



Module Handbook



Transnational ecosystem-based Water Management
Duisburg-Essen Nijmegen

Transnational ecosystem-based Water Management (TWM)

Version 1.9
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Course structure of the study programme

Module 1: Basics Water Ecology (compulsory)				
	Name of Course	Place	Semester	Credits
M1.1	Hydroclimatology and Sustainable Water Management	UDE	1 oder 2	3
M1.2	Hydrogeology and Application	UDE	1 oder 2	4
M1.3	Water Quality Modelling	UDE	1 oder 2	3
	Sum			9
Module 2: Applied Water Ecology (compulsory)				
	Name of Course	Place	Semester	Credits
M2.1	Ecology and Protection of Freshwater Ecosystems and Aquatic Organisms	UDE	1 oder 2	5
M2.2	Field Trips	UDE	1 oder 2	2
M2.3	Water-borne Diseases	UDE	1 oder 2	2
	Sum			9
Module 3: Water Engineering (compulsory)				
	Name of Course	Place	Semester	Credits
M3.1	Basics in Hydraulic Planning and Facility Design	UDE	1 oder 2	3
M3.2	Waste Water Treatment	UDE	1 oder 2	3
M3.3	Flood Management	UDE	1 oder 2	2
M3.4	Water Governance and Spatial Planning	RU	1 oder 2	3
	Sum			12
Module 4: Water Basin Management (compulsory)				
	Name of Course	Place	Semester	Credits
M4.1	River Basin Management	UDE	1 oder 2	3
M4.2	Orientation in Biology and Environmental Sciences	RU	1 oder 2	3
M4.3	Integrated Water Management	RU	1 oder 2	3
M4.4	Environmental and Ecological Modelling	RU	1 oder 2	3
M4.5	Management of Ecosystems	RU	1 oder 2	3
	Sum			15
Module 5: Sustainability / Wetland Management (compulsory)				
	Name of Course	Place	Semester	Credits
M5.1	Ecological and Environmental Concepts	RU	1 oder 2	3
M5.2	Biodiversity and Ecological Assessment	RU	1 oder 2	3
	Sum			6
Module 6: Social Environmental Sciences (compulsory)				
	Name of Course	Place	Semester	Credits
M6.1	Environmental Economics for Water Management	RU	1 oder 2	3
M6.2	Social Aspects of Water Management	RU	1 oder 2	3
M6.3	Philosophy of Water Management	RU	1 oder 2	3
	Sum			9
Total year 1			Semester	Credits
			1 und 2	60

Module 7: Project Water Management (compulsory)				
	Name of Course	Place	Semester	Credits
M7.1	Practical Course / Project	RU/UDE External	3	16 or 21
	Sum			16 or 21
Module 8: Optional Courses (elective-compulsory)				
	Name of Course	Place	Semester	Credits
M8.xx	Varying Courses on Ecology, Languages, Economics, Microbiology, Modelling, Sustainable Development, Socio-economics, Water Treatment, Statistics (specified in the module handbook)	RU/UDE	3	
	From this to be selected			14 or 9
Module 9: Master-Thesis (compulsory)				
	Name of Course	Place	Semester	Credits
	Master-Thesis	RU/ UDE External	4	30
	Sum			30
Total year 2			Semester	Credits
			3 und 4	60

Table of Modules and Courses

Module	Module Abbreviation
Basics Water Ecology	TWM-MA-1
Responsible for the module	Faculty
Prof. Dr. Daniel Hering, UDE Prof. Dr. Jan Hendriks RU	Faculty of Biology /UDE Faculty of Environmental Sciences/RU

Relevance for other study programmes	
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Academic year	Duration	Relevance within Curriculum
1	one year	Compulsory

Prerequisites according to examination regulations	Recommended prerequisites
None	Are listed in the lecture descriptions

No.	Course	hours per week (SWS)	Workload (h)	Credits (ECTS)
1.1	Hydroclimatology and Sustainable Water Management/UDE	3	90	3
1.2	Hydrogeology and Application/UDE	4	120	4
1.3	Water Quality Modelling /UDE	2	90	3
Sum		9	300	10

Learning Targets of this module
The students have the ability <ul style="list-style-type: none"> - to characterize water bodies with respect to their ecological functions, hydrological, hydraulic and abiotic properties; - to apply state of the art methods to analyse water bodies with regard to hydraulic and chemical properties and to set the results into a larger environmental/technical context; - have knowledge in technical and ecological topics of water management . - analyse and assess waterbodies and put those results into a broader ecological and/or technical context.

Module examinations to gain grades	Examinations will be performed as specified in the course sheets. From the average of grades for course examinations the module grades will be deduced.
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Module grade proportion of final grade	10/120
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Module		Abbreviation Module
Basics Water Ecology		TWM-MA-1
Course		Abbreviation Course
Hydroclimatology and Sustainable Water Management		1.1
Teacher (name, email, phone)	Subject	Division
Prof. Wilhelm Kuttler, (wiku[at]uni-due.de,)	TWM, IWM	Faculty of Biology/ UDE

Semester	Frequency	Language	
2	annually	English	

SWS (Lecturing hours)	presence (h)	preparation, self tutoring, preparation for exam (h)	Workload (h)	ECTS-Credits
3	42	48	90	3

Education Methodology
Lectures with seminar character, students will have to solve arithmetic problems concerning the field of hydroclimatology, short presentations on pre-defined topics including a plenary discussion at the end of the lecture about the target of the modul.
Learning targets
The student: <ul style="list-style-type: none"> - Gains a basic understanding of the physical basis of meteorology - Gains knowledge on general and special climatology - Gains knowledge on energy transfer to and from the atmosphere - Is able to transfer the background to special problems of water management - Is able to gain and filter information of hydroclimatological problems - Is able to analyse the transmission of energy via the different states of water in the climate system
Contents
<ul style="list-style-type: none"> • The climate system, general climatology, global hydrologic cycle • The realm of hydroclimatology • Measuring hydroclimatic atmospheric and terrestrial components • Precipitation, runoff processes and streamflow • Hydroclimate spatial and temporal variations • Floods and droughts, irrigation of land • Sources of irrigation water, geographical distribution of irrigation demand • Types and efficiency of irrigation, problems of irrigation
Examinations
Written exam
Recommended preparation and reading
Students not familiar with basics in general natural science, applied mathematics and applied physics, please consult the following book chapters/manuscripts before joining the course: Shelton, M. L. (2009): Hydroclimatology. Cambridge University Press, New York, 440 pp.

Literature used within the course

- 2) Barry, R. and Chorley, R. (2003): Atmosphere, Weather and Climate. Routledge; 8. Edition, 536 pp.
- 3) Hupfer, P. und W. Kuttler (2006): Witterung und Klima. Eine Einführung in die Meteorologie und Klimatologie. Teubner Verlag, Wiesbaden. 554 pp.
- 4) Kuttler, W. (2009): Klimatologie. Schöningh Verlag. UTB 3099. 260 pp.
- 5) Laycock, A., 2007: Irrigation Systems: Design, Planning and Construction. Cabi Publishing, 320 pp.
- 8) Shelton, M. L. (2009): Hydroclimatology. Cambridge University Press, New York, 440 pp.
- 9) Zmarsly, E., W. Kuttler und H. Pethe (2007): Meteorologisch-klimatologisches Grundwissen. Ulmer Verlag. UTB 2281. 182 pp.

Further Information on the course will be made available on the moodle course:
<https://moodle.uni-due.de/course/view.php?id=7814>

Module		Abbreviation Module
Basics Water Ecology		TWM-MA-1
Course		Abbreviation Course
Hydrogeology and Application		1.2
Teacher (name, email, phone)	Subject	Division
Stephanie Lohmeier, stephanie.lohmeier@uni-due.de , -4513	TWM, IWM	Faculty of Biology/ UDE

Semester	Frequency	Language	Prerequisites
2	annually	English	None

SWS (Lecturing hours)	presence (h)	preparation, self tutoring, preparation for exam (h)	Workload (h)	ECTS-Credits
4	56	64	120	4

Education Methodology
Lecture and exercises: Chemical analyses in the laboratory, field trip, oral presentations, exercises
Learning targets
The students gain a fundamental understanding of the principles in hydrogeology (clastic, fractured and karst aquifers). This includes: <ul style="list-style-type: none"> - the hydrologic circle - hydraulic properties of rocks - groundwater dynamics and hydraulics - groundwater physics and chemistry - use of groundwater - groundwater protection The students <ul style="list-style-type: none"> - gain an overview of methods to characterise groundwater systems (acquisition of geologic information and hydraulic parameters) and know how to apply them - have knowledge on chemical classification of groundwater (geochemistry of natural and contaminated groundwater) - are able to set results of analysis and measurements in relation to environmental questions and to give a constrained summary of the situation

