University of Debrecen
Faculty of Science and Technology
Institute of Biology and Ecology

HYDROBIOLOGY – WATER QUALITY MANAGEMENT MSC PROGRAM

2022

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DEAN'S WELCOME

Welcome to the Faculty of Science and Technology!

This is an exciting time for you, and I encourage you to take advantage of all that the Faculty of Science and Technology UD offers you during your bachelor's or master's studies. I hope that your time here will be both academically productive and personally rewarding

Being a regional centre for research, development and innovation, our Faculty has always regarded training highly qualified professionals as a priority. Since the establishment of the Faculty in 1949, we have traditionally been teaching and working in all aspects of Science and have been preparing students for the challenges of teaching. Our internationally renowned research teams guarantee that all students gain a high quality of expertise and knowledge. Students can also take part in research and development work, guided by professors with vast international experience.

While proud of our traditions, we seek continuous improvement, keeping in tune with the challenges of the modern age. To meet the demand of the job market for professionals, we offer engineering courses with a strong scientific basis, thus expanding our training spectrum in the field of technology. Based on the fruitful collaboration with our industrial partners, recently, we successfully introduced dual-track training programmes in our constantly evolving engineering courses.

We are committed to providing our students with valuable knowledge and professional work experience, so that they can enter the job market with competitive degrees. To ensure this, we maintain a close relationship with the most important national and international companies. The basis for our network of industrial relationships is in our off-site departments at various companies, through which market participants - future employers - are also included in the development and training of our students.

Prof. dr. Ferenc Kun
Dean

UNIVERSITY OF DEBRECEN

Date of foundation: 1912 Hungarian Royal University of Sciences, 2000 University of Debrecen

Legal predecessors: Debrecen University of Agricultural Sciences; Debrecen Medical University; Wargha István College of Education, Hajdúböszörmény; Kossuth Lajos University of Arts and Sciences

Number of Faculties at the University of Debrecen: 14

Faculty of Agricultural and Food Sciences and Environmental Management

Faculty of Child and Special Needs Education

Faculty of Dentistry

Faculty of Economics and Business

Faculty of Engineering

Faculty of Health

Faculty of Humanities

Faculty of Informatics

Faculty of Law

Faculty of Medicine

Faculty of Music

Faculty of Pharmacy

Faculty of Public Health

Faculty of Science and Technology

Number of students at the University of Debrecen: 29,954

Full time teachers at the University of Debrecen: 1,557

197 full university professors and 1,224 lecturers with a PhD.

FACULTY OF SCIENCE AND TECHNOLOGY

The Faculty of Science and Technology is currently one of the largest faculties of the University of Debrecen with about 3000 students and more than 200 staff members. The Faculty has got 6 institutes: Institute of Biology and Ecology, Institute of Biotechnology, Institute of Chemistry, Institute of Earth Sciences, Institute of Physics and Institute of Mathematics. The Faculty has a very wide scope of education dominated by science and technology (11 Bachelor programs and 13 Master programs), additionally it has a significant variety of teachers' training programs. Our teaching activities are based on a strong academic and industrial background, where highly qualified teachers with a scientific degree involve student in research and development projects as part of their curriculum. We are proud of our scientific excellence and of the application-oriented teaching programs with a strong industrial support. The number of international students of our faculty is continuously growing (currently ~770 students). The attractiveness of our education is indicated by the popularity of the Faculty in terms of incoming Erasmus students, as well.

THE ORGANIZATIONAL STRUCTURE OF THE FACULTY

Dean: Prof. Dr. Ferenc Kun, Full Professor
E-mail: ttkdekan@science.unideb.hu

Vice Dean for Educational Affairs: Prof. Dr. Gábor Kozma, Full Professor
E-mail: kozma.gabor@science.unideb.hu

Vice Dean for Scientific Affairs: Prof. Dr. Sándor Kéki, Full Professor
E-mail: keki.sandor@science.unideb.hu

Consultant on External Relationships: Prof. Dr. Attila Bérczes, Full Professor
E-mail: berczesa@science.unideb.hu

Consultant on Talent Management Programme: Prof. dr. Tibor Magura, Full Professor
E-mail: magura.tibor@science.unideb.hu

Dean's Office
Head of Dean's Office: Mrs. Katalin Kozma-Tóth
E-mail: toth.katalin@science.unideb.hu

English Program Officer: Mr. Imre Varga – Applied Mathematics (MSc), Chemical Engineering (BSc/MSc), Chemistry (BSc/MSc), Earth Sciences (BSc), Electrical Engineering (BSc), Geography (BSc/MSc), Mathematics (BSc), Physics (BSc), Physicist (MSc), International Foundation Year, Intensive Foundation Semester
Address: 4032 Egyetem tér 1., Chemistry Building, A/101, E-mail: vargaimre@unideb.hu

English Program Officer: Mrs. Szilvia Gyulainé Szemerédi – Biochemical Engineering (BSc), Biology (BSc/MSc), Environmental Science (MSc), Hidrobiology Water Quality Management (MSc)
Address: 4032 Egyetem tér 1., Chemistry Building, A/104,
E-mail: szemeredi.szilvia@science.unideb.hu

DEPARTMENTS OF INSTITUTES OF BIOLOGY AND ECOLOGY

Department of Hydrobiology (home page: http://biology.unideb.hu)
4032 Debrecen, Egyetem tér 1, Ecological Building

Name	Position	E-mail	room
Mr. Dr. István Grigorszky, PhD, habil	Associate Professor, Head of Department	grigorszky.istvan@science.unideb.hu	023
Mr. Dr. Sándor Alex Nagy, PhD, habil	Senior Research Fellow	nagy.sandor.alex@science.unideb.hu	115b
Mr. Dr. István Bácsi, PhD, habil	Associate Professor	bacsi.istvan@science.unideb.hu	020
Mr. Dr. László Antal PhD, habil	Associate Professor	antal.laszlo@science.unideb.hu	119
Mr. Dr. István Gyulai, PhD	Assistant Professor	gyulai.istvan@science.unideb.hu	06
Mr. Dr. Imre Somlyai, PhD	Assistant Professor	somlyai.imre@science.unideb.hu	120
Mr. Dr. Csaba Berta, PhD	Assistant Research Fellow	berta.csaba@science.unideb.hu	120
Mr. Dr. Krisztián Nyeste, PhD	Assistant Professor	nyeste.krisztian@science.unideb.hu	119

Department of Botany (http://biology.unideb.hu)
4032 Debrecen, Egyetem tér 1, Life Science Building

Name	Position	E-mail	room
Mr. Prof. Dr. Gábor Vasas, PhD, habil, DSc	University Professor, Head of Department	vasas.gabor@science.unideb.hu	1.506

Department of Ecology (http://biology.unideb.hu)
4032 Debrecen, Egyetem tér 1, Ecological Building

Name	Position	E-mail	room
Mr. Prof. Dr. Béla Tóthmérész, PhD, habil, DSc	University Professor	tothmerb@gmail.com	112

Department of Evolutionary Zoology and Human Biology (http://biology.unideb.hu)
4032 Debrecen, Egyetem tér 1, Life Science Building

Name	Position	E-mail	room
Mr. Dr. Ádám Lendvai, PhD, habil	Associate Professor	lendvai.adam@science.unideb.hu	1.207

Department of Physical Geography and Geoinformatics (http://geogis.unideb.hu)
4032 Debrecen, Egyetem tér 1, Geomathematics Building

Name	Position	E-mail	room
Mr. Prof. Dr. Szilárd Szabó, PhD, habil, DSc	University Professor, Head of Department	szabo.szilard@science.unideb.hu	2.223

Department of Civil Engineering (https://eng.unideb.hu/hu)
4028 Debrecen, Ótemető utca 2., Faculty of Engineering Building

Name	Position	E-mail	room
Mrs. Dr. Herta Czédli, PhD, habil	Associate Professor	herta.czedli@eng.unideb.hu	209/c

Hortobágy National Park Directorate (https://www.hnp.hu/en)
4024 Debrecen, Sumen u. 2. Nature Conservation Development Department

Name	Position	E-mail	room
Ms. Dr. Szilvia Gőri, PhD,	Head of Department, Ecologist	gori.szilvia@hnp.hu	103

ACADEMIC CALENDAR

General structure of the academic semester (2 semesters/year):

Study period	1st week	Registration*	1 week
	2nd – 15th week	Teaching period	14 weeks
Exam period	directly after the study period	Exams	7 weeks

*Usually, registration is scheduled for the first week of September in the fall semester, and for the first week of February in the spring semester.

For further information please check the following link:

https://www.edu.unideb.hu/tartalom/downloads/University_Calendars_2022_23/University_calendar_2022-2023-Faculty_of_Science_and_Technology.pdf

THE HYDROBIOLOGY – WATER QUALITY MANAGEMENT MASTER PROGRAM

Information about the Program

Name of MSc Program:	Hydrobiology MSc Program
Specialization available:	Water Quality Management
Field, branch:	Science
Qualification:	Hydrobiologist – Water Quality Manager
Mode of attendance:	Full-time
Faculty, Institute:	Faculty of Science and Technology Institute of Biology and Ecology
Head of programme:	Dr. István Grigorszky, Associate Professor
Programme coordinator:	Dr. Csaba Berta, Assistant Research Fellow
Duration:	4 semesters
ECTS Credits:	120

Objectives of the MSc program:

The aim of the Hydrobiology – Water Quality management MSc program is to train professional hydrobiologist who has deep insights the physical, chemical, and ecological aspects and processes of various water types in temperate, tropical and semi-arid regions, as well as interactions throughout the hydrological cycle, and the various hydrological processes and function, and the impact this has on health.

Professional competences to be acquired

A Hydrobiologist – Water Quality Management:

a) Knowledge:

- He/she knows the processes in the hydrosphere as well as the methods for exploring, evaluating and managing the connection system of the hydro-spherical processes.
- He/she knows, uses and develops the field- and laboratory practice methods and tools that are used by modern hydrobiology, and for their own work and research.
- He/she possesses the knowledge of theories, paradigms and principles that characterize the hydrobiology science, and knows the possibilities of sustainable use, utilization and preservation of water as an environmental element and resource.
- He/she possesses the knowledge needed to design and carry out hydrobiological research on aquatic and wetland habitats and to conduct various expert activities related to water.

b) Abilities:

- He/she has the ability to systematically understand and master the knowledge in the field of

hydrobiology, as well as the theoretical and practical knowledge of the field of science and the acquired experience to receive new information, to recognize new phenomena and solve the problems that arise.

