They have methodological competence in the area of assessment of the state of biodiversity, e.g. by means of proxies, and in the (experimental) investigation of ecological relationships. Students have basic taxonomic knowledge within selected groups of organisms. They have insight into the practical problems and challenges related to biodiversity conservation.

Literature

Different literature will be provided depending on the landscape / objective / topic.

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	5,0	Exercise	german

Title	Geoinformatics		
Number	3324000020	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Geodäsie und Photogrammetrie
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Markus Gerke
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Portfolio		
Course achievement			

Contents

- Web technologies (HTML, CSS, JavaScript)
- WebGIS frameworks (e.g. Leaflet)
- Geodata formats (GeoJSON)
- Working with map services (WMS / WFS)
- Practical experience with geodatabases
- Publishing, integrating and editing geodata in web-based systems
- Creation of REST APIs
- Development of mobile, map-based web applications

Objective qualification

In this module, theoretical and practical fundamental skills for the creation of web-based applications for the visualization and analysis of geodata are taught. In addition to the general technologies/frameworks that can be used to create a web application (HTML, CSS, Ja-vaScript), the course focuses on WebGIS components that can be used to implement map-centered web applications. In addition, server-side components such as geodatabases, map services and REST APIs are covered. Students gain a comprehensive overview of distributed systems for the visualization, collection and storage of geoinformation. In a final project, students apply the skills they have learned independently and implement a web application in the group based on predefined criteria.

Literature

Literature will be announced during lectures.

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Basics of Environmental and Resource Protection		
Number	4306640	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Siedlungswasserwirtschaft
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Thomas Dockhorn
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (approx. 60 Min.)		
Course achievement			

Contents

[Basic Natural Sciences for Environmental and Resource Protection (V)]
The class covers advanced questions of biological, chemical and physical processes as well as engineering fundamentals for technical resource and environment protection. Material flow cycles, resource economy and alternative treatment concepts are also part of the course.

[Eco-Balancing (VÜ)]
The class teaches methods and procedures for creating eco-balances, offers tutored case studies for creating eco-balances and discusses the special aspects of eco-balancing in the field of waste management.

Objective qualification

Students will gain essential knowledge and skills for understanding scientific and technical basics of environmental and resource protection. They will have advanced knowledge of biological, chemical and physical processes as well as engineering fundamentals for resource and environment protection (material flow cycles, resource economy, alternative treatment concepts). They will be able to create mass balances as well as eco-balances and thus will be able to critically discuss environmental impacts and resource efficiencies of various measures and products. They will be able to evaluate measures in regard to environmental impact taking into consideration social, scientific and ethical questions. They will be able to use eco-balances to understand and scientifically assess environmentally relevant problems and thus be able to support the implementation of environmental targets.

Literature

Used power point presentations are available as download

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
Scientific and technical fundamentals of environmental and resource protection	2,0	Lecture	german
	2,0	Lecture/Exercise	german

Title	Hydrogeophysics		
Number	1112180	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration	2	**Institution**	
Hours per Week / ECTS	5 / 6,0	**Module owner**	Prof. Dr. Andreas Hördt
Workload (h)			
Class attendance (h)	63	**Self studying (h)**	117
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			
Knödel, K., Krummel, H., Lange, G., 1997, Handbuch zur Erkundung des Untergrundes von Deponien und Altlasten, Band 3: Geophysik, Springer. Kearey, Ph., and Brooks, M., 2002, An introduction to geophysical exploration, Blackwell. Kirsch, R., 2006, Groundwater Geophysics - a Tool for hydrogeology, Springer. Rubin, Y. und Hubbard, S., 2005, Hydrogeophysics, Springer.			

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**

Geophysical Field Course	2,0	Internship	german
Literature			
Keary, P., Books, M., Hill, I., 2002. An introduction to geophysical exploration, Blackwell. Telford, W.M., Geldart, L.P., Sheriff, R.E., 1990, Applied Geophysics, Cambridge university Press. Knödel, K., Krummel, H., Lange, G., 1997, Handbuch zur Erkundung von Deponien und Altlasten, Band 3: Geophysik, Springer.			