Contents
<ul style="list-style-type: none"> - Introduction to hydrogeology, position and importance of hydrogeology for water supply - Hydrologic cycle: (main focus: groundwater system), aquifer properties, groundwater movement (recharge, flow, discharge) in porous medium, aquifer-types (confined, unconfined), construction of piezometric surface, data interpretation of chemical and other characteristic parameters (e.g., temperature, electrical conductivity, permeability) - Practical course: sampling methods (e.g., groundwater, unconsolidated sediments and soil), chemical analysis - Interpretation of hydro-geological data on the basis of current questions in planning, construction environmental science
Examinations
a) Oral presentation (duration 15-20 min) values 5% and written examination values 95%
Recommended
<p>Students not familiar with basics in geology, please consult the following book chapters/manuscripts before joining the course: A: PRESS, F. & SIEVER, R. (2003): Understanding Earth.- W.H. Freeman & Company</p>
Literature used in the course
<p>BELL F.G. (1999): Environmental Geology – Principles and Practice.- Blackwell Science BRASSINGTON, R. (1998): Field Hydrogeology.- John Wiley & Sons FETTER, C.W. (1999): Contaminant Hydrogeology.- Prentice Hall FETTER, C.W. (1999): Applied Hydrogeology.- Prentice Hall HUDAK, P.F. (2005): Principles of Hydrogeology.- CRC Press MONTGOMERY C.W. (2003): Environmental Geology.- McGraw-Hill NONNER, J.C. (2002): Introduction to Hydrogeology (The Delft Lecture Note Series) (Enke). WEIGHT, W.D., SONDEREGGER, J.L. (2001): Manual of Applied Field Hydrogeology, McGraw-Hill Professional Publishing. 007069639X.</p>
Further Information on the course (e.g. contact days,)
<p>Numerous literature (pdf files) will be available on the internet; also course materials will be made available prior to the courses on Moodle (education and file-sharing system of the University of Duisburg-Essen) at https://moodle.uni-due.de/course/view.php?id=7712</p>

Module		Abbreviation Module
Basics Water Ecology		TWM-MA-1
Course		Abbreviation Course
Water Quality Modelling		1.3
Teacher (name, email, phone)	Subject	Division
Dr.-Ing. Dipl. Ekkehard Christoffels ekkehard.christoffels@erftverband.de	Civil Engineering TWM	Erftverband

Semester	Frequency	Language	Prerequisites
2	annually	English	none

SWS (Lecturing hours)	presence (h)	preparation, self tutoring, preparation for exam (h)	Workload (h)	ECTS-Credits
2	28	62	90	3

Education Methodology
a) Lecture b) Practical exercises, in-class exercises
Learning targets
The students <ul style="list-style-type: none"> - Can discuss the usage of water quality models in the field of water resources management - Have a basic background on water quality modeling - Are introduced in the modules of the DWA Water Quality Model - Have first experiences with the software of the DWA Water Quality
Contents
Introduction to Water Quality Modelling Basics about the DWA Water Quality Model DWA Water Quality Model – Modules of the Model Several Hands-on Exercises: Water Quality Modelling
Examinations
Written examination (Duration will be announced at the beginning of the lecture. It is between 45 and 180 min)
Recommended prerequisites

If you are not familiar with basics in water quality processes and modelling approaches, please consult the following bookchapters/manuscripts before you join the course:

- River Water Quality Model no. 1 (RWQM1) (I, II, III), P. Vanrolleghem*, D. Borchardt**, M. Henze, W. Rauch, P. Reichert, P. Shanahan and L. Somlyódy
- The Hydraulics of Open Channel Flow: an Introduction, Hubert Chanson
- Surface Water-Quality Modeling, Steven C. Chapra ISBN 0-07-011364-5
- <http://unesdoc.unesco.org/images/0012/001213/121363Eo.pdf>, Jolankai, G.
- Decision support for water quality management of contaminants of emerging concern, Fischer, A. et al.
- DWA water quality model - an instrument to support water management planning functions with the example of the Erft river, Christoffels, E.
- Online monitoring of water quality on the river Erft, Christoffels, E.

Literature used within the course:

Suggested textbooks:

- DWA Water Quality Model - Operating Instructions (will be handed out)
- DWA Water Quality Model - User Manual (will be handed out)
- Williams B. Hydrobiological Modelling ISBN 978-1-84728-960-5
- James A. An Introduction to Water Quality Modelling ISBN 0-471-92347-8

Further Information on the course (e.g. contact days,)

course materials will be made available prior to the courses on Moodle (education and file-sharing system of the University of Duisburg-Essen) at <https://moodle.uni-due.de/course/view.php?id=7810>

Module	Module Abbreviation
Applied Water Ecology	TWM-MA-2
Responsible for the module	Faculty
Prof. Dr. Daniel Hering, UDE	Faculty of Biology/UDE

Relevance for other study programmes	Water Science, EnviTox, MTW3
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Academic year	Duration	Relevance within Curriculum
1	one year	Compulsory

Prerequisites according to examination regulations	Recommended prerequisites
None	Basic chemistry

No.	Course	hours per week (SWS)	Workload (h)	Credits (ECTS)
2.1	Ecology and Protection of Freshwater Ecosystems and Aquatic Organisms/UDE	4	150	5
2.2	Hydrobiological Field Trips/UDE	2	60	2
2.3	Water-borne Diseases/UDE	2	60	2
Sum		8	270	9

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Learning Targets of this module
The students have the ability <ul style="list-style-type: none"> - to select and apply suitable assessment systems to analyse the status of aquatic ecosystems and to understand their output, - to develop and to apply concepts for ecosystem regeneration. - to analyse and assess waterbodies and put those results into a broader ecological and/or technical context - to address and evaluate ethical questions relevant to society and give new impulses, especially to topics related to „diversity“, „sustainability“ and “resource protection”.

Module examinations to gain grades	Examinations will be performed as specified in the course sheets. From the average of grades for course examinations the module grades will be deduced.
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Module grade proportion of final grade	9/120
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Module		Abbreviation Module
Applied Water Ecology		TWM-MA-2
Course		Abbreviation Course
Ecology and Protection of Freshwater Ecosystems and Aquatic Organisms		2.1
Teacher (name, email, phone)	Subject	Division
Dr. Christian K. Feld, (christian.feld[at]uni-due.de, +49 201 183-4390), Prof. Dr. Daniel Hering, Dr. Armin W. Lorenz	TWM, IWM, EnviTox, Water Science, MTW3	Faculty of Biology/ UDE

Semester	Frequency	Language	Prerequisites
2	annually	English	Basics in freshwater ecology and biology

SWS (Lecturing hours)	presence (h)	preparation, self tutoring, preparation for exam (h)	Workload (h)	ECTS-Credits
4	56	94	150	5

Education Methodology (M2.1a: Ecology)
Combination of lectures and exercise: general lectures introduce to the topic, the student partly prepares a topic based on background materials; presentations by students, common discussions. Several practical exercises during the second half of the course, teamwork.
Learning targets
The student: <ul style="list-style-type: none"> - Gains knowledge of different freshwater ecosystem and its classifications - Gains knowledge of related environmental stressors and ecological impacts - Is able to obtain and structure water-related problems - Gains knowledge of and practice with freshwater ecological assessment and monitoring - Gains a basic understanding of applied water management - Gains knowledge of basic multivariate tools to analyse ecological data - Is able to transfer freshwater ecology into actual policies (e.g. the Water Framework Directive) - Is able to derive management options to protect freshwater ecosystems and biodiversity
Contents
A-priori and <i>a-posteriori</i> typology of freshwater ecosystems (rivers, lakes), impacts of different perturbations (pollution, eutrophication, acidification, pesticides, hydromorphological alteration, waterpower) on aquatic ecosystems, river and lake assessment according to national and international regulations, the organism groups addressed by the Water Framework Directive and how to use them in biomonitoring, transferring monitoring results into restoration measures, lake and river restoration, ecosystem services. Practical assignments on the development of monitoring, management and restoration schemes according to the WFD.
Examinations
Written examination with M2.2 (Duration of the exam will be announced at the beginning of the term. Min 45, max 180 min)
Recommended preparation and reading

<p>Students not familiar with basics in freshwater ecosystem ecology are recommended to read:</p> <p>Dudgeon, D., ARTHINGTON, A.H., Gessner, M.O., Kawabata, Z.-I., Knowler, D.J., Lévêque, C., Naiman, R.J., Prieur-Richard, A.-H., Soto, D., Stiassny, M.L.J. & Sullivan, C.A. (2006) Freshwater biodiversity: importance, threats, status and conservation challenges. <i>Biological Reviews</i>, 81, 163–182</p> <p>and the relevant (see contents) chapters in the following textbooks:</p> <p>Cooke, D., E.B. Welch, S.A. Peterson & S.A. Nichols (2005): <i>Restoration and Management of Lakes and Reservoirs</i>. 3rd edition. CRC Press, Boca Raton.</p> <p>Davis, W.S. & T.P. Simon (1995): <i>Biological Assessment and Criteria</i>. Boca Raton, Lewis Publishers.</p> <p>Naiman, R.J., R.E. Bilby (ed.) (2001): <i>River Ecology and Management</i>. New-York, Springer.</p>
<p>Literature used in the course</p> <p>Cooke, D., E.B. Welch, S.A. Peterson & S.A. Nichols (2005): <i>Restoration and Management of Lakes and Reservoirs</i>. 3rd edition. CRC Press, Boca Raton.</p> <p>Darby, S.E. & Sear, D.A. [eds.] (2008): <i>River Restoration: Managing the Uncertainty in Restoring Physical Habitat</i>. John Wiley and Sons Ltd., 328 pp.</p> <p>Davis, W.S. & T.P. Simon (1995): <i>Biological Assessment and Criteria</i>. Boca Raton, Lewis Publishers.</p> <p>Naiman, R.J., R.E. Bilby (ed.) (2001): <i>River Ecology and Management</i>. New-York, Springer.</p> <p>Firth, P. & S.G. Fisher (1992): <i>Global Climate Change and Freshwater Ecosystems</i>. New-York, Springer.</p> <p>Rosenberg, D.M. & V.H. Resh (ed.) (1992): <i>Freshwater Biomonitoring and Benthic Macroinvertebrates</i>. Springer, Chapman & Hall, New-York, 504 pp.</p>
<p>Further Information on the course (e.g. contact days,)</p>
<p>Willing students can do an optional presentation</p> <p>Numerous literature (pdf files of guidance documents, reports, brochures, determination keys, etc.) will be made available on the internet; also course materials will be made available prior to the courses on the education and file-sharing system "Moodle" of the University of Duisburg-Essen https://moodle.uni-due.de/course/view.php?id=7761</p>