- He/she is capable of recognizing ecological processes in waters, describing water quality, tracking water quality changes, and developing water quality improvement programs.
- He/she is capable of handling complex situations, application the data and knowledge of aquatic and wetland habitats in practice to carry out scientific researches.
- He/she is able to evaluate the effects of water and water changes in an objective, professional way,to perform expert tasks, to collect individual data, to record, to process and to coordinate field and laboratory observations with theoretical knowledge.

c) Attitude:

- He/she is open to the identification and analysis of emerging problems, seeking to solve them, synthesizing, communicating, and a positive contacting person.
- He/she is committed to a demanding and quality work, able to continue his/her studies, characterized by a practical managing nature with the acquired knowledge of practical hydrobiology, but also suitable for teamwork.
- He/she is open to new hydrobiological and other scientific research results, to professional co-operation.
- He/she strives to expand the existing scientific knowledge and to further develop methods, actively assisting the emergence of new research directions.

d) Autonomy and responsibility:

- He/she has the necessary autonomy to manage small workgroups, to organize their work, and the responsibility to identify development directions.
- In professional and non-professional circumstances, he/she has a responsible opinion on hydrobiological, research ethical and bio-ethical issues. Actively disseminates the results of his/her research field, publishes his/her knowledge even in media, and, if necessary defends his/her professional stands against other trends and representatives of pseudo-sciences.
- He/she is characterized by initiative and decision-making as well as strong personal responsibility.
- After gaining a professional experience, he/she finds out their place in the field of work, helping his/her colleagues in the conscious, goal-oriented tasks implementation. Consciously builds his/her career and helps his/her colleagues alike.

Completion of the MSc Program

The Credit System

Majors in the Hungarian Education System have generally been instituted and ruled by the Act of Parliament under the Higher Education Act. The higher education system meets the qualifications of the Bologna Process that defines the qualifications in terms of learning outcomes: statements of what students know and can do on completing their degrees. In describing the cycles, the framework usesthe European Credit Transfer and Accumulation System (ECTS).

ECTS was developed as an instrument of improving academic recognition throughout the EuropeanUniversities by means of effective and general mechanisms. ECTS serves as a model of academic recognition, as it provides greater transparency of study programs and student achievement. ECTS inno way regulates the content, structure and/or equivalence of study programs.
Regarding each major the Higher Education Act prescribes which professional fields define a certain training program. It contains the proportion of the subject groups: natural sciences, economics and humanities, subject-related subjects and differentiated field-specific subjects.

During the program students have to complete a total amount of 120 credit points. It means approximately 30 credits per semester. The curriculum contains the list of subjects (with credit points) and the recommended order of completing subjects which takes into account the prerequisite(s) of each subject. You can find the recommended list of subjects/semesters in chapter “Model Curriculum Hidrobiology – Water Quality Management MSc Program”.

Knowledge elements, lectures and lecturers	**semesters**				**ECTS credit points**	**evaluation**
	1.	**2.**	**3.**	**4.**		
	contact hours, types of teaching (l – lecture, s – seminar, p – practice), credit points					
	Basic knowledge elements					
General Hydrobiology *István Grigorszky*	28 l/4 cr. 14 s/1 cr.				5	exam
Mathematical methods in Hydrobiology *Béla Tóthmérész*	28 l/4 cr. 14 p/1 cr.				5	exam, mid-semester grade
Hydrology and Geography *Szilárd Szabó*	28 l/4 cr. 14 p/1 cr.				5	exam, mid-semester grade
Applied Hydrobiology *Imre Somlyai*		28 l/4 cr. 14 s/1 cr.			5	exam
					20	
Core subjects						
Water Chemistry *István Bácsi*	28 l/4 cr. 14 p/1 cr.				5	exam,
Running Water Ecology *István Grigorszky and Csaba Berta*	28 l/4 cr. 14 p/1 cr.				5	exam, mid-semester grade
Standing Water Ecology *István Grigorszky and Csaba Berta*	28 l/4 cr. 14 p/1 cr.				5	exam, mid-semester grade
Wetland Ecology *Imre Somlyai*	28 l/4 cr. 14 p/1 cr.				5	exam, mid-semester grade
Water Resources Management *Herta Czédli and Csaba Berta*		28 l/4 cr. 14 s/1 cr.			5	exam
					25	
Specific scientific knowledge						

Aquatic Toxicology *Gábor Vasas and István Bácsi*		28 l/4 cr. 14 p/1 cr.			5	exam, mid-semester grade
Paleohydrobiology *István Gyulai and Csaba Berta*		28 l/4 cr. 14 p/1 cr.			5	exam, mid-semester grade
Water Quality Monitoring *István Bácsi and István Gyulai*			28 l/4 cr. 14 s/1 cr.		5	exam
European Water Framework Directive *Krisztián Nyeste*				28 l/4 cr. 14 p/1 cr.	5	exam, mid-semester grade
Nature Conservation *Szilvia Gőri*				28 l/4 cr. 14 p/1 cr.	5	exam, mid-semester grade
					25	
Optional courses						
Water Microbiology *István Bácsi*		28 l/4 cr. 14 p/1 cr.			5	exam, mid-semester grade
Algology *István Bácsi*		28 l/4 cr. 14 p/1 cr.			5	exam, mid-semester grade
Macrophytes *István Gyulai*		28 l/4 cr. 14 p/1 cr.			5	exam, mid-semester grade
Zooplankton *István Gyulai and Csaba Berta*		28 l/4 cr. 14 p/1 cr.			5	exam, mid-semester grade
Macroinvertebrates *László Antal*		28 l/4 cr. 14 p/1 cr.			5	exam, mid-semester grade
Fishes *László Antal and Krisztián Nyeste*		28 l/4 cr. 14 p/1 cr.			5	exam, mid-semester grade
Research Project Management *Ádám Lendvai*		28 l/4 cr. 14 p/1 cr.			5	exam, mid-semester grade
Tropical Ecology *Alex Sándor Nagy*		28 l/4 cr. 14 p/1 cr.			5	exam, mid-semester grade
Fundamentals of Geoinformation Systems *Szilárd Szabó*		28 l/4 cr. 14 p/1 cr.			5	exam, mid-semester grade

Water pollution *Krisztián Nyeste*		28 l/4 cr. 14 p/1 cr.			5	exam, mid-semester grade
Aquatic invasions *Krisztián Nyeste*		28 l/4 cr. 14 p/1 cr.			5	exam, mid-semester grade
Basic information *Csaba Berta*		14 l/1 cr.			1	sign
Thesis work and consultation						
Thesis writing I.			56 s/5 cr.		5	mid-semester grade
Thesis writing II.				56 s/10 cr.	10	mid-semester grade
					15	
Field practice						
Field practice I.		28 s/5 cr.			5	mid-semester grade
					5	
Total					**120**	

Work and Fire Safety Course

According to the Rules and Regulations of University of Debrecen a student has to complete the online course for work and fire safety. Registration for the course and completion are necessary for graduation. For MSc students the course is only necessary only if BSc diploma has been awarded outside of the University of Debrecen.

Registration in the Neptun system by the subject: MUNKAVEDELEM

Students have to read an online material until the end to get the signature on Neptun for the completion of the course. The link of the online course is available on webpage of the Faculty.

Physical Education

According to the Rules and Regulations of University of Debrecen a student has to complete Physical Education courses at least in one semester during his/her Master's training. Our University offers a wide range of facilities to complete them. Further information is available from the Sport Centre of the University, its website: http://sportsci.unideb.hu.

Pre-degree Certification

A pre-degree certificate is issued by the Faculty after completion of the master's (MSc) program. The pre-degree certificate can be issued if the student has successfully completed the study and exam requirements as set out in the curriculum, the requirements relating to Physical Education as set out in Section 10 in Rules and Regulations – with the exception of preparing thesis – and gained the necessary credit points (120). The pre-degree certificate verifies (without any mention of assessment or grades) that the student has fulfilled all the necessary study and exam requirements defined in the curriculum and the requirements for Physical Education. Students who obtained the pre-degree certificate can submit the thesis and take the final exam.

Thesis

A Thesis is the creative elaboration of a professional task in written form. By solving the task,the student relies on his/her studies using national and international literature under the guidance of an internal and external supervisor (referee). By a completed dissertation and its successful defence an hydrobiologist student certifies that he/she is capable to apply the acquired knowledge in practice and to summarize the completed work and its results in professional way, to solve the tasks related to his/her topic creatively and to complete individualprofessional work. By preparing and defending a thesis a student who completes the Water Management Master program prove that he/she is capable of the practical applications of the acquired skills, summarizing the work done and its results in a professional way, creatively solving the tasks related to the topic and doing individual professional work.

The requirements of the thesis content, the general aspects of evaluation and the number of credits assigned to the thesis are determined by the requirements of the program. In water management program the credits assigned to the thesis is 15.

The formal requirements of a thesis shall be announced at the same time of task setting up by writing. A thesis can be submitted by a student supported solely by the internal supervisor and external referee. The thesis also need to be uploaded into the University of Debrecen Electronic Archive website (https://dea.lib.unideb.hu/dea/?locale-attribute=en). If a thesis is evaluated with a fail mark by the referee and the department the student is not allowed to take the final exam and is supposed to prepare a new or modified thesis. The student has to be informed about it. Conditions on resubmitting the thesis are defined by the program coordinator of the particularspecialization.

Final Exam

Students having obtained the pre-degree certificate will finish their studies by taking the final exam of Water Management-Hydrobiologist master program. A final exam is the evaluation and control of the knowledge and skills acquired. The candidate has to certify that he/she is able to apply the obtained knowledge in practice. A final exam can be taken after obtaining thepre-degree certificate. A final exam has to be taken in front of the Final Exam Board. If a candidate does not pass his/her final exam by the termination of his/her student status, he/she can take his/her final exam after the termination of the student status on any of the final exam days of the relevant academic year according to existing requirements on the rules of the final exam.