Hydrogeophysics	2,0	Lecture	german
Literature			
Kirsch, Groundwater Geophysics-a tool for hydrogeology, Springer. Vereecken, H., Binley, A., Cassiani, G., Revil, A. und Titov, K., Applied Hydrogeophysics. NATO Science Series IV. Earth and Environmental Sciences - 71. Knödel, Krummel, Lange, Handbuch zur Erkundung des Untergrundes von Deponien und Altlasten, Band 3: Geophysik, Springer. Reynolds, J.M., 1997, An introduction to Applied and Environmental Geophysics, Wiley. Rubin, Y., Hubbard, S., 2006. Hydrogeophysics, Springer. Everett, M.E., 2013, Near-Surface applied geophysics, Cambridge university press.			

Title	Image Processing and Interpretation		
Number	3324000030	**Module version**	
Shorttext		**Language**	english
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Geodäsie und Photogrammetrie
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Markus Gerke
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	written exam (90 min) or oral exam (30 min)		
Course achievement	term paper		

Contents

[Image Processing]
- image formation
- pixel operations
- linear and non-linear filters
- image segmentation
- morphology
- Typical fields of application, practical examples and exercises

[Image Interpretation]
-Supervised classification
-Unsupervised classification
-dimensionality reduction
-pixel-based and object-based approaches
- Typical fields of application, practical examples and exercises

Objective qualification

[Image Processing]
In this lecture/excercise, students are introduced to digital image processing, including the application of filters or operators that improve the image or represent a pre-processing step for image interpretation. Basic knowledge and methods are taught in the courses so that the participating students are able to independently record, evaluate and analyze data.

[Image Interpretation]
This course provides basic knowledge of methods for extracting information from images. It deals with supervised and unsupervised classification, as well as techniques for dimension reduction. Furthermore, a distinction is made between approaches that classify individual pixels and those that generate an object-based description. Basic knowledge and methods are taught in the courses so that the participating students are able to collect, evaluate and analyze data independently.

To reinforce the methodological understanding, individual tasks are also solved as part of small programming tasks. Some tasks are defined mandatory (*Studienleistung*)
Literature
Literature will be provided during lectures

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture/Exercise	english
	2,0	Lecture/Exercise	english

Title	Engineering surveying		
Number	3324000010	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Geodäsie und Photogrammetrie
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Markus Gerke
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	written exam (60 min) or oral exam (30 min) and portfolio		
Course achievement			

Contents

Geodetic Sensors:
- Automated total stations for monitoring tasks
- Basics of laser scanning: methodology, technology, systems
- Use of GNSS for monitoring tasks
- Sensor networks
- Typical fields of application, practical examples and exercises

Evaluation Methods:
- Coordinate calculation
- Variance propagation
- Introduction to the adjustment theory
- Analysis of epochal solutions
- Basics of time series analysis

Objective qualification

Geodetic Sensors:
- Automated total stations for monitoring tasks
- Basics of laser scanning: methodology, technology, systems
- Use of GNSS for monitoring tasks
- Sensor networks
- Typical fields of application, practical examples and exercises

Evaluation Methods:
- Coordinate calculation
- Variance propagation
- Introduction to the adjustment theory
- Analysis of epochal solutions
- Basics of time series analysis

Literature

Literature will be announced and provided during lectures

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
Geodetic Sensors	2,0	Lecture/Exercise	german
	2,0	Lecture/Exercise	german

Title	International Wastewater and Waste Management		
Number	4398310	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Siedlungswasserwirtschaft
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Thomas Dockhorn
Workload (h)	180		
Class attendance (h)	50	**Self studying (h)**	130
Compulsory requirements			
Recommended requirements	Prior successful completion of the module ‘Wastewater and Sludge Treatment’ or the module ‘Waste and Ressource Management’ is strongly recommended.		
Expected performance/ Type of examination	Portfolio and presentation		
Course achievement	Students will prepare a 30-minute presentation in teams. The information given in the lectures and in the student presentations are the basis for developing disposal concepts in team work at the end of the class. The portfolio covers a structured presentation of the team results for the developed disposal concepts. Portfolios are created by the teams under supervision of the institute’s assistants. It is possible to drop the class up to two weeks before the final group project. Organization of groups and assignment of research topics takes place in the first class meeting. This class has a compulsory attendance of 50 hours (first class meeting, student presentations, final group project). If students are absent with valid excuse (e.g. illness, child care etc.) individual solutions can be found for being able to complete the class successfully and still reach educational objectives of the class. Periods of absence may not exceed 15% of compulsory attendance, in order to reach educational objectives of the class.		