<p>Education Methodology (M2.1b: Determination exercises)</p>
<p>Introductory overview of aquatic organism groups, systematic information on the groups, practical exercises in identification and application of identification keys, ecological background information, application of bioindicators, practical exercise in river assessment using different organism groups.</p>
<p>Learning targets</p>
<p>The students</p> <ul style="list-style-type: none"> - obtain an overview on organism groups inhabiting fresh and marine waters, - are capable of using identification keys, - apply morphological and autecological characteristics of organism groups to ecosystem assessment and - understand the pros and cons with regard to the usage of bioindicators for aquatic monitoring.
<p>Contents</p>
<p>Algae, Protozoa, Bivalvia, Gastropoda, Annelida, Entomostraca, Malacostraca, insect larvae, insect adults, insect special groups, fish, macrophytes</p>
<p>Examinations</p>
<p>Written examination, Duration will be announced at the beginning of the lecture (45-180 min): Examination consists of a theoretical part (50%) and a identification exercise (50 %) (theory and practice)</p>

Recommended preparation and reading
Students not familiar with aquatic organisms are recommended to read the introductory chapters of the following textbooks before joining the course: Lockwood, A. and Murray, P. (Hrsg.) 1976. Effects of pollutants on aquatic organisms: lecture pres. at a seminar held Apr. 11, 1975, at Liverpool Univ. Society for Experimental Biology 2, Cambridge, University Press, 193 pp. Nilsson, A.N. (Hrsg.) 1996: Aquatic insects of North Europe : a taxonomic handbook. Stenstrup, Apollo books.
Literature used in the course
Identification keys and background information is compiled for each lecture. An overview of useful identification keys is subject to frequent updates and will be provided during the course. Downloadable versions will be placed on Moodle.
Further Information on the course (e.g. contact days,)
Regular attendance is obligatory

Module		Abbreviation Module
Applied Water Ecology		TWM-MA-2
Course		Abbreviation Course
Hydrobiological Field Trips		M2.2
Teacher (name, email, phone)	Subject	Division
Various lecturers (christian.feld[at]uni-due.de; +49 201 183-4390)	TWM	Faculty of Biology and Geography/ UDE

Semester	Frequency	Language	Prerequisites
2	annually	English	

SWS (Lecturing hours)	presence (h)	preparation, self tutoring, preparation for exam (h)	Workload (h)	ECTS-Credits
2	28	32	60	2

Education Methodology
Field trips; open discussion with water managers, practical field exercises, demonstration of facilities and techniques in water management.
Learning targets
The students <ul style="list-style-type: none"> - are able to recognize different types of aquatic and semi-aquatic ecosystems and know about their special properties and reactions regarding the biotic and abiotic features - know in which way water works influence aquatic systems and what kind of measures may be applied to reduce the impact - apply field methods to analyse the status of an ecosystem - get an overview of stressors on urban landscapes and of mitigation measures to reduce the impact of stressors - are introduced to river basin and flood management in practice - learn about climatic impacts in practice
Contents
One ecosystem type or restoration measure/field trip. Examples: <ul style="list-style-type: none"> - Typology and classification of rivers - Hydromorphology and community composition of near natural and degraded lowland streams - Hydromorphology and community composition of near natural and degraded mountain streams - Stressors on large rivers (Rhine, Ruhr): flood protection, water power generation, reservoirs - Fish migration devices - Flood management and flood protection measures - Waste water treatment and stormwater retention facilities - Measuring evapotranspiration with a lysimeter - Water Board Ruhrverband
Examinations
Individual protocols of field trips (5–10 pages)
Recommended preparation and reading
The field trips will refer to specific topics of previous lectures. No further preparation will be required

Literature used in the course

Depending on the topic. Basic determination keys will be introduced in the determination exercises (M2.1b) for field trips addressing the sampling and determination of aquatic organisms.

Further Information on the course (e.g. contact days,)

Regular attendance of field trips is required

A list of field trips, lecturers and targets will be disseminated at the beginning of the summer term.

All course materials will be made available on the Moodle system.

<https://moodle.uni-due.de/course/view.php?id=10245>

Module		Abbreviation Module
Applied Water Ecology		TWM-MA-2
Course		Abbreviation Course
Water-borne Diseases		M2.3
Teacher (name, email, phone)	Subject	Division
Dr. Milen Nachev (milen.nachev[at]uni-due.de) Dr. Daniel Grabner (daniel.grabner[at]uni-due.de) Prof. Bernd Sures, (bernd.sures[at]uni-due.de, +49 201 183-2617)	TWM, IWM	Faculty of Biology/ UDE

Semester	Frequency	Language	Prerequisites
2	annually	English	Basics in freshwater ecology and biology

SWS (Lecturing hours)	presence (h)	preparation, self tutoring, preparation for exam (h)	Workload (h)	ECTS-Credits
2	28	32	60	2

Education Methodology
Seminar, presentations to be prepared by students on pre-defined topics, plenary discussion.
Learning targets
The student: <ul style="list-style-type: none"> - Gains a basic understanding on the variety of water-borne parasitic diseases occurring in tropical and temperate regions - Gains knowledge on the biology and life cycles of important groups of protozoan and metazoan parasites - Gains knowledge on the variety and the biology of vector species - Is able to transfer the biological background of relevant water-borne diseases into parasite control programs and habitat management plans - Is able to gain and filter information to understand and explain water-related health problems - Is able to analyse the transmission risk of parasites in freshwater ecosystems
Contents
Bacterial and viral infections, protozoan infections, infection with "worms", aquatic insects as vectors for parasites, diarrhoeal diseases, chemical water pollution, water-based diseases, water-related diseases, ecological consequences of parasite treatment, freshwater habitat management and the occurrence of parasites, prevention of water-borne diseases, impact of global climate change on parasite distribution, effects of lake and river restoration on the occurrence of parasites
Examinations
Oral presentation (Duration: appr. 15-20 min), homework
Recommended preparation and reading

Students not familiar with basics in parasitology, please consult the following books before joining the course:

Parasitism. The diversity and ecology of animal parasites Albert O. Bush, Jacqueline C. Fernandez, Gerald W. Esch and Richard Seed (Eds.). Cambridge University Press, Cambridge, UK, 2001; 566 pp.

Encyclopedic reference of parasitology. Mehlhorn, H., (ed), Springer, Heidelberg 2001

Literature used in the course

Parasitism. The diversity and ecology of animal parasites Albert O. Bush, Jacqueline C. Fernandez, Gerald W. Esch and Richard Seed (Eds.). Cambridge University Press, Cambridge, UK, 2001; 566 pp.

Encyclopedic reference of parasitology. Mehlhorn, H., (ed), Springer, Heidelberg 2001

Waterborne zoonosis: Identification, Causes, and Control. J.A. Cotruvo, A. Dufour, G. Rees, J. Bartram, R. Carr, D.O. Cliver, G.F. Craun, R. Fayer, V.P.J. Gannon. World Health Organisation, 2004.

UNICEF Handbook on Water Quality. UNICEF, New York, 2008.

Mara, D.D., Feachem R.G.A. (1999) Water- and excreta-related diseases: unitary environmental classification. Journal of Environmental Engineering 125, 334-339.

Web sources:

Centers for Disease Control and Prevention (CDC) available on: www.cdc.gov

World Health Organization (WHO) available on: www.who.int

Further Information on the course (e.g. contact days,)

Course material can be found in the moodle course:

<https://moodle.uni-due.de/course/view.php?id=7743>

Module	Module Abbreviation
Water Engineering	TWM-MA-3
Responsible for the module	Faculty
Prof. Dr. Daniel Hering, UDE Prof. Dr. Toine Smits, RU	Faculty of Biology/UDE Centre for Sustainable Management of Resources/RU

Relevance for other study programmes	IWM, Water Engineering
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Academic year	Duration	Relevance within Curriculum
1	one year	Compulsory

Prerequisites according to examination regulations	Recommended prerequisites
	basic knowledge on surface hydrology

No.	Course	hours per week (SWS)	Workload (h)	Credits (ECTS)
3.1	Basics in Hydraulic Planning and Facility Design/UDE	2	90	3
3.2	Waste Water Treatment/UDE	1.5	90	3
3.3	Flood Management/UDE	1.5	60	2
3.4	Water Governance and Spatial Planning/RU	2	90	3
Sum		8	360	11

Learning Targets of this module
<p>The students have the ability</p> <ul style="list-style-type: none"> - to understand and present technical plans and projects of technical, ecological, structure planning and socio-economic disciplines. - to understand and evaluate technical papers and plans, - to select appropriate measures for river restoration, waste water treatment, and flood control under a variety of circumstances, - to judge the potentials of engineering measures in water management in view of concurring demands and alternative methods, - to communicate effectively with engineers.