The Final Exam consists of 2 parts on the basis of its curriculum:

According to the prerequisites of taking a final exam:

- compiling all the subjects provided from semester 1 to 4 in the model curriculum, obtaining at least 120 credits including subjects of criterion on the basis of curriculum;
- making and submitting the thesis (2 semesters, 15 credits).

The final exam (oral exam):
Subjects:

- The core material of the final exam (T1)
- Material related to the 'Water Quality Management' specialisation (T2)
- Grade for the thesis (D1) and grade for the thesis defence (D2)

Calculation of a final exam grade (FE) according to this formula:
FE= (T1+T2+D1+D2)/4

The requirements of the oral part of the final exam, the agenda of the topics with the indicationof their literature are announced by the department during the final week of the study period

the latest. The oral part of the final exam is evaluated on a five-point scale by the Final Exam Board. The final grade for the final exam will be decided on by voting in a closed meeting after

the final exam. In case of equal votes the committee chair will take the decision. Final exam results will be announced by the committee chair. A note of the final exam will be taken.

Retaking failed final exam

If any parts of the final exam is evaluated with a fail mark according to the existing rules of theuniversity, it can be retaken. The ensuing final exam period is the soonest that the re-sit is allowed. If a thesis is evaluated with a solid fail mark by the supervisor and the referee, the graduate is not allowed to take a final exam and a new thesis has to be written. A final exam can be retaken twice on each topic.

Final Exam Board

Committee chair and members of the committee are selected from the acknowledged internal and external experts of the professional field. Traditionally, it is the chair and in case of his/herabsence or indisposition the vice-chair who will be called upon, as well. The committee consistsof – besides the chair – at least two members, and questioners as required. The mandate of a Final Exam Board lasts for one year.

Diploma

The diploma is an official document decorated with the coat of arms of Hungary which verifiesthe successful completion of studies in the Hydrobiology – Water Quality Management MasterProgram. It contains the following data: name of HEI (higher education institution); institutional identification number; serial number of diploma; name of diploma holder; date and place of his/her birth; level of qualification; training program; specialization; mode of attendance; place, day, month and year issued. Furthermore, it has to contain the rector's (or vice-rector's) original signature and the seal of HEI. The University keeps a record of the diplomas issued.

In Hydrobiology – Water Quality Management Master Program the diploma grade is calculatedas the average grade of the results of the followings:

- Weighted average of the overall studies at the program (A)
- Average of grades of the thesis and its defense given by the Final Exam Board (B)
- Average of the grades received at the Final Exam for the two subjects (C)

Diploma grade = (A + B + C)/3

Classification of the award on the bases of the calculated average:

Excellent	4.81 – 5.00
Very good	4.51 – 4.80
Good	3.51 – 4.50
Satisfactory	2.51 – 3.50
Pass	2.00 – 2.50

Course Descriptions of Hidrobiology – Water Quality Management MSc Program

Title of course: General Hydrobiology **Code**: TTHME9104_EN	**ECTS Credit points: 3**

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 64 hours

Total: 120 hours

Year, semester: 1st year, 1 st semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

Physical and chemical properties of various water types. Geological and morphological characteristics of natural water bodies. Physical characteristics of water areas, such as movementsof sea water-waves, tidal phenomena, ocean currents, eddies, water movements in lakes and lagoons. Temperature of natural water bodies. Transparency, light, color and turbidity in sea, standing and running waters. Basic chemical characteristics of natural water. The main mineral elements and compounds, gases, nutrients. Overview of the aquatic life nekton, plankton, pleuston, neuston, periphyton, benthos.). Food chain. Primary production. Biogeography of aquatic organisms.

Literature

1. Moss, B. (2010): Ecology of Fresh Waters: A View for the Twenty-First Century, Wiley-Blackwell, I
2. Michael J. and Mills D., (1990): Freshwater Ecology: Principles and Applications, Wiley-Blackwell,
3. Levinton J.S., (2010): Marine Biology: International Edition: Function, Biodiversity, Ecology, OUP USA,
4. Kaiser M. J., Attrill M.J., Jennings S., Thomas D.N., Barnes D.K.A, Brierley A.S., HiddinkJ.G, Kaartokallio H, Polunin N.V.C), Raffaelli D.G, (2011): Marine Ecology: Processes, Systems, and Impacts, OUP USA,

Schedule:

Lectures:

1st week Field of hydrobiology in science and its practical applications.

2nd week Biological production in water bodies.

3rd week Basics of nutrient cycles in the waters and energy levels.

4th week Eutrophication and oligotrophication processes.

5th week Water quality and water merit.

6th week The hydrological cycle.

7th week Effects of the quantitative changes in water resources.

8th week Quality changes in water resources.

9th week Typology of standing waters.

10th week Typology of running waters.

11th week Typology of ground waters and springs.

12th week Physiognomy and space of living of standing waters.

13th week Physiognomy and space of living of running waters.

14th week Zonation and succession.

Requirements:
Lecture:

The minimum requirement for the examination is 50% from the midterm and closing tests. Based on the summarized score of the test the grade for the examination is given according to the following table:

Score	Grade
0-49%	fail (1)
50-59%	pass (2)
60-72%	satisfactory (3)
73-84%	good (4)
85-100%	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. habil. Istvan Grigorszky, associate professor, PhD

Lecturer: Dr. habil. István Grigorszky, associate professor, PhD

Title of course: General Hydrobiology **Code**: TTHMG9104_EN	**ECTS Credit points: 2**

Type of teaching, contact hours

- lecture: -
- practice: 1 hours/week
- laboratory: -

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:

- lecture: -
- practice: 14 hours
- laboratory: -
- home assignment: 16 hours
- preparation for the exam: -

Total: 30 hours

Year, semester: 1st year, 1 st semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

Physical and chemical properties of various water types. Geological and morphological characteristics of natural water bodies. Physical characteristics of water areas, such as movementsof sea water-waves, tidal phenomena, ocean currents, eddies, water movements in lakes and lagoons. Temperature of natural water bodies. Transparency, light, color and turbidity in sea, standing and running waters. Basic chemical characteristics of natural water. The main mineral elements and compounds, gases, nutrients. Overview of the aquatic life nekton, plankton, pleuston, neuston, periphyton, benthos.). Food chain. Primary production. Biogeography of aquatic organisms.

Literature

1. Moss, B. (2010): Ecology of Fresh Waters: A View for the Twenty-First Century, Wiley-Blackwell, I
2. Michael J. and Mills D., (1990): Freshwater Ecology: Principles and Applications, Wiley-Blackwell,
3. Levinton J.S., (2010): Marine Biology: International Edition: Function, Biodiversity, Ecology, OUP USA,
4. Kaiser M. J., Attrill M.J., Jennings S., Thomas D.N., Barnes D.K.A, Brierley A.S., HiddinkJ.G, Kaartokallio H, Polunin N.V.C), Raffaelli D.G, (2011): Marine Ecology: Processes, Systems, and Impacts, OUP USA,

Schedule:

Lectures:

1st week. Presenting further training courses and specializations in hydrobiology.

2nd week. Producer and demolisher organisms.

3rd week. Anthropogenic effects in waters.

4th week. Presentation of eutrophication in a specific example.

5th week. Different land use and their impacts.

6th week. El Niño and La Niña.

7th week. Demonstration the effects of drought on an example area.

8th week. Demonstration the effects of water pollution based on an example.

9th week. Introducing the major standing waters of the Earth.

10th week. Introducing the major running waters of the Earth.

11th week. Problems with the non-renewable water resources of the Earth.

12th week. Presentation of the most important living organism groups in standing waters.

13th week. Presentation of the most important living organism groups in running waters.

14th week. Presentation of the most important macrophytes in waters.

Requirements:

Practice:

Participation at classes is compulsory. A student must attend the courses and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

During the semester there is one practical test. It can be completed in the 14th week.

The minimum score is 50%. Based on the score of the test, the grade for the test is given accordingto the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-72	satisfactory (3)
73-84	good (4)
85-100	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. habil. István Grigorszky, associate professor, PhD

Lecturer: Dr. habil. István Grigorszky, associate professor, PhD

Title of course: Mathematical methods in hydrobiology **Code**: TTHME9101_EN	**ECTS Credit points: 3**

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 64 hours

Total: 120 hours

Year, semester: 1st year, 1 st semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

A comprehensive introduction to probability, probability distributions, sampling distributions, basic techniques of statistical inference, analysis of variance, linear regression, inference for categorical variables, and nonparametric statistics. This course is designed to teach the students about a variety of mathematical methods which are used in modelling through their application to solving hydrobiological problems. In the practical part of the course students learn the methods of mathematical methods of data processing and planning of experiment.

Literature

- Venables, W. N. and Ripley, B. D. 2003: Modern Applied Statistics with S. 4th edition. Springer, New York.
- Cox D.R., Donnelly C.A. (2011): Principles of Applied Statistics Cambridge University Press
- Wasserman L. (2004): All of Statistics: A Concise Course in Statistical Inference, Springer;

Schedule:

1st week. Introduction to the course.

2nd week. Basics of model building in science.

3rd week. Introduction to the programming languages, with special reference to R programming language end environment.

4th week. Basics of data management.

5th week. Graphical methods in descriptive statistics. 6th week. Basic statistics; statistical distributions.

7th week. Exam.

8th week. Sampling, design of experiments.

9th week. Regression analyses.

10th week. Analysis of variance (ANOVA).

11th week. General linear models and generalized linear models.

12th week. Multivariate methods: classification.

13th week. Multivariate methods: ordination.

14th week. Exam.

Requirements:

Participation at classes is compulsory. A student must attend the courses and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

During the semester there are two tests: the mid-term test in the 7th week and the end-term test in the 14th week.

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

-an offered grade:

it may be offered for students if the average grade of the two exams is at least satisfactory (3) and the average of the mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of them.

- in case an offered grade cannot be given, or it is not convenient for the student there is a possibilityto have an exam in the exam session.