Contents

[International Wastewater and Waste Management (V)]
The class introduces the topic of waste and wastewater treatment in an international context by presenting various problems and solutions from developing and emerging countries. These lectures are the introduction, basis and preparation for the team work of the following seminar ‘Waste, Wastewater and Resource Management for Developing and Emerging Countries’.

[Waste, Wastewater and Resource Management for Developing and Emerging Countries (S)]
Participants will work independently in student teams and will develop a concept for the disposal of municipal waste and wastewater. Two locations in different parts of the world will be chosen each semester and students will establish a disposal concept for these locations taking into consideration specific legal, geographical, political and social conditions.
As preparatory work, teams of two students each will prepare a 30-minute presentation dealing with basic questions such as processes of wastewater and waste treatment, costs and planning of treatment plants, economy, infrastructure, culture and religion in the area and present their results to the class.

With this information, two teams (one for each location) will then develop a complete disposal concept as a group project during the 2-day block seminar at the end of the course. Finally, the developed concepts will be introduced to the class in a 30-minute presentation and will be discussed with the participants. A written report is required to complete the class.

Objective qualification

Students are able to understand and solve problems in the field of international wastewater and waste management. They will acquire fundamental knowledge for solving problems concerning waste and wastewater in developing and emerging countries taking into special consideration country-specific aspects. They will have the ability to adapt suitable concepts and technologies to given locations with special reference to globalization. Understanding material flow management and resource protection in a global context are a further teaching objective. Students are able to scientifically discuss engineering problems in a team and to acquire additional required knowledge independently. They are able to analyse and evaluate existing problems under consideration of country-specific aspects and are able to find and realize strategies for solving these problems under given local conditions (regional governance). They are able to skillfully present their solutions to the public. A special focus in this seminar is on practicing teamwork, acquiring debate techniques and rhetorical skills and learning how to discuss controversial questions in a scientific setting.

Literature

Die relevante Fachliteratur kann je nach Aufgabenstellung variieren. Die erforderliche Literatur steht den Studierenden in
der Institutsbibliothek zur Verfügung.

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Related courses

Rules for the choice of courses

Prior successful completion of the module ‘Wastewater and Sludge Treatment’ or the module ‘Waste and Ressource Management’ is strongly recommended.
This module is only availabe to students specializing in Sanitary and Environmental Engineering or Waste Management. Number of participants is limited to max. 40 participants.

Compulsory attendance

This class has a compulsory attendance of 50 hours (first class meeting, student presentations, final group project). If students are absent with valid excuse (e.g. illness, child care etc.) individual solutions can be found for being able to complete the class successfully and still reach educational objectives of the class. Periods of absence may not exceed 15% of compulsory attendance, in order to reach educational objectives of the class.

Name of the course	SWS	Eventtype	Language
	1,0	Lecture	german
	3,0	Seminar	german

Title			
Number	1514010	**Module version**	
Shorttext		**Language**	
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Geochemie
Hours per Week / ECTS	3 / 6,0	**Module owner**	Prof. Dr. Harald Biester
Workload (h)	180		
Class attendance (h)		**Self studying (h)**	
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**

	3,0	Block course	english german

Literature

Brantley et al., 2017: Reviews and syntheses: on the roles trees play in building and plumbing the critical zone, Biogeosciences, 14(22), 5115–5142, doi:10.5194/bg-14-5115-2017, 2017
Dawson, T. E. and Ehleringer, J. R., 1991: Streamside trees that do not use stream water, Nature, 350(6316), 335–337, doi:10.1038/350335a0
Ehleringer, J. R., Roden, J. and Dawson, T. E., 2000: Assessing Ecosystem-Level Water Relations Through Stable Isotope Ratio Analyses, in Methods in Ecosystem Science, pp. 181–198, Springer New York, New York, NY.
Penna, D. et al., 2018: Ideas and perspectives: Tracing terrestrial ecosystem water fluxes using hydrogen and oxygen stable isotopes – challenges and opportunities from an interdisciplinary perspective, Biogeosciences, 15(21), 6399–6415, doi:10.5194/bg-15-6399-2018