Module examinations to gain grades	Examinations will be performed as specified in the course sheets. From the average of grades for course examinations the module grades will be deduced.
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Module grade proportion of final grade	11/120
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Module		Abbreviation Module
Water Engineering		TWM-MA-3
Course		Abbreviation Course
Basics of Hydraulic Planning and Facility Design		M3.1
Teacher (name, email, phone)	Subject	Division
Prof. Dr.-Ing. André Niemann, (andre.niemann[at]uni-due.de, +49 201 183-2225)	TWM, Civil Engineering, IWM	Faculty of Civil Engineering/UDE

Semester	Frequency	Language	Prerequisites
2	annually	English	None

SWS (Lecturing hours)	presence (h)	preparation, self tutoring, preparation for exam (h)	Workload (h)	ECTS-Credits
2	28	62	90	3

Education Methodology
a) Lecture b) Practical exercises, in-class exercises
Learning targets
The student: <ul style="list-style-type: none"> - learns the fundamental relationships between hydraulics, hydrology, water management and hydraulic engineering - is able to estimate the important interdependencies that arise during the planning and design of hydraulic facilities - learns to evaluate the influence of new facilities on existing ones (keywords: building on and in the water) - acquires knowledge of the fundamentals of flood planning and the design of waterways
Contents
Understand the important relationships between hydraulics, hydrology, water resource management and hydraulic engineering; design of hydraulic structures and upgrade of existing facilities (in particular, methods of watercourse construction as well as weirs and dams); concepts of flood control.
Examinations
Presentation and short assignments
Recommended preparation and reading
Students not familiar with basics in hydraulics, please consult the following book chapters/manuscripts before joining the course: Open-Channel Hydraulics, Ven Te Chow ISBN: 978-1932846188 The Hydraulics of Open Channel Flow: an Introduction, Hubert Chanson ISBN: 9780750659789
Literature used in the course

Novak, P., A.I.B. Moffat, C. Nalluri & R. Narayanan (1996) : Hydraulic Structures. 2nd edition. Chapman & Hall, London.

Further Information on the course (e.g. contact days,)

Further information as well as the course material can be found at <https://moodle.uni-due.de/course/view.php?id=7809>

Module		Abbreviation Module
Water Engineering		TWM-MA-3
Course		Abbreviation Course
Waste Water Treatment		M3.2
Teacher (name, email, phone)	Subject	Division
Prof. Dr. M. Denecke (martin.denecke[at]uni-due.de, +49 201 183-2742)	TWM	Faculty of Civil Engineering, Dept. of Waste- and Waste Water Management/UDE

Semester	Frequency	Language	Prerequisites
2	annually	English	Basic knowledge of chemistry and microbiology

SWS (Lecturing hours)	presence (h)	preparation, self tutoring, preparation for exam (h)	Workload (h)	ECTS-Credits
1.5	21	69	90	3

Education Methodology
Combination of lecture, exercises, practical course (2 weeks, groups of 2 to 3 students)
Learning targets
The student: <ul style="list-style-type: none"> - gains knowledge of wastewater biology and chemistry, - gains understanding the fundamentals in the field of Urban Water Management, - masters the design of a wastewater treatment plants
Contents
Sources and composition of wastewater, basic biological processes, activated sludge plants, nitrification, denitrification, P-elimination, anaerobic processes, sludge treatment, mass balances
Examinations
a) Written examination (120 min) (values 50% of the grade for this lecture). b) Laboratory report (values 50% of the grade for this lecture)
Recommended preparation and reading
Students not familiar with basics in wastewater treatment, please consult the following book chapters/manuscripts before joining the course: There is a handout for the course in the moodlecourse wastewater treatment. Please read it carefully BEFORE the course starts and you will be perfectly prepared to follow the course.
Literature used in the course
Henze, M., Harremoës, P., Jansen, J. la Cour, Arvin, E. (1996): Wastewater Treatment, Biological and Chemical Processes, Springer Verlag; Vesilind, A., Rooke, R.L., (2003): Wastewater Treatment Plant Design, IWA Publishing; Bitton, G., (1990): Wastewater Microbiology, Wiley-Liss Verlag, DWA Dictionary; The Microbiology of Activated Sludge Second Edition Author(s): Robert Seviour, Linda Blackall NYP ISBN: 1843390329; ATV Dictionary; Principles of Water and Wastewater Treatment Processes Editor(s): R Stuetz ISBN: 1843390264; Hosang, W., Bischof, W. (1998): Abwassertechnik, Teubner Verlag
Further Information on the course (e.g. contact days,)

Further information as well as the course material can be found at:

<https://moodle.uni-due.de/course/view.php?id=10183>

Module		Abbreviation Module
Water Engineering		TWM-MA-3
Course		Abbreviation Course
Flood Management		M3.3
Teacher (name, email, phone)	Subject	Division
Dr. A. Hartung (Hartung.Alexander[at]eglv.de, +49 201 104-2673) Dr. B. Teichgräber	TWM, IWM	Emscher Genossenschaft Lippe Verband (EGLV)

Semester	Frequency	Language	Prerequisites
2	annually	English	Basic knowledge on surface hydrology recommended

SWS (Lecturing hours)	presence (h)	preparation, self tutoring, preparation for exam (h)	Workload (h)	ECTS-Credits
1.5	10,5	49,5	60	2

Education Methodology
Lectures
Learning targets
The student <ul style="list-style-type: none"> • will become basic knowledge about watersheds and measuring principles • will learn about different causes and mechanisms of floods • will be presented different approaches for flood management and risk management • will hear about special aspects of floods in urban areas • will come to know our operational flood early warning system • will be introduced to case studies concerning dikes, rainwater and flood management
Contents
<ul style="list-style-type: none"> • Hydrology related to flood management • How to get data and dealing with uncertainties • Weather radar, Applications and requirements in water management • Flood forecast with an operational flood early warning system • Flood and risk management in urban areas including case studies and action plans • Water Framework Directive • Flood management under operational aspects
Examinations
a) Written examination (Duration 90 min) determining the final grade of the course

Recommended preparation and reading
Students not familiar with basics in hydrology, please consult the elementary chapters of the books given below in the literature part.

Literature used in the course

Dingman, S.L.: Physical Hydrology, Prentice Hall, 2002.
Chow, V.T., Maidment, D.R. and Mays, L.W.: Applied Hydrology, McGraw-Hill, 1988.
Brutsaert, W.: Hydrology, Cambridge University Press, 2005.
Gupta, R.S.: Hydrology and Hydraulic Systems, Waveland Press, 2001.
Maidment, D.R. (Editor): Handbook of Hydrology, McGraw-Hill, 1993.
Bedient, P.B. and Huber, W.C.: Hydrology and Floodplain Analysis, Prentice Hall, 2002.

Further Information on the course (e.g. contact days,)

Course materials can be found at <https://moodle.uni-due.de/course/view.php?id=7813>

Module		Abbreviation Module
Water Engineering		TWM-MA-3
Course		Abbreviation Course
Water Governance and Spatial Planning		M3.4
Teacher (name, email, phone)	Subject	Division
Dr. S.V. Meijerink	Environmental Sciences/TWM	Environmental Science/RU

Semester	Frequency	Language	Prerequisites
2	annually	English	Obligatory for TWM students

SWS (Lecturing hours)	presence (h)	preparation, self tutoring, preparation for exam (h)	Workload (h)	ECTS-Credits
2	30	60	90	3

Education Methodology
Lectures, tutorials
Learning targets
<ul style="list-style-type: none"> · To supply students with a basic insight in the state of the art in water resources management and planning · To introduce students to recent developments in the relationships between water resources management and spatial planning and to provide students with an integrated perspective and understanding of the relationships involved, both theoretically as practically. · To provide students with the skills to analyse developments in the integrated field of water management and spatial planning, with the use of institutional or other relevant social theories. · To illustrate this with concrete river management cases, linked to spatial planning.

Contents
<p>This course aims to help students reading, understanding and using the social science literature on water resources management and planning. The empirical focus is on the key-themes of present-day water management, such as the coordination between water management and spatial planning, flood risk management, the implementation of the European water framework directive and cross-border river basin management. Although the focus is on recent developments in Dutch water management primarily, there is a strong international dimension as well. Part of the literature deals with issues of cross-border cooperation and the development of the European water regime, and some topics are discussed from an international comparative perspective.</p> <p>Theoretically, in this course various institutional perspectives are used (1) to better understand recent developments in water resources management and planning and (2) to develop strategies for contributing to a better coordination between water management and spatial planning, and a more sustainable development of water resources.</p> <p>Subjects: Nexus between water management and spatial planning International river conflicts The European water regime Transition management Flood risk management Long term developments in water management and spatial planning</p>
Examinations
Written exam (Duration will be announced at the beginning of the term, min. 45 min, max. 180 min)
Recommended prerequisites
Will be announced
Literature
A set of journal articles
Further Information on the course (e.g. contact days,)
Availability of Literature and course material will be announced

Module	Module Abbreviation
Water Basin Management	TWM-MA-4
Responsible for the module	Faculty
Prof. Dr. Daniel Hering, UDE Prof. Dr. Jan Hendriks, RU	Faculty of Biology/UDE Faculty of Environmental Sciences/RU

Relevance for other study programmes	Environmental Science (RU)
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Academic year	Duration	Relevance within Curriculum
1	one year	compulsory

Prerequisites according to examination regulations	Recommended prerequisites
None	none

No.	Course	hours per week (SWS)	Workload (h)	Credits (ECTS)
4.1	River Basin Management/UDE, <i>Ruhrverband</i>	2	90	3
4.2	Orientation in Biology and Environmental Sciences/RU	2	90	3
4.3	Integrated Water Management/RU	2	90	3
4.4	Environmental and Ecological Modelling/RU	3	90	3
4.5	Management of Ecosystem/RU	3,5	90	3
Sum		12,5	450	15

Learning Targets of this module

- Students are able to apply the knowledge gained in the Modules “Basics Water Ecology”, “Applied Water Ecology” and “Water Engineering” in the context of River Basin Management Plans;
- Students are able to judge legal requirements and administrative responsibilities relevant for River Basin Management with a particular focus on the Euregion;
- Students will master, internship and job orientation in environmental research and management
- They analyse and assess waterbodies and put those results into a broader ecological and/or technical context.
- They know different state of the art methods to analyse and assess waterbodies.
- They know the european environmental legislation regarding watermanagement and use those methods autonomous in the field.
- The students use those methods autonomous in the field.