Person responsible for course: Prof. Dr. habil. Béla Tóthmérész, university professor, DSc

Lecturer: Prof. Dr. habil. Béla Tóthmérész, university professor, DSc

Title of course: Mathematical Methods in Hydrobiology **Code**: TTHMG9101_EN	**ECTS Credit points: 2**

Type of teaching, contact hours

- lecture: -
- practice: 1 hours/week
- laboratory: -

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:

- lecture: -
- practice: 14 hours
- laboratory: -
- home assignment: 16 hours
- preparation for the exam: -

Total: 30 hours

Year, semester: 1st year, 1 st semester

Further courses built on it:

Topics of course

A comprehensive introduction to probability, probability distributions, sampling distributions, basic techniques of statistical inference, analysis of variance, linear regression, inference for categorical variables, and nonparametric statistics. This course is designed to teach the students about a variety of mathematical methods which are used in modelling through their application to solving hydrobiological problems. In the practical part of the course students learn the methods of mathematical methods of data processing and planning of experiment.

Literature

- Venables, W. N. and Ripley, B. D. 2003: Modern Applied Statistics with S. 4th edition. Springer, New York.
- Cox D.R., Donnelly C.A. (2011): Principles of Applied Statistics Cambridge University Press
- Wasserman L. (2004): All of Statistics: A Concise Course in Statistical Inference, Springer;

Schedule:

1st week. Practical basic knowledge to the course.

2nd week. Techniques and tools of model building in science.

3rd week. Basic usage of the R environment and programming language.

4th week. Basic methods of data management.

5th week. Practical usage of graphical methods in descriptive statistics.6th week Basic statistics and statistical distributions of real data.

7th week. Exam.

8th week. Sampling, design of experiments.

9th week. Analysis of variance (ANOVA) and regression analyses based on R.

10th week. General linear models and generalized linear models in R.

11th week. Models of population dynamics and their implementation in R.

12th week. Discrete and continuous models, chaotic dynamics and their programming in R.

13th week. Multispecies communities and diversity. R packages to calculate these methods.

14th week. Exam.

Requirements:

Participation at classes is compulsory. A student must attend the courses and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

During the semester there are two tests: the mid-term test in the 7th week and the end-term test in the 14th week.

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

-an offered grade:

it may be offered for students if the average grade of the two designing tasks is at least satisfactory (3) and the average of the mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of them.

- in case an offered grade cannot be given, or it is not convenient for the student there is a possibilityto have an exam in the exam session.

Person responsible for course: Prof. Dr. habil. Béla Tóthmérész, university professor, DSc

Lecturer: Prof. Dr. habil. Béla Tóthmérész, university professor, DSc

Title of course: Hydrology and Geography **Code**: TTHME9201_EN	**ECTS Credit points: 3**

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 64 hours

Total: 120 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

The course aims to provide detailed information about the physical characteristics of water resources. Students will learn both the surface waters and groundwater specific knowledge including the water cycle from the beginning: forming of precipitation, its spatial and temporal distribution as well the consequences of the inhomogeneous distribution (scarcity and floods anderosion). Surface water characteristics are also important including the network types, catchments,watersheds, shape of catchments. Geomorphology of riverine systems. Subsurface water types (groundwater, aquifer, aquitard, sensitive water resources), groundwater movement and its effecton pollution spreading. In the practical part of the course students learn the methods of the determination of flow direction and the speed of groundwater movement, furthermore, the metricsof the river parameters and a simple method will be introduced to calculate the soil erosion.

Literature

1. Han, D. 2010. Concise hydrology, www.BookBooN.com, ISBN 978-87-7681-536-1, 145 p.
2. Brutsaert, W. 2005. Hydrology – An introduction. Cambridge University Press, ISBN 9780521824798 618 p.
3. Loucks, D.P. and van Beek, E. 2005. Water resources systems planning and management. UNESCO Publishing ISBN 92-3-103998-9, 680 p. http://hydrologie.org/BIB/Publ_UNESCO/SR_999_E_2005.pdf

Schedule:

Lectures:

1st week. Water cycle and water courses of the Earth.

2nd week. Horizontal and vertical structure of seas.

3rd week. Geographical distribution of the chemical characteristics, temperature and the ice.

4th week. Movements of the seas: waves.

5th week. Movement of the seas: currents, tidal waves.

6th week. Rivers, wells, estuaries.

7th week. Catchments, watersheds, morphometrical indices, network-patterns.

8th week. Runoff, floods.

9th week. Genetical lake types.

10th week. Water budget types for lakes.

11th week. Geometric and attribute data collection and extraction.

12th week. Types of undersurface waters.

13th week Remote sensing in hydrology.

14th week. Grade-offering exam.

Requirements:
Lecture:

The minimum requirement for the examination is 50% from the midterm and closing tests. Based on the summarized score of the test the grade for the examination is given according to the following table:

Score	Grade
0-49%	fail (1)
50-59%	pass (2)
60-72%	satisfactory (3)
73-84%	good (4)
85-100%	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Prof. Dr. habil. Szilard Szabó, university professor, DSc

Lecturer: Prof. Dr. habil. Szilárd Szabó, university professor, DSc
Dr. László Bertalan, assistant professor, PhD

Title of course: Hydrology and Geography **Code**: TTHMG9201_EN	**ECTS Credit points: 2**

Type of teaching, contact hours

- lecture: -
- practice: -
- laboratory: 1 hours/week

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:

- lecture: -
- practice: -
- laboratory: 14 hours
- home assignment: 16 hours
- preparation for the exam: -

Total: 30 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

The course aims to provide detailed information about the physical characteristics of water resources. Students will learn both the surface waters and groundwater specific knowledge including the water cycle from the beginning: forming of precipitation, its spatial and temporal distribution as well the consequences of the inhomogeneous distribution (scarcity and floods anderosion). Surface water characteristics are also important including the network types, catchments,watersheds, shape of catchments. Geomorphology of riverine systems. Subsurface water types (groundwater, aquifer, aquitard, sensitive water resources), groundwater movement and its effecton pollution spreading. In the practical part of the course students learn the methods of the determination of flow direction and the speed of groundwater movement, furthermore, the metricsof the river parameters and a simple method will be introduced to calculate the soil erosion.

Literature

1. Han, D. 2010. Concise hydrology, www.BookBooN.com, ISBN 978-87-7681-536-1, 145 p.
2. Brutsaert, W. 2005. Hydrology – An introduction. Cambridge University Press, ISBN 9780521824798 618 p.
3. Loucks, D.P. and van Beek, E. 2005. Water resources systems planning and management. UNESCO Publishing ISBN 92-3-103998-9, 680 p. http://hydrologie.org/BIB/Publ_UNESCO/SR_999_E_2005.pdf

Schedule:

Lectures:

1st week. Application of geodetic instruments in hydrology I.

2nd week. Application of geodetic instruments in hydrology II.

3rd week. Application of geodetic instruments in hydrology III.

4th week. Field data processing and interpretation for thematic map compositions.

5th week. Small-scale flume experiments for understanding river morphology I.

6th week. Small-scale flume experiments for understanding river morphology II.

7th week. Methods for spatio-temporal analysis of river channel development.

8th week. Floodplain management.

9th week. Effects of river regulation works; floodplain rehabilitation.

10th week. Applied hydrometrics; surface water survey and gauging methodology.

11th week. Hydrological time series data analysis.

12th week. Digital Elevation Models, Applied GIS methods in hydrology.

13th week. Delineation of wetlands based on remote sensing data.

14th week. Practical test.

Requirements:

Practice:

Participation at classes is compulsory. A student must attend the courses and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

During the semester there is one practical test. It can be completed in the 14th week.

The minimum score is 50%. Based on the score of the test, the grade for the test is given accordingto the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-72	satisfactory (3)
73-84	good (4)
85-100	excellent (5)

Person responsible for course: Prof. Dr. habil. Szilárd Szabó, university professor, DSc

Lecturer: Prof. Dr. habil. Szilárd Szabó, university professor, DSc
Dr. László Bertalan, assistant professor, PhD

Title of course: Applied Hydrobiology **Code**: TTHME9210_EN	**ECTS Credit points: 3**

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 64 hours

Total: 120 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

The types of natural water supplies (surface waters and groundwaters) and their main characteristics. Water pollution, waste materials. Technologies for providing drinking water fromdifferent water sources. Domestic, industrial and agricultural wastewaters. Wastewater treatment (primary, secondary, tertiary). Biological methods (activated sludge, fixed-film reactors). Treatment of sewage sludge (biogas production, composting). Natural wastewater treatment systems (stabilization ponds, constructed wetlands). Types and function of reservoirs. Fish pondsand fish breeding. Biomanipulation.

Literature

Compulsory:

K. Edzwald (2011): Water Quality and Treatment. Handbook of Drinking Water. American Water Works Assosiation, USA ISBN**:** 9780071630115

J.E. Drinan, F.Spellman (2012): Water and Wastewater Treatment: Guide for the Nonengineering Professional. CRC Press, USA ISBN 9781439854006

R.W. Crites, E.J. Middlebrooks, S.C. Reed (2005): Natural Wastewater Systems, CRC Press, USA ISBN 9780849338045

H. Reinersten, L.A. Dahle, L. Jorgensen 1993: Fish Farming Technology. CRC Press ISBN 9789054103264

Schedule:

1st week. Surface and underground water resources, their qualitative and quantitativecharacteristics, the factors determining them.

2nd week. The definition of drinking water. Drinking water production from groundwater. The characteristics of the river bank filtration and the technology used for purification. Artificial recharge of groundwater.

3rd week. Drinking water from confined groundwater. The characteristics and treatment technologies of the confined groundwater. Arsenic removal methods. Characteristics and use of karstic

waters for drinking water supply.

4th week. Production of drinking water from surface waters. Water extraction methods from standing and running waters, purification characteristics, the applied technological processes.

5th week. Types of industrial water demand. Procedures for industrial water treatment (membrane technologies, softening, desalting, iron and manganese removal).

6th week. Biology of drinking water supply systems. The biological features of water withdrawal sites and the drinking water supply network.

7th week. The definition of wastewater and its types. The technology of domestic wastewater treatment.

8th week. Biological treatment processes 1. The operation of artificial methods (active sludge and fixed film systems)

9th week. Biological treatment processes 2. Types of natural methods and their functional characteristics.

10th week. Characterization and treatment methods of sewage sludge. Biogas production.

11th week. The hydrobiological effects of heat pollution. Effects of hydromorphological interventions in surface waters.

13th week. The basics of fish farming, extensive and intensive methods.

12th week. Future tasks of applied hydrobiology (effects of global warming, biomanipulation, drug residues in water).