Weiterführende Literatur und ein derzeit laufendes Forschungsprojekt als Motivation sind unter www.isodrones.com zu finden. Informationen zu Isoscapes: http://wateriso.utah.edu/waterisotopes/index.html

Title	Practical Lab Training and Dimensioning of Treatment Plants		
Number	4398280	**Module version**	4398280-E-FK3
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Siedlungswasserwirtschaft
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Thomas Dockhorn
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements	Prerequisite is prior participation in the module "Wastewater and Sludge Treatment"		
Recommended requirements	Students are expected to have a thorough knowledge of treatment processes for wastewater and sludge treatment in order to participate in this class.		
Expected performance/ Type of examination	The portfolio covers a detailed handout for each class, showing lab results and scientific discussion of the results or dimensioning drafts and scientific evaluation of the draft. Portfolios are design in independent teams under tuition of the lecturer. Lab results and scientific background will be presented to the class participants and the lab tutors in a final 30-minute seminar presentation. Grading will be based on participation during the lab days and on the quality of the presentation and on the corresponding student handout. Deregistration from the exam is possible up to wo weeks before the scheduled class participation. Dates for class presentations are scheduled in the first class meeting. The class Dimensioning and Design of Treatment Plants has a compulsory attendance of 16 hours (first class meeting, final class meeting). If students are absent with valid excuse (e.g. illness, child care etc.) individual solutions can be found for being able to complete the class successfully and still reach educational objectives of the class. Periods of absence may not exceed 15% of compulsory attendance, in order to reach educational objectives of the class. Practical Lab Training has a compulsory attendance of 40 hours (first class meeting, lab days, final class meeting). If students are absent with valid excuse (e.g. illness, child care etc.) individual solutions can be found for being able to complete the class successfully and still reach educational objectives of the class. Periods of absence may not exceed 15% of compulsory attendance, in order to reach educational objectives of the class.		
Course achievement			

Contents

[Dimensioning and Design of Treatment Plants (S)]
During the class, participants will work independently in student teams and will dimension the most important components of a wastewater treatment plant. Using the information and knowledge acquired in the prior classes on wastewater and sludge treatment as well as given dimensioning data, the students will design a wastewater treatment plant. Every other week meetings with the instructor and/or tutor will take place in order to discuss problems encountered during the work process. At the end of the semester each team will present its project to the class and discuss it with the participants and turn in a written report on the project work.

[Practical Lab Training on Wastewater Treatment (Ü)]
During the practical lab training, tutored lab experiments will be conducted in relation to current research projects of the institute (e.g. degradation experiments, precipitation/flocculation, respiration experiments, microscopic experiments, monitoring of experimental set-ups). Several tutored lab days will be arranged for conducting the experiments. Lab results and scientific background will be presented to the class participants in a final 30-minute seminar presentation. Grading will be based on participation during the lab days and on the quality of the presentation and on the corresponding student handout.

Objective qualification

Students are able to work independently in a research lab for wastewater and sludge treatment and discuss environmental engineering questions at a scientific level. They are able to independently acquire additional knowledge in the field of environmental engineering and can find solutions for wastewater problems at various levels. They are able to skillfully present their solutions to the public. A special focus in this seminar is on doing practical lab work, practicing teamwork, acquiring debate techniques and rhetorical skills and learning how to discuss controversial questions in a scientific setting.

Literature

Technical literature and additional information are available at the institute’s library.

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Related courses

Rules for the choice of courses

Prior successful completion of the module ‘Wastewater and Sludge Treatment’ is pre-requisite for participating in this module. Students from other universities must have sufficient basic knowledge in the field of wastewater and sludge treatment.

Compulsory attendance

The class Dimensioning and Design of Treatment Plants has a compulsory attendance of 16 hours (first class meeting, final class meeting). If students are absent with valid excuse (e.g. illness, child care etc.) individual solutions can be found for being able to complete the class successfully and still reach educational objectives of the class. Periods of absence may not exceed 15% of compulsory attendance, in order to reach educational objectives of the class.