Module examinations to gain grades	Examinations will be performed as specified in the course sheets. From the average of grades for course examinations the module grades will be deduced.
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Module grade proportion of final grade	15/120
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Module		Abbreviation Module
Water Basin Management		TWM-MA-4
Course		Abbreviation Course
River Basin Management		M4.1
Teacher (name, email, phone)	Subject	Division
Dr. Michael Weyand, (mwy[at]ruhrverband.de, +49 201 178-2330)	TWM, IWM	Faculty of Biology/UDE (contract teacher <i>Ruhrverband</i> Essen)

Semester	Frequency	Language	Prerequisites
2	annually	English	See below.

SWS (Lecturing hours)	presence (h)	preparation, self tutoring, preparation for exam (h)	Workload (h)	ECTS-Credits
2	28	62	90	3

Education Methodology
Lecture, exercises, discussion groups; combination of theoretical planning and practical activities
Learning targets
The students <ul style="list-style-type: none"> - gain insight in responsibilities and targets in river basin management planning (depending on administration and stakeholders involved) - know different strategies to assess and weigh up competing demands in water management
Contents
River basin characteristics, human pressure analysis, measure scenarios ("best practice"), public participation, monitoring, transboundary basins, administrative competencies in river basin management
Examinations
<ul style="list-style-type: none"> a) Homework (contributes 50% to the final grade of this lecture) b) Oral contribution within the course (contributes 50% to the final grade of this lecture)
Recommended preparation and reading
Students not familiar with basics in River Basin Management issues please consult the following book chapters/manuscripts before joining the course: <ul style="list-style-type: none"> - Handbook for Integrated Water Resources Management in Transboundary Basins of Rivers, Lakes and Aquifers - Handbook for Integrated Water Resources Management in Basins - Water Framework Directive
Literature used in the course
European CIS Guidance Documents to the EU Water Framework Directive, reports on river basin management plans of selected examples, papers published in journals on river basin management, design tools for fish migration structures
Further Information on the course (e.g. contact days,)
Course material can be found at: https://moodle.uni-due.de/course/view.php?id=7815

Module		Abbreviation Module
Water Basin Management		TWM-MA-4
Course		Abbreviation Course
Orientation in Biology and Environmental Science		M4.2 (RU internal ID: MM012)
Teachers (email, phone)	Subject	Division
Prof. Dr. Hans de Kroon (h.dekroon@science.ru.nl) Prof. Dr. Jan Hendriks (a.j.hendriks@science.ru.nl)	Environmental Sciences/TWM	Environmental Sciences/ RU, guest lecturers, representatives of water authorities/organizations,

Semester	Frequency	Language	Prerequisites
1	annually	English	The course is obligatory for students of the MSc Environmental Sciences/TWM and open to students of other programmes. In case of indistinctness, the examination committee takes the final decision on entry allowance.

SWS (Lecturing hours)	presence (h)	preparation, self tutoring, preparation for exam (h)	Workload (h)	ECTS-Credits
2	28	62	90	3

Education Methodology
The course comprises <i>theme days</i> with <i>lectures</i> , <i>presentations</i> and <i>discussions</i> , <i>excursions</i> in the field, <i>visits</i> to organisations in the field of environmental management, <i>group assignments</i> , the <i>self assessment/vacancy analysis</i> , and <i>writing a reflection paper</i> .
Learning targets
<ul style="list-style-type: none"> • The student can make an informal choice for a track in the Master of Environmental Sciences (Master orientation); • The student can make an informal choice for an internship in the field of environmental research and management (internship orientation); • The student can formulate a personal study path towards a working career based on his/her own qualities and preferences (job orientation).

Contents
<p>Master, internship and job orientation in environmental research and management by</p> <ul style="list-style-type: none"> • Presentations of and discussions with environmental researchers and (project) managers; • Excursions in the field and visit to organisations in the field of environmental management; • Lectures by teachers on environmental issues; • Group assignments based on application software dealing with environmental management issues. <p>These teaching methods are related to the following five environmental topics:</p> <ul style="list-style-type: none"> • River basin morphology and management; • Institutional water management; • Ecology and management of estuaries and deltas; • Chemical pollution; • Water governance in interaction with river communities. <p>To structure students' Master, internship and job orientation, they will carry out a self assessment/vacancy analysis during the course, and write a reflection paper at the end of the course.</p>
Examinations
Written reflection report.
Recommended prerequisites
Will be announced
Literature used within the course
<p>The following study material will be provided:</p> <ul style="list-style-type: none"> • A student manual with general course information (downloadable via Blackboard); • A reader with (additional) theoretical background documents (downloadable via Blackboard); • Relevant literature and information on the excursions and visits (e.g. booklets, background information).
Further Information on the course (e.g. contact days,)
Availability of Literature and course material will be announced

Module		Abbreviation Module
Water Basin Management		TWM-MA-4
Course		Abbreviation Course
Integrated Water Management		M4.3 (RU internal ID: MM019)
Teachers (email, phone)	Subject	Division
Prof. Dr. (Toine) A.J.M. Smits (a.smits[at]science.ru.nl, +31 24-3652411), Dr. S.V. Meijerink, Dr. M.A. Wiering, Prof.Dr. P. Leroy	Environmental Sciences/TWM	Environmental Sciences/Center for Sustainable Management of Resources at the RU, guest lecturers, representatives of water authorities/organizations,

Semester	Frequency	Language	Prerequisites
1	annually	English	The course is obligatory for students of the MSc Environmental Sciences/TWM and open to students of other programmes. In case of indistinctness, the examination committee takes the final decision on entry allowance.

SWS (Lecturing hours)	presence (h)	preparation, self tutoring, preparation for exam (h)	Workload (h)	ECTS-Credits
2	30	60	90	3

Education Methodology
Groepsgewijs college and individual studies
Learning targets
<p>The student</p> <ul style="list-style-type: none"> • can formulate what political and legal factors basin managers need to understand and take into account when establishing basin management systems (Establishing basin management systems). • can give a description of the functions and the different kinds of Institutional and legal arrangements for basin organizations (Roles & types of river basins organizations). • can describe through which ways the basin organizations and basin Management can be financed (Finance). • has an understanding of how basin managers can involve stakeholders (Involving Stakeholders). • has an understanding of how basin managers go about strategic planning (Strategic long-term planning). • can formulate what basin managers need to consider in developing and implementing basin action plans, and how can they get feedback on how plans are progressing (Basin action plans). • can describe what data and information management systems basin managers need for integrated water resources management (Basin information systems and monitoring). • can formulate the key communication issues basin managers need to consider (Communication).

Contents
Excursions in the field and visit to organisations in the field; lectures by teachers and professionals; Group assignments sometimes based on application software dealing with environmental management issues.
Examinations
The course will be evaluated by assessment of the assignments and a theoretical examination. Duration of the theoretical exam will be announced at the beginning of the term (min. 45, max. 180 min)
Recommended prerequisites
Will be Announced
Literature
The following study material will be provided: <ul style="list-style-type: none"> • a student manual with general course information (downloadable via Blackboard); • a reader with (additional) theoretical background documents (downloadable via Blackboard) • relevant literature and information on the excursions and visits (e.g. booklets, background information).
Further Information on the course (e.g. contact days,)
Absence at sessions without having reasonable excuse and/or a negative assessment of the participation, input and working attitude leads to student's exclusion from the final assessment of the course. The course will be lectured on wednesday, thursday and friday during November Availability of Literature and course material will be announced

Module		Abbreviation Module
Water Basin Management		TWM-MA-4
Course		Abbreviation Course
Environmental and Ecological Modelling		M4.4 (RU course code MM002A)
Teacher (name, email, phone)	Subject	Division
Prof.Dr. ing. A.J. Hendriks	Environmental Sciences/TWM	Environmental Science/RU

Semester	Frequency	Language	Prerequisites
1	annually	English	BSc Environmental Science(s), Biology, Chemistry, Molecular Sciences or Natural Sciences.

SWS (Lecturing hours)	presence (h)	preparation, self tutoring, preparation for exam (h)	Workload (h)	ECTS-Credits
3	45	45	90	3

Education Methodology
Lectures (10h), computer practicals (32h), self study (45h), discussion (3h)
Learning targets
<ul style="list-style-type: none"> Indicate why and where models are needed in research and management on environmental, nature and water issues. Classify and evaluate environmental and ecological models (analytical, numerical, stochastic, deterministic etc.) Identify and follow the stages in model development in a structured approach (from derivation to validation) Understand and apply a few elementary models that are often used in ecological and environmental issues (e.g. exponential, logistic, hyperbolic equations) Build and apply simple models critically in the context of his/her own research or management activities in internships and jobs
Contents

If we prepare an outdoor trip, we check the weather forecast, as projected by meteorological models. Political parties submit their programs for calculation of the expected economic benefits. Mathematical models have become indispensable in various parts of society, including ecological and environmental issues. Conclusions by scientists, recommendations by consultants and decisions by managers are often based on models.