14th week. Consultation or exam.

Requirements:

- for a signature

Attendance at lectures is recommended, but not compulsory.

- for a grade

The course ends in a written examination. 2 (Pass) grade: 50% of the maximum points available. If the score of any test is below 50%, students can take a retake test.

-an offered grade:

There are at least two tests during the semester, and the offered grade is the average of them.

Person responsible for course: Dr. Imre Somlyai, assistant professor, PhD

Lecturer: Dr. Imre Somlyai, assistant professor, PhD

Title of course: Applied Hydrobiology **Code**: TTHMG9210_EN	**ECTS Credit points: 2**

Type of teaching, contact hours

- lecture: -
- practice: 1 hours/week
- laboratory: -

Evaluation: signature

Workload (estimated), divided into contact hours:

- lecture: -
- practice: 14 hours/week
- laboratory: -
- home assignment: 16 hours
- preparation for the exam: -

Total: 30 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

Comparative assessment of methods used in water and wastewater treatment. Possibilities for controlling operation. Visit the drinking water treatment plant, a sewage treatment plant, a fish farm and a waterworks laboratory.

Literature

Compulsory:

M.P. Cheremisinoff (2002): Handbook of water and wastewater treatment technologies. Butterworth-Heinemenn, USA ISBN 0-7506-7498-9

K. Edzwald (2011): Water Quality and Treatment. Handbook of Drinking Water. American Water Works Assosiation, USA ISBN**:** 9780071630115

J.E. Drinan, F.Spellman (2012): Water and Wastewater Treatment: Guide for the Nonengineering Professional. CRC Press, USA ISBN 9781439854006

Schedule:

1st week. Methods of water withdrawal, well types and their operation.

2nd week. Comparing types of sand filters and their operation.

3rd week. Applicability of various primary coagulant and the possibilities of increasing the coagulation process.

4th week. Comparison of using of different disinfectants. Case study.

5th week. Evaluation of membrane techniques, their applicability in water and wastewatertreatment.

6th week. Comparison of arsenic removal methods. Case study.

7th week. Investigation of the operation of activated sludge: organic matter load (COD, BOD), Nand P forms, sediment sludge, Mohlmann index.

8th week. Using chemicals in wastewater treatment.

9th week. Types of municipal water supply systems and sewer networks.

10th week. Design and operation of industrial cooling water systems. *11th week.* Options of stormwater treatment. *13th week.* Visit to a drinking water treatment plant and a fish farm. *12th week.* Visit to a wastewater treatment plant and a waterworks lab. *14th week.* Consultation.
Requirements: - for a signature Participation at practice classes is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will notbe signed and the student must repeat the course. In case of further absences, a medical certificateneeds to be presented. - for a grade The practice ends with submitting a term paper.
Person responsible for course: Dr. Imre Somlyai, assistant professor, PhD
Lecturer: Dr. Imre Somlyai, assistant professor, PhD

Title of course: Water Chemistry **Code**: TTHME9215_EN	**ECTS Credit points: 3**

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 64 hours

Total: 120 hours

Year, semester: 1st semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

The course introduces the chemical and physical properties of water and processes occurring in aqueous media, furthermore, the course discusses the main laws of behavior of aqueous solutions. Basic knowledge: the structure of the water molecule, water phase diagram, different states (consistence, phases) of water will be discussed. Subjects as supercritical state, polarity, and wateras solvent will be introduced. Chemical equilibrium and kinetic principles will be introduced for the acid-base reactions, complex formation, precipitation/dissolution, oxidation/reduction reactions, and for dilution processes.

Literature

1. Snoeyink VL (2006) Water Chemistry. John Wiley & Sons Inc.
2. Spellman FR (2014) The Science of Water: Concepts and Applications. CRC Press.
. Stanley EM (2010) Water Chemistry: Green Science and Technology of Nature's MostRenewable Resource. CRC Press.

Schedule:

1st week. Development of hydrophysics and hydrochemistry.

2nd week. The structure of the water molecule. General characterization and physical properties of water.

3rd week. The proportion of water resources on Earth I: Fresh, salty and brackish waters.

4th week. Proportions of water resources on Earth II .: Surface- and groundwaters.

5th week. Water cycles.

6th week. Cold and warm sea currents, the Coriolis force.

7th week. Methods of measuring the physical parameters of the water, their importance in water management.

8th week. The chemical properties of water: general laws of dissolution, reactivity of water.

9th week. Water as a solvent: dissolution of gases, cations and anions.

10th week. Dissociation equilibria in aqueous solutions. *11th week.* The pH of aqueous solutions. *12th week.* Laws of acid-base equilibria. *13th week.* Oxidation -reduction systems, basic knowledge of electrochemistry. *14th week.* Organic substances in the waters, reactions of organic matter: hydrolysis, hydration, dehydration.
Requirements: *- for a signature* Attendance at lectures is highly recommended, but not compulsory. *- for a grade* During the semester there will be no written tests, there will be an oral exam in the exam period.
Person responsible for course: Dr. habil. István Bácsi, associate professor, PhD
Lecturer: Dr. habil. István Bácsi, associate professor, PhD

Title of course: Water Chemistry laboratory **Code**: TTHMG9215_EN	**ECTS Credit points: 2**

Type of teaching, contact hours

- lecture: -
- practice: -
- laboratory: 1 hours/week

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:

- lecture: -
- practice: -
- laboratory: 14 hours
- home assignment: 16 hours
- preparation for the exam: -

Total: 30 hours

Year, semester: 1st semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

The conditions of water sampling, sample types. Chemical properties of waters, inorganic compounds, and inorganic materials related to eutrophication. Organic substances in water, indicators of organic matter content. Interpretation of water treatment, classification of water treatment methods. Methods for degassing. Methods for removing soluble and floating substances.

Literature

1. Snoeyink VL (2006) Water Chemistry. John Wiley & Sons Inc.
2. Spellman FR (2014) The Science of Water: Concepts and Applications. CRC Press.
. Stanley EM (2010) Water Chemistry: Green Science and Technology of Nature's Most Renewable Resource. CRC Press.

Schedule:

1st week. Measurement of depth and transparency. Measurement of water conductivity in different water types.

2nd week. Instrumental measurement of pH, dissolved oxygen content and saturation in different water types.

3rd week. Surveying of waterbed section by ultrasonic measuring instrument.

4th week. The pH. Acidity, alkalinity, water hardness.

5th week. Methods for determination of dissolved oxygen: classical analytical, electrochemical and optical methods.

6th week. Measurement of inorganic nutrients I. - Reduced nitrogen forms: ammonium.

7th week. Measurement of inorganic nutrients II. - Oxidized nitrogen forms: nitrite, nitrate.

8th week. Measurement of inorganic nutrients III. - Phosphorous forms.

9th week. Measurement of water nutrition indicators: chlorophyll content.

10th week. The most important metal ions in water: the classical analytical measurementpossibilities of iron and manganese.

11th week. Methods for measuring the organic matter content of waters I: measurement of chemical oxygen demand.

12th week. Methods for measuring the organic matter content of water II: compiling experimentsto determine the biological oxygen demand.

13th week. Methods for measuring the organic matter content of water III: biological oxygen demand. Definition of BOD7.

14th week. Consultation.

Requirements:

- for a signature

Participation at laboratory practices is compulsory. A student must attend the laboratory practices and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

- for a grade

During the semester there will be short written tests on every practice, reports should be prepared after every topic. The final grade will be the average of the grades of written tests and reports.

Person responsible for course: Dr. habil. István Bácsi, associate professor, PhD

Lecturer: Dr. habil. István Bácsi, associate professor, PhD

Title of course: Running Water Ecology **Code**: TTHME9205_EN	**ECTS Credit points: 3**

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 64 hours

Total: 120 hours

Year, semester: 1st year, 1 st semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

This course will introduce students to major conceptual themes in ecology of running waters. . Our goals for this course are to gain an understanding of major physical and biological features of streams and rivers; the range of diversity of running waters around the world; fundamental processes producing patterns of riverine structure and function and critical issues associated with the conservation and management of streams and their biota.
We will study the functional aspects of running waters and its ecological state by comparing natural and human impacted running water types. In the field, we will measure the running watertypes structure and discharge, sample organisms, and determine water chemistry and the ecological state on the basis of biological, chemical and hydro-morphological characteristics. In the lab, we will identify selected organisms and will learn about adaptation mechanism as regardsnutrition, life cycles and resistance to water current.

Literature

4. Allan J.D. Castillo M.M., (2011) Stream Ecology: Structure and function of running waters, Springer Netherlands,

5. Michael J. and Mills D., (1990): Freshwater Ecology: Principles and Applications, Wiley-Blackwell,

6. Giller P.S. (1999): The Biology of Streams and Rivers (Biology of Habitats), Oxford University Press, USA,

7. APHA (2012): Standard Methods for the Examination of Water and Wastewater, Clearway Logistics Phase 1a;

Schedule:

Lectures:
1st week. Water resources and water cycle.

2nd week. The streamflow system.

3rd week. Zonation of watercourses.

4th week. Water temperature and dissolved oxygen.

5th week. The sedimentation process.

6th week. Organic matter processing.

7th week. River continuum concept, guilds.

8th week. Ecological zonation of streams.

9th week. Floodplain landforms.

10th week. Typology of springs and running waters.

11th week. Succession patterns of fish populations.

12th week. Main streams of the Carpathian Basin: River Danube.

13th week. Main streams of the Carpathian Basin: River Tisza.

14th week. Grade-offering exam.

Requirements:
Lecture:

The minimum requirement for the examination is 50% from the midterm and closing tests. Based on the summarized score of the test the grade for the examination is given according to the following table:

Score	Grade
0-49%	fail (1)
50-59%	pass (2)
60-72%	satisfactory (3)
73-84%	good (4)
85-100%	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. habil. Istvan Grigorszky, associate professor, PhD

Lecturer: Dr. Csaba Berta, research assistant fellow, PhD

Title of course: Running Water Ecology **Code**: TTHMG9205_EN	**ECTS Credit points: 2**

Type of teaching, contact hours

- lecture: -
- practice: 1 hours/week
- laboratory: -

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:

- lecture: -
- practice: 14 hours
- laboratory: -
- home assignment: 16 hours
- preparation for the exam: -

Total: 30 hours

Year, semester: 1st year, 1 st semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

This course will introduce students to major conceptual themes in ecology of running waters. . Our goals for this course are to gain an understanding of major physical and biological features of streams and rivers; the range of diversity of running waters around the world; fundamental processes producing patterns of riverine structure and function and critical issues associated with the conservation and management of streams and their biota.
We will study the functional aspects of running waters and its ecological state by comparing natural and human impacted running water types. In the field, we will measure the running watertypes structure and discharge, sample organisms, and determine water chemistry and the ecological state on the basis of biological, chemical and hydro-morphological characteristics. In the lab, we will identify selected organisms and will learn about adaptation mechanism as regardsnutrition, life cycles and resistance to water current.