Practical Lab Training has a compulsory attendance of 40 hours (first class meeting, lab days, final class meeting). If students are absent with valid excuse (e.g. illness, child care etc.) individual solutions can be found for being able to complete the class successfully and still reach educational objectives of the class. Periods of absence may not exceed 15% of compulsory attendance, in order to reach educational objectives of the class.

Name of the course	SWS	Eventtype	Language
	2,0	Seminar	german
	2,0	Internship	german

Title	Multivariate Statistical Methods		
Number	1116120	**Module version**	V1
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung für Landschaftsökologie und Umweltsystemanalyse
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Boris Schröder-Esselbach
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Portfolio		
Course achievement			

Contents

Introduction: Motivation, representations, multidimensional distributions
Similarity, dissimilarity.
Ordination: Principal Components, Correspondence Analysis, Multidimensional Scaling, Sammons Mapping
Canonical Ordination: Canonical Correspondence Analysis, Redundancy Analysis
Classification: Hierarchical Cluster Analysis, k-Means, Affinity Propagation, Comparison of Clusterings, Indicator Types
Mantel tests

Objective qualification

This module teaches multivariate statistical methods that are frequently used in ecological studies. In the lecture, the theoretical basics as well as the advantages and disadvantages of the individual methods are dealt with, while in the exercise, the methods are applied to concrete examples and questions from ecological research. The freely available program R is used (cran.r-project.org).

The students learn to
1. translate ecological questions into statistical models or hypotheses,
2. select suitable methods for these models or hypotheses,
3. apply the methods to the data at hand and
4. present and interpret the results scientifically.

Literature

Leyer & K. Wesche (2007): Multivariate Statistik in der Ökologie. Springer Verlag
Borcard, Gillet, Legendre (2011): Numerical Ecology with R. Use R! Springer Verlag
Legendre & Legendre (2012) Numerical ecology. Developments in Environmental Modelling. Elsevier

Remark

Restriction on participation: A maximum of 25 places are available.

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Related courses			
Rules for the choice of courses			
Students should know the statistical basics (e.g. distributions, density function, expected value, variance, correlation, quantiles, confidence intervals, hypothesis tests).			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Mechanical and Thermal Waste Treatment and Air Pollution Control		
Number	4398340	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Abfall- und Ressourcenwirtschaft
Hours per Week / ECTS	4 / 6,0	**Module owner**	Dr. Kai Münnich
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (approx. 30 Min.)		
Course achievement			

Contents

[Mechanical and Thermal Treatment of Waste (VÜ)]
The lecture "Mechanical and Thermal Treatment of Waste" imparts knowledge on the thermo-chemical conversion of municipal waste. It focuses on household waste, commercial waste, sewage sludge and hazardous waste. The route from mechanical preparation to conversion and gas purification is described; design principles, planning and design of plants. In addition to technical aspects, legal and licensing aspects are covered.

[Technologies and Concepts for Air Pollution Control and Climate Protection (VÜ)]
Knowledge of legal regulations relevant to exhaust air, of construction and operational requirements, of different technologies for air purification; methods for monitoring and analyses and teaching the ability to design and plan individual components.

Objective qualification

Students gain in-depth knowledge of processes for the mechanical and thermal treatment of waste. The relevant basics of the waste law, in particular with the legal regulations for thermal waste treatment, are taken into account here. Furthermore, detailed knowledge about waste incineration plants, the thermal use of waste in industrial processes as well as in biomass power plants with the respective upstream treatment chains is imparted. The course enables the students to calculate performance data of incineration plants as well as to perform the rough design of plants.

Students acquire basic knowledge of technologies and concepts for emission prevention and reduction as well as air pollution control with a focus on the sectors of waste, wastewater and energy production. Students will be able to develop, plan, implement/execute and operate total solutions. Furthermore, they are able to recognize, analyze and evaluate regional and supra-regional ecological contexts in order to take these findings into account in planning tasks.