Models allows one to

- connect causes to effects in long term, large scale and inherently complex issues, such as climate change or population development
- understand related phenomena in different fields, e.g. Michaelis-Mention kinetics of enzymes and Holling type II responses of predators
- combine confusing, contradicting or incomplete information, as obtained in the lab and field.
- circumvent practical, financial, ethical restrictions imposed by experiments and surveys
- provide quantitative predictions, including uncertainties, in addition to qualitative descriptions and explanations
- allow extrapolation knowledge outside the domain
- select models based on theoretical concepts for empirical curve fitting

The course starts with an introduction in modelling, discussing objectives, types and stages of models. Next, you will be made familiar with a few equations often used in ecological and environmental issues, by lectures and exercise demonstrating their behaviour. Next you will be trained in developing your own models, going through different stages, such translation of systems to models, calibrating parameters and a sensitivity analysis. You will become acquainted with different models used in different setting (research, management, consultancy) and different disciplines (ecology, chemistry, hydrology).

Examinations

Written exam (preceded by daily assignments), Duration will be announced at the beginning of the term (min 45, max 180 min)

Recommended prerequisites

Will be announced

Literature used within the course

Manual and syllabus available via Blackboard

Further Information on the course (e.g. contact days,)

Manual and syllabus available via Blackboard

Module		Abbreviation Module
Water Basin Management		TWM-MA-4
Course		Abbreviation Course
Management of Ecosystems		M4.3 (RU internal ID: BM039A)
Teachers (email, phone)	Subject	Division
Prof. dr. J.G.M. Roelofs Dr. L.P.M. Lamers Prof. dr. A.P. Grootjans Dr. A.J.P. Smolders Dr. L.J.L. van den Berg Dr. P. Vergeer Dr. E.C.H.E.T. Lucassen Dr. I.A. Nagelkerken Prof. Dr. G. van der Velde Dr. A.W. Boxman	Environmental Sciences/TWM	Environmental Sciences/Center for Sustainable Management of Resources at the RU, guest lecturers, representatives of water authorities/organizations,

Semester	Frequency	Language	Prerequisites
1	annually	English	The course is obligatory for students of the MSc Environmental Sciences/TWM and open to students of other programmes. In case of indistinctness, the examination committee takes the final decision on entry allowance.

SWS (Lecturing hours)	presence (h)	preparation, self tutoring, preparation for exam (h)	Workload (h)	ECTS-Credits
3,5	50	40	90	3

Education Methodology
20 hrs excursion 30 hrs lecture
Learning targets
Student can give a critical vision on the management of ecosystems Student is able to formulate restoration and management measures to compensate environmental effects in various ecosystem types Student enumerate critical factors which make the restoration measures a success or a failure
Contents

<ul style="list-style-type: none"> • Management of surface water ecosystems • Climate change and management of C-limited lakes • Management of boreal lakes • Management of wetland ecosystems • Management of tropical coastal systems • Control of invasive species • Management of tropical seagrass systems • Management of temperate coastal ecosystems • Management of heathland, peatland and dune fauna • Atmospheric pollution and ecosystem management • Management of heathlands, calcareous and acidic grasslands • Management of forests • Habitat fragmentation, dispersal and management
Examinations
Written exam (closed book). Duration of the exam will be announced at the beginning of the term (min. 45, max 180 min)
Recommended prerequisites
Will be announced
Literature used within the course
Will be announced at the beginning of the lecture.
Further Information on the course (e.g. contact days,)
Course takes place in the first quarter Availability of Literature and course material will be announced

Module	Module Abbreviation
Sustainability/Wetland Management	TWM-MA-5
Responsible for the module	Faculty
Prof. Dr. Jan Hendriks	Faculty of Environmental Science/RU

Relevance for other study programmes	Environmental Science
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Academic year	Duration	Relevance within Curriculum
1	6 months	compulsory

Prerequisites according to examination regulations	Recommended prerequisites

No.	Course	hours per week (SWS)	Workload (h)	Credits (ECTS)
5.1	Ecological and Environmental Concepts/RU	2	90	3
5.2	Biodiversity and Ecological Assessment/RU	3	90	3
Sum		5	180	6

Learning Targets of this module
The students are able <ul style="list-style-type: none"> - to judge societal implications and consequences of River Basin Management; - to understand and to perform actor analyses; - to judge measures related to River Basin Management in the context of sustainable development. - to address and evaluate ethical questions relevant to society and give new impulses, especially to topics related to „diversity“, „sustainability“ and “resource protection”.

Module examinations to gain grades	Examinations will be performed as specified in the course sheets. From the average of grades for course examinations the module grades will be deduced.
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Module grade proportion of final grade	6/120
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Module		Abbreviation Module
Sustainability / Wetland Management		TWM-MA-5
Course		Abbreviation Course
Ecological and Environmental Concepts		M5.1 (RU course ID: BM038A)
Teacher (name, email, phone)	Subject	Division
Dr. H.J.R. Lenders, r.lenders@science.ru.nl Prof. Dr. ir. A. J. Hendriks, a.j.hendriks@science.ru.nl Dr. R.S.E.W. Leuven, r.leuven@science.ru.nl	Environmental Sciences/TWM	Environmental Science/RU

Semester	Frequency	Language	Prerequisites
1	annually	English	none

SWS (Lecturing hours)	presence (h)	preparation, self tutoring, preparation for exam (h)	Workload (h)	ECTS-Credits
2	30	60	90	3

Education Methodology
Lectures, self study and discussion sessions
Learning targets
The student is acquainted with the concept of sustainable development and can handle derived concepts and methods for environmental and ecological research and management.
Contents
In this 3EC course ecological and environmental concepts will be presented and discussed. Starting point will be the concept of Sustainable Development in its broadest sense (ecology/environment, economy and social aspects, otherwise known as the triple P concept: People, Planet and Profit). Emphasis will be on the historical context and on (handling) the unknown future of sustainable development. Subjects that will be passed in review are: Natural Sciences and the Environment, Reference and Target Images, Ecology & Economy, Ecosystem Health, Novel Ecosystems, Ecological Footprint, Scenario Analysis, and Multiple Criteria Analysis. Presently, further details cannot be given since the course is still under construction yet.
Examinations
Written examination in the form of writing an essay. Duration of the exam will be announced at the beginning of the term (min. 45, max. 180 min)
Recommended prerequisites
Will be announced
Literature used within the course
Study material will be made available online via Blackboard.
Further Information on the course (e.g. contact days,)
none

Module		Abbreviation Module
Module 5: Sustainability / Wetland Management		TWM-MA-5
Course		Abbreviation Course
Biodiversity and Ecological Assessment		M5.2 (RU internal ID: BM040A)
Teacher (name, email, phone)	Subject	Division
Dr. Rob S.E.W. Leuven (r.leuven[at]science.ru.nl, +31 24 365-2096)	Environmental Sciences/TWM	Environmental Sciences/ Centre for Sustainable Management of Resources/ RU

Semester	Frequency	Language	Prerequisites
1	annually	English	none

SWS (Lecturing hours)	presence (h)	preparation, self tutoring, preparation for exam (h)	Workload (h)	ECTS-Credits
3	45	45	90	3

Education Methodology
Lectures (10 h), Tutorials (1 h), study group assignments (6 h), Project: writing review and presentations (27 h), self tuition (45 h), written exam and evaluation (4 h)
Learning targets
The course is focused on competences, skills and knowledge that will be required for research on biological diversity and assessments of biodiversity in (aquatic) ecosystems.
Contents

<p>The course consists of four learning units:</p> <p>Biological diversity: concepts and theory This learning unit deals with concepts and theory on biological diversity. The focus will be on key questions, such as: What is a species, what is biodiversity? How to measure and to value biodiversity at various spatial and temporal scales? What are key factors determining biological diversity? In addition, attention will be paid to extinction of species (the concept of critical population size; irreplaceability of species, global biodiversity and indicators of recent decline) and conservation of biodiversity (legal protection of biodiversity and restoration measures for biodiversity).</p> <p>Species diversity and ecosystem functioning The second learning unit deals with the role of biodiversity in ecosystem functioning. This issue will be elaborated for various types of aquatic ecosystems and wetlands such as seagrass dominated ecosystems, riverine ecosystems, coral reefs, mangroves and wet grasslands.</p> <p>Biodiversity assessment and valuation In this learning unit attention will be focussed on ecological status assessments in water- and nature management. Biodiversity assessment and valuation will be elaborated for a case study on biodiversity in riverine ecosystems (e.g. the application of the BIO-SAFE model).</p> <p>Current themes in biodiversity research The course will be concluded with reviews of current themes in biodiversity research, such as biodiversity in relation to ecosystem services, ecosystem engineers, novel ecosystems, economical values, agricultural practice, aquaculture, appropriate assessments, nitrogen deposition effects to biodiversity and bioinvasions.</p>
Examinations
Written exam; Duration of the exam will be announced at the beginning of the term (min. 45, max. 180 min)
Recommended prerequisites
Will be announced
Literature used within the course
Student manual and literature will be available on Blackboard
Further Information on the course (e.g. contact days,)
The course covers two consecutive. Study activities are planned on five days per week.