Literature

8. Allan J.D. Castillo M.M., (2011) Stream Ecology: Structure and function of running waters, Springer Netherlands,
9. Michael J. and Mills D., (1990): Freshwater Ecology: Principles and Applications, Wiley-Blackwell,
10. Giller P.S. (1999): The Biology of Streams and Rivers (Biology of Habitats), Oxford University Press, USA,
11. APHA (2012): Standard Methods for the Examination of Water and Wastewater, Clearway Logistics Phase 1a;

Schedule:

Lectures:
1st week. Physical and chemical attributes of water.

2nd week. Order of streamflows.

3rd week. Riverbed geology, bedload transport and substrate.

4th week. Measuring dissolve oxygen, flow rate, and current speed.

5th week. Mountain stream, piedmont river, river plain.

6th week. Autochtonous and allochthonous sources of nutrients.

7th week. Functional feeding groups (shredders, grazers, collectors, predators).

8th week. Space of living.

9th week. Oxbow lake, chute, backswamps.

10th week. The small streams: rivulet, brooke, rill.

11th week. Typical fish species of the zonations.

12th week. Presentations I.: the major streams of the students own country.

13th week. Presentations II.: the major streams of the students own country or other main tributariesof Danube.

14th week. Grade-offering exam.

Requirements:

Practice:

Participation at classes is compulsory. A student must attend the courses and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

During the semester there is one practical test. It can be completed in the 14th week.

The minimum score is 50%. Based on the score of the test, the grade for the test is given accordingto the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-72	satisfactory (3)
73-84	good (4)
85-100	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. habil. Istvan Grigorszky, associate professor, PhD

Lecturer: Dr. Csaba Berta, research assistant fellow, PhD

Title of course: Standing Water Ecology **Code**: TTHME9204_EN	**ECTS Credit points: 3**

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 64 hours

Total: 120 hours

Year, semester: 1st year, 1 st semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

The primary objective of this course is to allow the students to become familiar with the scope of standing water ecology and to master its basic facts, principles, concept and fundamental processes. The course explores the structure and function of standing water types, including physical, chemical and biological controls of productivity and species composition of aquatic plants and animals and effects of pollution on organisms and water quality. The laboratory emphasizes modern, hands-on techniques for answering fundamental and applied questions. During thepractise/field work the students will learn the qualitative and quantitative techniques for studying lakes, ponds and various standing water types. During the laboratory work the students will identifyvarious aquatic organisms and will learn about adaptation mechanism as regards nutrition, life cycles.

Literature

1. Kalff J (2001): Limnology. Benjamin and Cummings.
2. Williams D. D. (2001): The Ecology of Temporary Waters. Blackburn Pr.
3. Belgrano A., Ulanowicz R. E., Scharler U. M., Dunne J. (2005): Aquatic Food Webs: An Ecosystem Approach, Oxford University Press,
4. Burk A. R. (2005): Progress In Aquatic Ecosystems Research. Nova Science Pub Inc.

Schedule:

Lectures:

1st week. Limnology, Water cycle, habitats, water yields.

2nd week. The vertical segmentation of a standing water.

3rd *week.* Standing water typology.

4th week. Space of living and physiognomy.

5th week. Eutrophication (trophy and trophity).

6th week. Halobity.

7th week. Saprobity.

8th week. Toxicity.

9th week. Physical parameters of standing waters.

10th week. Chemical parameters of standing waters.

11th week. Fish communities of standing waters.

12th week. Macroinvertebrates of standing waters.

13th week. Saline lakes and reservoirs, Lake Balaton "hungarian sea".

14th week. Grade-offering exam.

Requirements:
Lecture:

The minimum requirement for the examination is 50% from the midterm and closing tests. Based on the summarized score of the test the grade for the examination is given according to the following table:

Score	Grade
0-49%	fail (1)
50-59%	pass (2)
60-72%	satisfactory (3)
73-84%	good (4)
85-100%	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. habil. Istvan Grigorszky, associate professor, PhD

Lecturer: Dr. Csaba Berta, research assistant fellow, PhD

Title of course: Standing Water Ecology **Code**: TTHMG9204_EN	**ECTS Credit points: 2**

Type of teaching, contact hours

- lecture: -
- practice: 1 hours/week
- laboratory: -

Evaluation: mid-semester grade grade

Workload (estimated), divided into contact hours:

- lecture: 0 hours
- practice: 14 hours
- laboratory: 0hours
- home assignment: 20 hours
- preparation for the exam: 30 hours

Total: 64 hours

Year, semester: 1st year, 1 st semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

The primary objective of this course is to allow the students to become familiar with the scope of standing water ecology and to master its basic facts, principles, concept and fundamental processes. The course explores the structure and function of standing water types, including physical, chemical and biological controls of productivity and species composition of aquatic plants and animals and effects of pollution on organisms and water quality. The laboratory emphasizes modern, hands-on techniques for answering fundamental and applied questions. During the practise/field work the students will learn the qualitative and quantitative techniques for studyinglakes, ponds and various standing water types. During the laboratory work the students will identify various aquatic organisms and will learn about adaptation mechanism as regards nutrition,life cycles.

Literature

1. Kalff J (2001): Limnology. Benjamin and Cummings.
2. Williams D. D. (2001): The Ecology of Temporary Waters. Blackburn Pr.
3. Belgrano A., Ulanowicz R. E., Scharler U. M., Dunne J. (2005): Aquatic Food Webs: An Ecosystem Approach, Oxford University Press,
4. Burk A. R. (2005): Progress In Aquatic Ecosystems Research. Nova Science Pub Inc.
5. Padisák, J (2005): Általános limnológia, ELTE Eötvös Kiadó.

Schedule:

Lectures:

1st week. Division of the different habitats and water yields. All the student's need to recognize different habitat and water yield, in case of an example. 10

2nd week. Have to distinguish the different parts of the water body. Discussion about their functions.

3rd week. Division of the Hungarian standing water types. Every student needs to differentiate water body. 10

4th week. Space of living and their main organisms.

5th week. Isolation of the different types of eutrophication and their main consequences. All the students need to discuss about the trophy.

6th week. Categorization of an example water body based on halobity.

7th week. Categorization of an example water body based on saprobity.

8th week. Categorization of an example water body based on toxicity.

9th week. Analyzing water bodies with data series. Monomythic, dimictic, polymictic, oligomictic, amictic lakes.

10th week. Measurement of different chemical parameter of a standing water.

11th week. Analyses of characteristic fish groups of standing water based on data series andtheir water quality aspects.

12th week. Analyses of typical macroinvertebrates community of standing waters based ondata series and their water quality aspects.

13th week. Investigation of the physical, chemical and biological characteristics that characterizethe different water quality status of water bodies.

14th week. Grade-offering exam.

Requirements:

Practice:

Participation at classes is compulsory. A student must attend the courses and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

During the semester there is one practical test. It can be completed in the 14th week.

The minimum score is 50%. Based on the score of the test, the grade for the test is given accordingto the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-72	satisfactory (3)
73-84	good (4)
85-100	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. habil. Istvan Grigorszky, associate professor, PhD

Lecturer: Dr. Csaba Berta, research assistant fellow, PhD

Title of course: Wetland ecology **Code**: TTHME9216_EN	**ECTS Credit points: 3**

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 64 hours

Total: 120 hours

Year, semester: 1st year, 1st semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

Students will be provided with state-of-the-art basic knowledge of wetland flora and fauna and ecology. The course emphasizes wetlands functions and values in an ecosystem perspective. Both saltwater and freshwater wetlands will be addressed in the course. The relationship of wetlands to adjacent terrestrial and deep water habitats, along with wetlands succession and dynamics will be discussed.
This course provides instruction in the following topics: wetland hydrology; wetland vegetation; major faunal populations associated with wetlands; wetland plant and animal communities, ecosystem relationships, and dynamic processes; wetland classification systems, principles of wetlands ecology and dynamics; evaluation of wetland functions; overview of wetland development, restoration, and constructed wetlands.

Literature

Compulsory:

1. Mitsch,W.J. ,J.G.Gosselink, C.J.Anderson and L.Zhang. (2009): Wetland Ecosystems, John Wiley & Son, Inc., NewYork.
2. Wright, W. and J. Gosselink (2007):Wetlands, John Wiley & Sons, Inc.
3. Keddy P.A. (2010): Wetland Ecology Principles and Conservation, Cambridge University Press

Schedule:

1st week. Definition of wetland. Wetland functions: hydrologic processes, water quality improvement,wildlife habitat. Productivity of wetlands.

2nd week. Classification of wetland systems. Freshwater and coastal wetlands.

3rd week. Formation, chemistry, and biology of wetland soils. Soil forming factors. Features of hydric soils, horizonization. Types of wetland soils.

4th week. Organic vs inorganic soils. Redox reactions, carbon , phosphorous, sulfur and nitrogen transformations in the wetland soils.

5th week. Soil communities in wetlands, their importance in the formation and change of the soils. Biologicalindicator species and assemblages.

6th week. Vegetation and fauna of wetlands. The most important species and taxa.

7th week. Adaptations of plants to wetland environments: structural adaptations (aerenchyma, adventitious roots, stem elongation, lenticels, pneumatophores), physiological adaptations (anaerobicrespiration, malate production, carnivorous nutrition).

8th week. Adaptatation of animals to wetland environment. Adaptation to salt stress (osmoregulation) and anoxia. Necton adaptations. Estuarine-dependent life cycles. Importance of wetlands in the bird migration.

9th week. Wetlands as ecosystems. Trophic structures. Features of bio-geochemical cycles. Carbon cycle.