Literature

Powerpoint slides

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture/Exercise	german
	2,0	Lecture/Exercise	german

Title	Sustainable Chemistry		
Number	1112220	**Module version**	
Shorttext	GEA-STD2-2	**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Geochemie
Hours per Week / ECTS	4 / 6,0	**Module owner**	Dr. Marit Kolb
Workload (h)			
Class attendance (h)	60	**Self studying (h)**	120
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	1,0	Exercise	german
	2,0	Lecture	german
	1,0	Exercise	german

Title	Conservation Biology		
Number	1112230	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung für Landschaftsökologie und Umweltsystemanalyse
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Frank Suhling
Workload (h)			
Class attendance (h)	80	**Self studying (h)**	100
Compulsory requirements			
Expected performance/ Type of examination	Presentation		
Course achievement			

Contents

Conservation Biology: The lecture introduces the problems of conservation and explains the main concepts of scientific conservation. Then, in the Conservation Biology seminar, current issues in scientific conservation are elaborated and discussed by the students. The lectures and discussion will be given in English. Lecture topics: Causes of the biodiversity crisis, Red Lists: meaning and methodology, Species conservation concepts Biotope conservation concepts, Priority setting in conservation, Biodiversity conservation conventions, Conservation instruments and institutions.
Introduction to Practical Nature Conservation (VÜ): The lecture first gives an overview of planning levels, types of technical contributions for the different planning levels, the framework conditions as well as different nature conservation assessment procedures and their methods. In the exercise (Ü), the students themselves will prepare a proposal or tender for an environmental impact assessment (EIA) or similar with guidance from the teaching staff, including the specification of relevant methods and the calculation of costs, in order to prepare for professional practice in applied nature conservation. Contents of the lecture: planning levels; framework conditions: Spatial planning, protected areas, budget biotope assessment; recording methods of different groups assessment procedures and guidelines; technical contributions for the different planning levels (FFH review, EIA, LBP, environmental report, species protection contribution, etc.); biological technical contributions in the judicial control special species protection review; biological construction monitoring and functional control; recording of organisms: what and how is recorded?

Objective qualification

The students know the fundamental concepts of scientific conservation biology and have an overview of its methods. They know how to deal with Red Lists and know the main causes of species endangerment as well as the different conservation concepts. They can apply strategic concepts such as key species, flagship species, indicator species, etc. and correctly interpret concepts of prioritization of conservation targets. Through independent development of a topic and discussion in the seminar, students will have in-depth knowledge of current research priorities in conservation biology. Since this is done in English, they are also familiar with the relevant terminology of scientific conservation. Students also gain basic knowledge of the framework and planning levels of applied conservation and have basal knowledge of the requirements of surveying organisms for conservation planning. They are able to prepare a tender or offer for planning nature conservation measures for nature conservation planning.

Literature
Wird zur Verfügung gestellt

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	1,0	Lecture/Exercise	german
	2,0	Lecture/Exercise	german

Title	Organic Environmental Analysis		
Number	1112210	**Module version**	V1
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften Fakultät für Lebenswis-senschaften
Module duration	1	**Institution**	Abteilung Geochemie
Hours per Week / ECTS	5 / 6,0	**Module owner**	Dr. Hubertus Wichmann
Workload (h)			
Class attendance (h)	60	**Self studying (h)**	120
Compulsory requirements			
Expected performance/ Type of examina-tion			
Course achievement			
Contents			
Objective qualification			
Literature			
Hein, H., Kunze, W. (1995): Umweltanalytik mit Spektrometrie und Chromatographie. VCH-Verlag. Kreuzig, R. (1998): Entwicklung analytischer Methoden zur Differenzierung von Abbau und Sorption als konzentrationsbestimmenden Prozessen für Pflanzenschutzmittel-Wirkstoffe in Böden. Habilitationsschrift, TU Braunschweig, ISBN 3-89720-291. Marr I.L. et al. (1988): Umweltanalytik. Thieme Verlag. Rump, H.H. (1998): Laborhandbuch für die Untersuchung von Wasser, Abwasser und Boden., Wiley-VCH. Publikationen zur Vorlesung.			

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**

		Internship	german
	2,0	Lecture	german

Title	Photogrammetry		
Number	4310690	**Module version**	V1
Shorttext	BAU-STD3-65	**Language**	english german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Geodäsie und Photogrammetrie
Hours per Week / ECTS	4 / 6,0	**Module owner**	
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	written exam+ (90 min) or oral exam+ (30 min)		
Course achievement	term paper During the lecture period, several term papers are offered, which are graded. The average grade counts for 50% of the final grade for the module. The application for an exam+ must be submitted by the student at the end of the lecture period. Further information on deadlines for the submission of assignments is provided in the courses of the module.		