Module	Module Abbreviation
Social Environmental Sciences	TWM-MA-6
Responsible for the module	Faculty
Prof. Dr. Daniel Hering, UDE Prof. Dr. Jan Hendriks, RU	Faculty of Biology/UDE Faculty of Science/RU

Relevance for other study programmes	Environmental Science
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Academic year	Duration	Relevance within Curriculum
1	one year	compulsory

Prerequisites according to examination regulations	Recommended prerequisites
None	None

No.	Course	hours per week (SWS)	Workload (h)	Credits (ECTS)
6.1	Environmental Economics for Water Management/RU	2	90	3
6.2	Social Aspects of Water Management/RU	2	90	3
6.3	Philosophy of Water Management/RU	2	90	3
Sum		6	270	9

Learning Targets of this module
<p>The students are able:</p> <ul style="list-style-type: none"> - to apply methodologies of problem analysis relevant for River Basin Management; - to identify and to solve problems with various stakeholder groups, which may arise from River Basin Management; - to understand and to apply principles of environmental management. - to address and evaluate ethical questions relevant to society and give new impulses, especially to topics related to „diversity“, „sustainability“ and “resource protection”. - to understand and present technical plans and projects of technical, ecological, structure planning and socio-economic disciplines.

Module examinations to gain grades	Examinations will be performed as specified in the course sheets. From the average of grades for course examinations the module grades will be deduced.
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Module grade proportion of final grade	9/120
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Module		Abbreviation Module
Social Environmental Sciences		TWM-MA-6
Course		Abbreviation Course
Environmental Economics for Water Management		M6.1 (RU internal ID: MM018)
Teacher	Subject	Division
D.F. Boezeman Prof. dr. A.J.M. Smits Prof. dr. ir. W.T. de Groot	TWM	Centre for Sustainable Management of Resources/ RU

Semester	Frequency	Language	Prerequisites
1	annually	English	Obligatory for TWM students; elective for all 3rd and 4th year students of Radboud University

SWS (Lecturing hours)	presence (h)	preparation, self tutoring, preparation for exam (h)	Workload (h)	ECTS-Credits
2	30	60	90	3

Education Methodology
Lecture and question sessions
Learning targets
The students <ul style="list-style-type: none"> • Know the basics of environmental (neo-classic) economics and ecological economics • Have an ethically reflected insight in the core theory of (neo-classic) economics geared towards the practice of environmental decision-making and policies • Have a practicable insight in the limitations and alternatives to these theories • Know real-world cases that link to the core theories as well as the limitations and alternatives.
Contents
<ul style="list-style-type: none"> • Intro to economics, history of environmental economics • Ethics, values, economic valuation • Functions of the environment, total economic value, cost-benefit analysis • Efficiency versus equity: two-tiered value theory for decision-making • Case: natural resources and fisheries • Case: payment for ecosystem services
Examinations
a) Closed-book written exam (70%); Duration will be announced at the beginning of the term (min 45, max 180 min) b) participation/quality of assigned and own responses (30%)

Recommended prerequisites
Will be announced
Literature used within the course
Edwards-Jones et al., 2000, Ecological Economics - an introduction. Blackwell Publishing. Other literature will be made available via Blackboard.
Further Information on the course (e.g. contact days,)
Availability of Literature and course material will be announced

Module		Abbreviation Module
Social Environmental Sciences		TWM-MA-6
Course		Abbreviation Course
Social Aspects of Water Management		M6.2 (RU course code MM021)
Teacher (name, email, phone)	Subject	Division
Prof.dr.ir. W.T. de Groot (w.degroot@science.ru.nl ; +31-24-3552578)	Environmental Sciences/TWM	CSMR, ISIS, Fac. Of Science, Radboud University

Semester	Frequency	Language	Prerequisites
1	annually	English	All students can join the course, if they have permission for joining the Master Programme Environmental Sciences or Biology. For students of the TWM specialisation this course is obligatory.

SWS (Lecturing hours)	presence (h)	preparation, self tutoring, preparation for exam (h)	Workload (h)	ECTS-Credits
2	30 (lecture + exam)	60	90	3

Education Methodology
<p>River management, as any management, is people management. The idea behind the course is that somewhere in the student's career, and maybe even from the very beginning, the student will move out of the purely technical details of water and rivers and be challenged by a need to 'deal with people' one way or another. How to do this? How to avoid ineffective shyness or conflict? How to be respectful and yet adequate? How to find a scientific basis for operation? This course is meant to strengthen the capacities that students already have, i.e. the student's capacities to listen, to interpret and to act with communities.</p> <p>The course is 'literature-based', which implies lots of pages for (diligent, active, critical) reading but also that the lectures focus mainly on helping the students to move smoothly into that literature. The last lecture focuses on the questions that students have on the literature.</p>
Learning targets
After following the course, students are able to engage actively and reflectively with questions of how to approach, study and work with communities in situations of river management.
Contents
The course is built on a general basis that reflects on rational choice, contextualise, collective action and joint planning. The case studies come from rivers and floodplains but through the general theories and your existing social and self-insights, much of this will be translatable to other management settings inside and outside the water and landscape planning sectors.
Examinations
Written exam (closed book; short + essay questions). Duration of the exam will be announced at the beginning of the term (min. 45, max 180 min)

Recommended prerequisites
Will be announced
Literature used within the course
<ul style="list-style-type: none"> • John Elster (chapters II, III and XII): Rational choice and social norms • Wouter de Groot: Broad rational choice (the Action-in-Context framework) • Anna Davies: Contextuality and visions of nature • Wouter de Groot: Moral domains (The HEC actor model) • Elinor Ostrom ('Governing the Commons'), chapter 3 • W.T. de Groot and J. Warner (eds.): The Social Side of River Management (whole book) • Bruce Mitchell: the Visioning method • Mirjam de Groot: Visioning with the public • Toni Morris Oswald: Community values in a Canadian floodplain • US-Aid: Payments for Watershed Services brief.
Further Information on the course (e.g. contact days,)
Availability of Literature and course material will be announced

Module		Abbreviation Module	
Social Environmental Sciences		TWM-MA-6	
Course		Abbreviation Course	
Philosophy of Water Management		M6.3 (RU internal ID: FFIL212)	
Teachers (email, phone)		Subject	Division
Dr. M.A.M. Drenthen, (m.drenthen[at]science.ru.nl, +31 24 365-2730), Prof. Dr. H. A. E. Zwart, Prof. Dr. F. W. J. Keulartz		Environmental Sciences	Institute for Science, Innovation and Society/RU
Semester	Frequency	Language	Prerequisites
3	annually	English	none

SWS (Lecturing hours)	presence (h)	preparation, self tutoring, preparation for exam (h)	Workload (h)	ECTS-Credits
1,5	22,5	67,5	90	3

Education Methodology
Lectures, seminars, assignments, excursion
Learning targets
<p>The student</p> <ul style="list-style-type: none"> • is familiar with the major topics, approaches and concepts in environmental ethics and landscape philosophy; • can distinguish scientific reasoning from other forms of intellectual activity; • can take a substantiated position in ethical debates on issues of landscape and ecosystem management; • can read, analyze and critically assess philosophical texts, and to apply them to actual cases; • can publicly present and discuss philosophical texts.
Contents
<p>This course deals with some philosophical aspects regarding water management. The following major topics from environmental ethics and landscape philosophy will be discussed:</p> <ul style="list-style-type: none"> • The relation between environmental science and environmental ethics; • Basic attitudes toward and images of nature, anthropocentrism vs. ecocentrism; • Intrinsic value of nature: subjective? objective? • Ecological restoration or faking nature? • Conflict between animal ethics and ecological ethics; • Aesthetics and environmental protection; • The concept of wilderness; • Bioregionalism and Ethics of Place; • Excursion to a 'new' nature reserve.

Examinations
Grades will be based on <ul style="list-style-type: none">a) written assignments,b) on oral presentations (Duration 15-20 min)c) on participation in group presentations and class discussions. There will be no final exam.
Recommended prerequisites
Will be announced
Literature used within the course
Texts and assignments will be made available in Blackboard.
Further Information on the course (e.g. contact days,)
There is a maximum number of applicants. TWM-students will have prior access; foreign language students have prior access over Dutch-speaking students. Availability of Literature and course material will be announced

Module	Module Abbreviation
Project Water Management	TWM-MA-7
Responsible for the module	Faculty
Prof. Dr. Daniel Hering, UDE Prof. Dr. Jan Hendriks, RU	Faculty of Biology/UDE; Faculty of Science/RU

Relevance for other study programmes	none
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Academic year	Duration	Relevance within Curriculum
2	12 or 16 weeks	compulsory

Prerequisites according to examination regulations	Recommended prerequisites
none	Modules 1 to 7

No.	Course	Duration	Workload (h)	Credits (ECTS)
7.1	Practical Course / Project	12 weeks or 16 weeks	480 or 630	16 or 21
Sum			480 or 630	16 or 21

Learning Targets of this module
<p>The students have the ability</p> <ul style="list-style-type: none"> - to effectively apply theoretical/practical knowledge and competencies to real-world problems in water management; - to work in a multidisciplinary (and bi-/multinational) setting; - to analyse and present complex matters; - to communicate and cooperate with water managers, stakeholders, NGOs, and the general public. - use this knowlegde to evaluate research and testresults - review results, interpret them critically and put results into a transdisciplinary context - present results in oral and written form to different stakeholders - communicate with stakeholders of different disciplines related to water management - develope autonomous research questions and hypotheses - plan research projects under limiteded time and resources - conduct research projects with suitable methods, work in research teams, evaluate results, interpret results critically, and put results into a transdisciplinary context - present results in oral and written presentations to different stakeholders <p>The students use those methods autonomous in the field.</p> <p>They understand and present technical plans and projects of technical, ecological, structure planning and socio-economic disciplines.</p>

Module examinations to gain grades	See description "Internship".
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Module grade proportion of final grade	16/120
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Module		Abbreviation Module
Project Water Management		TWM-MA-7
Course		Abbreviation Course
Practical Course / Project		M7.1
Coordinators	Subject	Division
Daniel Hering, UDE (daniel.hering[at]uni-due.de, +949 201 183-3113), Jan Hendriks, RU (a.j.hendriks[at]science.ru.nl, +31 24 365-2932)	TWM	UDE/RU/water institutions and organisations, projects, GOs and NGOs, etc.