10th week. Nitrogen cycle (fixation, ammonification, immobilization, nitrification and denitrification). Phosphorus and sulphur cycles.

11th week. Primer and seconder production in wetlands. Productivity of different types of wetlands.

12th week. The Ramsar Convention on Wetlands. Key features of the Ramsar Convention.

13th week. Wetland and landscape. Restoration of wetlands. Constructed wetlands

14th week. Consultation or exam

Requirements:

- for a signature

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. In case of further absences, a medical certificate needs to be presented.

- for a grade

The course ends in an written **examination**. 2 (Pass) Grade: 50% of the maximum points available. If the score of any test is below 50%, students can take a retake test.

-an offered grade:

There are at least two test during the semester, and the offered grade is the average of them.

Person responsible for course: Dr. Imre Somlyai, assistant professor, PhD

Lecturer: Dr. Imre Somlyai, assistant professor, PhD

Title of course: Wetland ecology **Code**: TTHMG9216_EN	**ECTS Credit points: 2**

Type of teaching, contact hours

- lecture: -
- practice: 1 hours/week
- laboratory: -

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:

- lecture: -
- practice: 14 hours
- laboratory: -
- home assignment: 16 hours
- preparation for the exam: -

Total: 30 hours

Year, semester: 1st year, 1st semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

Students will be provided with state-of-the-art basic knowledge of wetland flora and fauna and ecology. The course emphasizes wetlands functions and values in an ecosystem perspective. Both saltwater and freshwater wetlands will be addressed in the course. The relationship of wetlands to adjacent terrestrial and deep water habitats, along with wetlands succession and dynamics will be discussed.
This course provides instruction in the following topics: wetland hydrology; wetland vegetation; major faunal populations associated with wetlands; wetland plant and animal communities, ecosystem relationships, and dynamic processes; wetland classification systems, principles of wetlands ecology and dynamics; evaluation of wetland functions; overview of wetland development, restoration, and constructed wetlands.

Literature

Compulsory:

1. Mitsch,W.J. ,J.G.Gosselink, C.J.Anderson and L.Zhang. (2009): Wetland Ecosystems, John Wiley & Son, Inc., NewYork.
2. Wright, W. and J. Gosselink (2007):Wetlands, John Wiley & Sons, Inc.
3. Keddy P.A. (2010): Wetland Ecology Principles and Conservation, Cambridge University Press

Schedule:

1st week. Importance of hydrologic processes (recharging and discharging wetlands). Importance of waterquality improvement.

2nd week. Discussing wetland types of student's country.

3rd week. Methods for analysis of soil structure and physical characteristics. The importance of soil gascontent.

4th week. Methods for analysis of soil chemical characteristics.

5th week. Methods for investigating of soil fauna and flora.

6th week. Showing the most important plant and animal taxa according to the wetland types.

7th week. Presentation of structural and physiological adaptations of plants.

8th week. Definition of osmosis. Mechanisms of osmoregulation. Conformers and regulators.

9th week. Trophic structures of different wetland types. General features of bio-geochemical cycles. Energyflow int he ecosystems.

10th week. Adaptation of plants and animal to low nitrogen content.

11th week. Primer and secunder production in wetlands. Proctivity of different types of wetlands.

12th week. The Ramsar Convention on Wetlands. Key features of the Ramsar Convention.

13th week. Wetland and landscape. Restoration of wetlands. Constructed wetlands

14th week. Consultation

Requirements:

- for a signature

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. In case of further absences, a medical certificate needs to be presented.

- for a grade

The course ends in an written **examination**. 2 (Pass) Grade: 50% of the maximum points available. If the score of any test is below 50%, students can take a retake test.

-an offered grade:

There are at least two test during the semester, and the offered grade is the average of them.

Person responsible for course: Dr. Imre Somlyai, assistant professor, PhD

Lecturer: Dr. Imre Somlyai, assistant professor, PhD

Title of course: Water Resource Management **Code**: TTHME9213_EN	**ECTS Credit points: 3**

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 64 hours

Total: 120 hours

Year, semester: 1st year, 2 nd semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

The course aims to enhance understanding of the multi-scale interconnections between water management, environmental and socioeconomic issues. In particular, it considers multidisciplinary approaches to water management problems. Students will learn the basic concepts of hydrology and water resource, like water properties, hydrological cycle, sources of water and water balance calculation, impacts of population, urbanization, agriculture and climate change on water. Also, to explore the linkages between water and human health.
Examples and case studies will be used to illustrate the water management, drawing on perspectives from both the natural and social sciences. Topics will be covered through lectures from a range of contributors, investigation of case-studies and small group work.

Literature

1. Loucks D. P., van Beek E., Stedinger J, R., Dijkman J. P.M., Villars M. T. (2005): Water Resources Systems Planning and Management: An Introduction to Methods, Models and Applications. UNESCO Paris,
2. Hussey K. (2011): Water Resources Planning and Management. Cambridge University Press
3. Wurbs R. (2013): Water Resources Planning and Management. InTech

Schedule:

Lectures:

1st week. Basics of water management. Its specializations, water balance and damage prevention.

2nd week. Wastewater management and global water scarcity. Ground waters, aquifer protection.

3rd week. The purpose, significance and conditions of irrigation.

4th week. Water Framework Directive

5th week. Erosion, slopes, harmful water surplus.

6th week. Natural disasters

7th week. Surface waters

8th week. Water and climate change: challenges for the 21st century - Problems and Solutions. Roleof engineering in sustainable water management

9th week. Managing Floods – Dams, Mobile Dams; Mobile flood walls; Strategies for ManagingSea Level Rise; Barriers

10th week. Flood Risk Reduction; Managing Risk

11th week. Sediments; Processes and Modelling Assumptions; Sedimentation, Bed Shear Stress

12th week. Urban Water Systems: Drinking Water, Wastewater, Urban Drainage

13th week. Lakes and Reservoirs; Downstream Characteristics

14th week. Hydroelectric Power Production

Requirements:
Lecture:

The minimum requirement for the examination is 50% from the midterm and closing tests. Based on the summarized score of the test the grade for the examination is given according to the following table:

Score	Grade
0-49%	fail (1)
50-59%	pass (2)
60-72%	satisfactory (3)
73-84%	good (4)
85-100%	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Herta Czédli, associate professor, PhD

Lecturer: Dr. Herta Czédli, associate professor, PhD, Dr. Csaba Berta, research assistant fellow, PhD

Title of course: Water Resource Management **Code**: TTHMG9213_EN	**ECTS Credit points: 2**

Type of teaching, contact hours

- lecture: -
- practice: 1 hours/week
- laboratory: -

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:

- lecture: -
- practice: 14 hours
- laboratory: -
- home assignment: 16 hours
- preparation for the exam: -

Total: 30 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

The course aims to enhance understanding of the multi-scale interconnections between water management, environmental and socioeconomic issues. In particular, it considers multidisciplinary approaches to water management problems. Students will learn the basic concepts of hydrology and water resource, like water properties, hydrological cycle, sources of water and water balance calculation, impacts of population, urbanization, agriculture and climate change on water. Also, to explore the linkages between water and human health.
Examples and case studies will be used to illustrate the water management, drawing on perspectives from both the natural and social sciences. Topics will be covered through lectures from a range of contributors, investigation of case-studies and small group work.

Literature

1. Loucks D. P., van Beek E., Stedinger J, R., Dijkman J. P.M., Villars M. T. (2005): Water Resources Systems Planning and Management: An Introduction to Methods, Models and Applications. UNESCO Paris,

2. Hussey K. (2011): Water Resources Planning and Management. Cambridge University Press

3. Wurbs R. (2013): Water Resources Planning and Management. InTech

Schedule:

Lectures:

1st week. The practical usage of Salamin Pál's water equation for the calculation of the water balance.

2nd week. Calculation of quantitative water supply in global scale based on data series.

3rd week Practice-oriented insight for the different irrigation systems.

4th week. All of the students must categorize an example water body in case of the EU Water Framework Directive.

5th week. Wischmeier-Smith soil loss factor calculation under different regions of the world (usage o data series).

6th week. Students task: find those natural disasters that are caused by water directly and has a connected affect to their own country.

7th week. The assessment of the characteristics of surface waters mainly focusing on the water supply systems. Make of a comprehensive study.

8th week. The Resource Types, their Uses and Pressure

9th week. The Governance of Common Goods. Between the State and the Marketplace

10th week. Case study I: Community Water Management in Europe

11th week. Case study II: Community Water Management in North-America

12th week. Case study III: Community Water Management in Latin America

13th week. Case study IV: Community Water Management in Africa

14th week. Case study V: Community Water Management in Asia

Requirements:

Lecture:

The minimum requirement for the examination is 50% from the midterm and closing tests. Based on the summarized score of the test the grade for the examination is given according to the following table:

Score	Grade
0-49%	fail (1)
50-59%	pass (2)
60-72%	satisfactory (3)
73-84%	good (4)
85-100%	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Herta Czédli, associate professor, PhD

Lecturer: Dr. Herta Czédli, associate professor, PhD, Dr. Csaba Berta, research assistant fellow, PhD

Title of course: Aquatic Toxicology **Code**: TTHME9207_EN	**ECTS Credit points: 3**

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 64 hours

Total: 120 hours

Year, semester: 1th year, 2nd semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

The discipline of aquatic toxicology aims to study the mode and mechanisms of entry of these pollutants into the aquatic ecosystem. Also elucidate the potential impacts, hazards and risks. Investigate the health of individual organisms and the community structures they inhabit. The complexity of the effluents in aquatic systems presents a number of challenges to the toxicologist. The course will discuss some of the different chemical and biological pollutants and these analytical strategies that have been used for water quality assessment and will discuss some of their strengths and limitations in terms of being able to accurately quantify the various physico/chemical species of the pollutant. The course will also discuss the interpretational complexities resulting from synergistic and antagonistic effects between chemicals.

Literature

1. Mikko Nikinmaa (2014) An Introduction to Aquatic Toxicology. Elsevier: USA
2. Ernest Hodgson (Editor) (2010) A Textbook of Modern Toxicology, 4th Edition. John Wiley & Sons, Inc.: USA
3. http://www.oecd.org/env/ehs/testing/more-about-oecd-test-guidelines.htm

Schedule:

1st week. Introduction to toxicology: the history, disciplines and main principles (hazard, risk, exposure, tolerance, toxicity, toxicity end points, threshold, adverse effect, dose) are discussed in this section.