Contents

- the geometry of the perspective image
- projection from 3D space into the image
- image orientation and bundle block adjustment
- dense point matching and derived products
- ortho projection
- UAV (drone)-based photogrammetry
- practical examples and (programming) exercises in which typical fields of application are addressed.

Objective qualification

Photogrammetry is the science that derives geometric and semantic information from images. In this course, basic knowledge and methods are taught so that the participating students are able to independently capture, evaluate and analyze data. Commercial products are used in the exercise to demonstrate the processing steps. To reinforce the methodological understanding, individual tasks are also solved as part of small programming tasks. Some tasks are defined mandatory (*Studienleistung*)

Literature

Wird während der Vorlesung bekanntgegeben

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
Photogrammetry	4,0	Lecture/Exercise	english german

Title	Drinking Water Treatment, Water Chemistry and Wastewater Discharge		
Number	4398290	**Module version**	
Shorttext	BAU-STD2-64	**Language**	german
Frequency of offer		**Teaching unit**	
Module duration	1	**Institution**	Institut für Siedlungswasserwirtschaft
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Thomas Dockhorn
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (approx. 60 Min.)		
Course achievement			

Contents

[Drinking Water Treatment]
The class introduces basic processes of drinking water treatment, legal regulations and drinking water standards. It presents treatment processes such as decarbonisation, flocculation, filtration, removal of iron and manganese, calcium carbonate equilibrium, processes for water softening, removal of organic compounds and water disinfection. The class also discusses world-wide problems concerning drinking water supply and treatment.

[Discharge of Municipal Wastewater (VÜ)]
The course presents a general introduction on various aspects of sewer systems. The class consists of three theoretical class meetings and two field trips. Class meetings cover the topics sewer net hydraulics, dimensioning of sewers, sewer inspection, pipes, pipe materials, separate and combined sewer systems. The field trips present the practical aspects such as manhole entry, sewer construction zones and an Oker boat tour in regard to drinking water aspects.

[Water Chemistry and Water Analytics (VÜ)]
The class covers basics of organic chemistry, characteristics of water, calculation and application examples for solubility and precipitation reactions, acid base equilibrium, sampling and sample preparation for environmental engineering questions, special chemical parameters for water and wastewater (sum parameters, rapid testing, standard analytics) and special instruments for water analytics (atomic absorption spectrometry, mass spectrometry, chromatography)

Objective qualification

[Drinking Water Treatment]
Students gain general knowledge of all questions concerning drinking water production, supply and treatment. They are able to dimension drinking water treatment plants. They understand world-wide concerns in regard to drinking water supply and treatment. They are able to critically discuss various treatment options and find adequate solutions taking into consideration social, scientific and ethical concerns.

[Discharge of Municipal Wastewater]
Students gain advanced knowledge of modern sewer systems and are able to analyse and understand hydraulic, topographic and operational correlations in a sewer system. They are able to design new

sewer systems and evaluate existing systems. They are able to critically discuss problems of wastewater discharge and find adequate solutions taking into consideration environmental, scientific and ethical concerns.

[Water Chemistry and Water Analytics]
Students will gain essential knowledge of general and inorganic chemistry and relevant problems in water chemistry. They will be able to understand the fundamental behavior of chemical elements and compounds, to solve stoiciometric calculations, to understand biochemical and chemical problems in water and wastewater treatment and find solutions for these problems.

Literature

Comprehensive lecture notes for ‘Drinking Water Treatment’ and ‘Water Chemistry and Water Analytics’ are available for download. Power point presentations for ‘Water Chemistry’ are also available for download. Technical literature and additional information for the class ‘Discharge of Municipal Wastewater’ is presented during the class.

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Related courses

Rules for the choice of courses

Two out of the tree offered classes must be selected. The course Water Chemistry and Analysis cannot be chosen in the Master's programme in Environmental Engineering.