Semester	Frequency	Language	Prerequisites
3	Every term	English (exceptions possible depending on the country)	Modules 1 to 6

Duration	presence (h)	preparation, self tutoring, preparation for exam (h)	Workload (h)	ECTS-Credits
12 or 16 weeks	-	-	480	16 or 21 (depending on the length)

Education Methodology
Practical work in an institution/organisation in the field of water management.
Learning targets
<ul style="list-style-type: none"> • The students: • gain work and practical experience in water management; • learn about current water-related problems and apply theoretical/practical knowledge and competencies in practice; • get insight into transnational projects and activities; • know how to act in multidisciplinary (and bi-/multinational) groups (communication skills).
Contents
a) Elaboration of a small self-contained <i>project</i> , or b) carrying out <i>research</i> related to a project/activity in the field of water management. The student's project/research is embedded in a larger project/activity carried out by the host institution/organisation.
Examinations
Internship report
Literature used within the course
Actual publications, regulations related to water management; depending on thematic preference of employer.
Further Information on the course (e.g. contact days,

Students have to conduct a process report and final presentation.

THE INTERNSHIP HAS TO BE REGISTERED AT UDE!

For organizational help, please see also the in the "Guidance to TWM" and/or ask your student advisors Conny Mooren RU or Nadine Ruchter UDE or have a look into the moodle course <https://moodle.uni-due.de/course/view.php?id=4581>

Here you will find a list with internship suggestions and the registration form.

Students can choose, if they want to do a 12 or a 16 week long internship. They have to indicate the length of the internship on the registration form, BEFORE THEY START the internship.

Accordingly, they have to do 14 or 9 Credits in optional courses.

Module	Module
Optional Courses	TWM-MA-8
Responsible for the module	Faculty
Prof. Dr. Daniel Hering, UDE Prof. Dr. Jan Hendriks, RU	Faculty of Biology/UDE; Faculty of Science/RU

Relevance for other study programmes	Miscellaneous
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Academic year	Duration	Relevance within Curriculum
2 (partly possible before)	one year	Elective-compulsory; <u>actual offer of optional courses may deviate from the following list due to short-term additions and re-organizations → check at the beginning of each term!</u>

No.	Course	University	hours per week (SWS)	Workload (h)	Credits (ECTS)
8.1	German Language for Dutch Students	UDE	2	60	2
8.2	Lake Ecosystems/UDE	UDE	6 (Block course)	180	6
8.3	Project Management/UDE (Water Science)	UDE	2	90	3
8.4	Chemometrics and Statistics	UDE	3	150	5
8.5	Quality Management/UDE (Water Science)	UDE	2	90	3
8.6	Biofilm, Biofouling, Biocorrosion/UDE	UDE	3	150	5
8.7	Water - The Lecture	UDE	2	90	3
8.8	Hygiene – Water, Sanitation and Health	UDE	2	90	3
8.9	European Environmental Legislation	UDE	2 (Block course)	90	3
8.10	Assessment of Chemicals under REACH	UDE	3 (Block	150	5

			course)		
8.11	Introduction to ArcView 10	UDE	2 (Block course)	90	3
8.12	River Ecosystems	UDE	6 (Block course)	180	6
8.13	Ecology and management of large rivers	RU		90	3
8.14	Population Ecology	RU		90	3
8.15	European Vegetation	RU		90	3
8.16	Science Literature	RU		90	3
8.17	Bioethics for Life Scientists	RU		90	3
8.18	Estuarine ecology	RU		90	3

Learning Targets of this module

The students apply ecological, technical, socio-economic principles to current fields related to water management and gain knowledge and competences beyond the compulsory contents.

They have knowlegde in technical, ecological, structure planning and socio-economic topics of water management.

They analyse and assess waterbodies and put those results into a broader ecological and/or technical context.

They know different state of the art methods to analyse and assess waterbodies.

The students have an overview about the current knowledge in specific topics in watermanagement and can critically interpret new research results.

They can address and evaluate ethical questions relevant to society and give new impulses, especially to topics related to „diversity“, „sustainability“ and “resource protection”.

They use appropriate technical methods in waterbody renaturation, waste water treatment and flood control.

They understand and present technical plans and projects of technical, ecological, structure planning and socio-economic disciplines.

Module examinations to gain grades

Examinations will be performed as specified in the beginning of the course. From the average of grades for course examinations the module grades will be deduced.

Module grade proportion of final grade

14/120 or 9/20

Note: The offer of optional courses suited for TWM may change from term to term. Therefore, the list above contains suggestions rather than warranted courses. Moreover, TWM students cannot claim a place in these courses, since the courses will not exclusively be offered for TWM; there may be competition with other programmes and students. Therefore, please check the current offer of each University frequently!

Note:

Please note that Module 8 encompasses optional courses, i.e. courses that can be chosen according to the student's personal preferences. However, a total of 14 or 9 credits have to be covered by a student's choice in order to complement the 16 or 21 credits awarded for the internship in term 3.

Please also note that the list of optional courses given above comprises a selection of courses, which be frequently offered at both universities.

It is not possible to provide a full list of options here, thus, the student is strongly recommended to check for additional options frequently on the websites of both universities.

The lists for actual offered optional courses can be found at.

http://www.ru.nl/biowetenschappen/onderwijs_education/master-tracks/
for Courses at RU

and in <https://moodle.uni-due.de/course/view.php?id=4581> for courses at UDE.

If desired you may also attend courses at other Universities than RU or UDE while you are in your internship or you may attend to courses of other faculties or the Institute of Optional Courses (IOS at UDE, check: <http://www.uni-due.de/ios/>).

If you want to do so, please contact the examination boards of both universities to check if this is possible (just write a short email with the information of the courses you want to attend to).

How many credits you have to do in the optional course part, depends on the credits you are doing in your internship. If you chose the short internship (12 weeks) you will have to do 14 Credits in optional courses. If you chose the long internship (16 weeks) you will have to do 9 Credits in optional courses.

Module	Module Abbreviation
Master Thesis	TWM-MA-9
Responsible for the module	Faculty
Prof. Dr. Daniel Hering, UDE Prof. Dr. Jan Hendriks, RU	Faculty of Biology/UDE; Faculty of Science/RU

Relevance for other study programmes	none
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Academic year	Duration	Relevance within Curriculum
2	6 months	compulsory

Prerequisites according to examination regulations	Recommended prerequisites
	Modules 1 to 7

No.	Course	hours per week (SWS)	Workload (h)	Credits (ECTS)
9.1	Master-Thesis		900	30
Sum			900	30

Learning Targets of this module
<p>The students have the ability</p> <ul style="list-style-type: none"> - to apply ecological, technical, socio-economic principles to current fields related to water management, - to comprehensively deal with a given topic within a limited timeframe, - to cooperate with professionals in the water management practice, - to collect topic-related information by means of modern information technology. <p>They can address and evaluate ethical questions relevant to society and give new impulses, especially to topics related to „diversity“, „sustainability“ and “resource protection”.</p> <p>The students</p> <ul style="list-style-type: none"> - use this knowledge to evaluate research and test results - review results, interpret them critically and put results into a transdisciplinary context - present results in oral and written form to different stakeholders - communicate with stakeholders of different disciplines related to water management - develop autonomous research questions and hypotheses - plan research projects under limited time and resources - conduct research projects with suitable methods, work in research teams, evaluate results, interpret results critically, and put results into a transdisciplinary context - present results in oral and written presentations to different stakeholders - Use those methods autonomously in the field.

Module examinations to gain grades
Specified in the examination regulations for TWM.

Module grade proportion of final grade	30/120
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Impressum

University of Duisburg-Essen
Faculty of Biology/Centre for Water and Environmental Research (CWE)
Responsible for the programme: Prof. Dr. Bernd Sures and Prof. Dr. Daniel Hering
Universitätsstraße 5
D-45141 Essen
Germany
Tel. +49 201 183-3113
Fax +49 201 183-4442

and

Radboud University
Faculty of Science, Mathematics and Computing Science
Centre for Sustainable Management of Resources (CSMR)
Responsible for the programme: Prof. Dr. Jan Hendriks, Prof. Dr. (Toine) A.J.M. Smits
P.O. Box 9102
NL-6500 HC NIJMEGEN
The Netherlands
Tel: +31 24 365-2932
Fax: +31 24 365-2430

The latest valid version of the model handbook can be found at:
www.uni-due.de/twm

Please note: Only the study and examination regulations of the respective university are legally binding. All contents described here are subject to frequent changes and not legally binding.

Abbreviations

ECTS = European Credit Transfer System
M.Sc. = Master of Science
SWS = lecture hours per week (*Semesterwochenstunden*)
TWM = Transnational ecosystem-based Water Management
UDE = University of Duisburg-Essen
RU = Radboud University Nijmegen