Compulsory attendance

The class ‘Discharge of Municipal Wastewater’ has compulsory attendance (first class meeting, theoretical lectures, field trips). Participation in the theoretical lessons is pre-requisite to understand the problems presented in the field trips. If students are absent with valid excuse (e.g. illness, child care etc.) individual solutions can be found for being able to complete the class successfully and still reach educational objectives of the class. Periods of absence may not exceed 15% of compulsory attendance, in order to reach educational objectives of the class

Name of the course	SWS	Eventtype	Language
	2,0	Lecture/Exercise	german
Water Chemistry and Water Analytics	2,0	Lecture/Exercise	german
Drinking Water Treatment	2,0	Lecture/Exercise	german

Title	Environmental Geochemistry - Biogeochemical Cycles: Applications and Project Planning		
Number	1514240	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Geochemie
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Harald Biester
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			
W.G. Ernst, Earth Systems M. Jacobson et al., Earth System Science Ebel und Bliefert: Bachelor-, Master- und Doktorarbeit: Anleitungen für den naturwissenschaftlich-technischen Nachwuchs Verschiedene wissenschaftliche Artikel aus Fachzeitschriften Skript/Foliensammlung zur Veranstaltung inkl. Vorlagen Projekskizzen (DFG, BMBF)			

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Internship	german

Title			
Number	4306250	**Module version**	
Shorttext	BAU-STD-25	**Language**	german
Frequency of offer		**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration		**Institution**	
Hours per Week / ECTS	0 / ,0	**Module owner**	
Workload (h)			
Class attendance (h)		**Self studying (h)**	
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**

Title			
Number	4306260	**Module version**	
Shorttext	BAU-STD-26	**Language**	german
Frequency of offer		**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration		**Institution**	
Hours per Week / ECTS	0 / ,0	**Module owner**	
Workload (h)			
Class attendance (h)		**Self studying (h)**	
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**

Title			
Number	4306270	**Module version**	
Shorttext	BAU-STD-27	**Language**	german
Frequency of offer		**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration		**Institution**	
Hours per Week / ECTS	0 / ,0	**Module owner**	
Workload (h)			
Class attendance (h)		**Self studying (h)**	
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**

Pool of Interdisciplinary Qualifications

Title	Softskills		
Number	1112190	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration	2	**Institution**	
Hours per Week / ECTS	8 / 12,0	**Module owner**	
Workload (h)			
Class attendance (h)	112	**Self studying (h)**	248
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			

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Related courses
Rules for the choice of courses
Compulsory attendance

Name of the course	**SWS**	**Eventtype**	**Language**
Project Management for Environment and Traffic	2,0	Lecture/Exercise	german

Frame Activities

Title	Seminar Module		
Number	3328000000	**Module version**	
Shorttext		**Language**	
Frequency of offer		**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration	2	**Institution**	
Hours per Week / ECTS	4 / 6,0	**Module owner**	
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement	[Praxisseminar] SL: Presentation (2/3) [Literaturseminar] SL: Presentation (1/3)		

Contents

[Literature seminar (S)]:
Students work on a scientific topic related to one of the specialisations in the Master's program and present the topic orally in the seminar. The presentation with subsequent scientific discussion serves to train the scientific dialogue. The preparation of a term paper in the form of a review publication in the format of an international journal serves to deepen the students' skills in the area of scientific writing.

[Practical seminar (S)]:
The practical seminar is usually conducted within the framework of several excursion days that have a focus on the subject area of the respective specialisation. The students work their way into a topic in advance of the excursion and present it on site within the framework of an excursion with the corresponding focus. A written elaboration of the topic can take place in the form of a contribution to a preparatory excursion guide and/or in the form of a follow-up

Objective qualification

The general qualification objective is to enable students to research, excerpt and evaluate international literature, to classify it for their own studies and to pass on the essential contents to peers. The qualification takes the form of two courses: a literature seminar and a practical seminar by oral presentations and the preparation of homeworks.

Literature

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Seminar	german
	2,0	Seminar	german

Master's Thesis

Title	Master's Thesis		
Number	1199740	**Module version**	
Shorttext	GEA-STD-74	**Language**	
Frequency of offer		**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration		**Institution**	
Hours per Week / ECTS	0 / 30,0	**Module owner**	
Workload (h)			
Class attendance (h)		**Self studying (h)**	
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**