2nd week. The values determined in ecotoxicology: EC/ED, IC/ID, LC/LD, NOEL, NOEC, NOAEL, NOAEC, LOEL, LOEC, LOAEL, maximum allowable concentration (MAC), maximum tolerated dose (MTD). The dose-effect and dose-response relationships are explained through an example. Bioelimination and biodegradation processes.

3rd week. Correlation among bioconcentration, bioaccumulation and biomagnification. Persistence,

examples for persistent inorganic/organic pollutants.

4th week. Governmental agencies of regulatory toxicology as well as biological indicators, biomarkers, and biological monitoring are discussed. Processes of ecological risk assessment: problem formulation,analysis, risk characterization, risk management, data acquisition and monitoring.

5th week. Toxicokinetics of aquatic pollutants: toxicokinetic compartment models, quantitative structure- activity relationship (QSAR). Uptake, distribution, metabolism and excretion of compounds.

6th week. Bioavailability: the characteristics of pharmacological and environmental bioavailability. Abiotic and biotic factors. Octanol/water coefficient (K_{ow}).

7th week. Biotransformation of organic compounds, the principles of detoxification: phase I and phase II enzymes. Complex formation of metals with metallothioneins and phytochelatins.

8th week. Application of genomics (microarray, qPCR), proteomics (2D GE, MS) and metabolomics (NMR, MS). Genotoxicity, carcinogenesis, teratogenicity, neurotoxicity, effects on reproduction and behaviour, oxidative stress.

9th week. Toxicity bioassays, tests according to OECD guidelines. Acute and chronic testing. Growth inhibition (algal, plant) tests, Daphnia acute immobilisation and reproduction tests, Fish embryo acute toxicity (FET) tests, Microtox. Microcosm and mesocosm model ecosystems. Factors in testdesigning: selecting test species, environment (salinity, pH, temperature, O_2).

10th week. Eutrophication: factors and consequences. Harmful algal blooms, cyanotoxins and other cyanobacterial secondary metabolites. Control of algal blooms, biomanipulation by the alteration of food web.

11th week. Inorganic pollutants in water and sediment: metals - copper, lead, mercury, cadmium, chroTmium,arsenic, zinc, aluminium, iron. Organometallic compounds. The main sources and adverse effectson aquatic species are discussed.

12th week. Organic pollutants in water and sediment: oil, pesticides (herbicides, insecticides, fungicides), endocrine-disruptors (detergents, personal hygiene compounds, human and veterinary drugs), paper and pulp-mill wastewater, halogenated organic compounds (PCBs, dioxin, PBBs, TBBPA),PAH, ionic liquids, nanomaterials, nano and microplastics. The main sources and adverse effects on aquatic species are discussed.

13th week. Wastewater treatment processes: primary, secondary and tertiary treatment. Disinfection steps forgenerating household water. Sludge treatment (anaerobic, aerobic processes). Phytoremediation. Constructed wetlands: ecological role of plants, microorganisms and animals used in CWs.

14th week. Presentations of the students. Overview and summary of semester.

Requirements:

- *for a signature*

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will notbe signed and the student must repeat the course. A student can't make up any practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented.Missed practice classes should be made up for at a later date, to be discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments of the course to each practice class. Active participation is evaluated by the teacher in every class. If a student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.

Students have to submit all the two designing tasks as scheduled minimum on a sufficient level.

During the semester there are two tests: the mid-term test in the 8th week and the end-term test in the 15th week. Students have to sit for the tests

- for a grade

The course ends in an examination. Based on the average of the grades of the designing tasks and the examination, the exam grade is calculated as an average of them:

- the average grade of the two designing tasks
- the result of the examination

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

-an offered grade:

it may be offered for students if the average grade of the two designing tasks is at least satisfactory

(3) and the average of the mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of them.

Person responsible for course: Prof. Dr. habil. Gábor Vasas, university professor, Dsc

Lecturer: Prof. Dr. habil. Gábor Vasas, university professor, Dsc

Title of course: Aquatic Toxicology laboratory practice **Code**: TTHML9207_EN	**ECTS Credit points: 2**

Type of teaching, contact hours

- lecture: -
- practice: -
- laboratory: 1 hours/week

Evaluation: mid-semester grade grade

Workload (estimated), divided into contact hours:

- lecture: -
- practice: -
- laboratory: 14 hours
- home assignment: 16 hours
- preparation for the exam: -

Total: 30 hours

Year, semester: 1st semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

Testing potential water contaminants using ecotoxicological tests: algae test, seedling test, Daphnia test. The effect of the toxic substance on growth, physiological processes (nutrition, movement / behavior). Calculation of EC_{50} and LD_{50}. Possibilities for detection of contaminants: classical or instrumental analytical methods. Evaluation of toxicological tests, toxicology based risk assessment. Possibilities to remove toxic substances.

Literature

1. Gary M. Rand (1995): Fundamentals Of Aquatic Toxicology: Effects, Environmental Fate And Risk Assessment, ISBN: 1560320915 / 9781560320913
2. Mikko Nikinmaa (2014) An Introduction to Aquatic Toxicology ISBN: 978-0-12-411574-3
3. Ernest Hodgson (2004)A Textbook of Modern Toxicology, Third Edition ISBN: 9780471265085

Schedule:

1st week. Testing potential water pollutants by algae test I: testing systems with different algae. Sampling, determining initial density in cultures.

2nd week. Testing potential water pollutants by algae test II: measurement of growth, establishmentof growth inhibition, calculation of EC_{50}.

3rd week. Testing potential water pollutants by algae test III: studying the impact of the potential pollutant on algae biomass and organic matter production.

4th week. Testing potential water pollutants by algae test IV: studying the effect of potential pollutant on nutrient uptake (phosphate, nitrate) of algae.

5th week. Testing potential water pollutants by seedling test I: assembling of test systems with seedlings.

6th week. Testing potential water pollutants by seedling test II: calculation of germinationpercentage and the extent of growth inhibition.

7th week. Testing potential water pollutants by Daphnia test I: assembling of test systems with daphnids.

8th week. Testing potential water pollutants by Daphnia test II: observation of immobility or mortality. Calculation of LD_{50}.

9th week. Evaluation of toxicological tests, toxicology based risk assessment.

10th week. Toxic component analysis I: classical analytical methods to test toxic substances(metals, inorganic micro-pollutants).

11th week. Toxic component analysis II: instrumental analytical methods for determination of toxic substances.

12th week. Possibilities to remove toxic materials I: mechanical methods.

13th week. Possibilities to remove toxic materials II: physico-chemical methods.

14th week. Possibilities to remove toxic materials I: biological methods.

Requirements:

- for a signature

Participation at laboratory practices is compulsory. A student must attend the laboratory practices and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

- for a grade

During the semester there will be short written tests on every practice, reports should be prepared after every topic. The final grade will be the average of the grades of written tests and reports.

Person responsible for course: Dr. habil. István Bácsi, associate professor, PhD

Lecturer: Dr. habil. István Bácsi, associate professor, PhD

Title of course: Paleohydrobiology **Code**: TTHME9211_EN	**ECTS Credit points: 3**

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 64 hours

Total: 120 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s):

Further courses built on it: -

Topics of course

This course will introduce the students to analyses the relationships between zooplankton remains and an ancient lake history. Sampling and data collections methods, problems and solutions. Sediment collecting and analysing. Laboratory methods using for analyses different lake sediments. Geochemical analyses. Dating using ^{137}Cs, ^{210}Pb and radiokarbon methods. Subfossil remains responses to climate changes. Verification of lake level changes using subfossil remains.Effects of environmental pollutions in diversity and abundance. Problems of bioturbations. Statistical analyses of results.

Literature

Compulsory:

1. Binford, M. W., Deevey, E. S. 1983: Paleolimnology: An Historical Perspective on LacustrineEcosystems. Ann. Rev. Ecol. Syst. 14: 255-286.
2. Bjorn, E. Berglund (ed.) 2003: Handbook of Holocene Palaeoecology and Palaeohydrology.The Blackburn Press, 869 pp.
3. Last, W.M. and Smol, J.P. (eds) 2001: Tracking Environmental Change Using Lake Sediments
4. Volume 1 Basin analysis, coring and chronological techniques
5. Smol, J.P., Birks, H.J.B., Last, W.M. (eds) 2001: Tracking Environmental Change Using LakeSediments - Volume 4 Zoologial indicators

Schedule:

1st week. What is paleolimnology? Paleo and neoecology. Aims of Hungarian and International researches.

2nd week. Main objects of paleohydrobiology. Differences of methods in stagnant and running waters.

3rd week. Sediment sampling methods. Soft and hard sediment catchers. Sample size and physical parameters of a sediment column.

4th week. Dating: radiocarbon and cesium dating. Dendrocronology, pollen and spore analysing.

5th week. Subfossil remains in sediments I. Algees plant remains and fungis.

6th week. Subfossil remains in sediments II. Molluscs, amoebas, ostracods and fishes.

7th week. Subfossil remains in sediments III. Rotifers and Cladocerans.

8th week. Effects of climate change and antropogenic impacts in paleolimnology.

9th week. Verify the climate change using stabile isotopes, geochemistry as a paleolimnology method.

10th week. Importance of paleolimnology in environmental protection.

11th week. Sediment sampling, soil deposit and soil erosion. Effects of a river flood.

12th week. Statistical methods in paleolimnology. Main component analysing. Non-metric multidimensionalscaling. canonical correspondence analysis.

13th week. Demonstration of environmental pollution. Heavy metals in sediments.

14th week. Case-studies.

Requirements:

- for a signature

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will notbe signed and the student must repeat the course. A student can't make up any practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented.Missed practice classes should be made up for at a later date, to be discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments of the course to each practice class. Active participation is evaluated by the teacher in every class. If a student's behavioror conduct doesn't meet the requirements of active participation, the teacher may evaluate his/herparticipation as an absence because of the lack of active participation in class.

Students have to **submit all the two designing tasks** as scheduled minimum on a sufficient level.

During the semester there are two tests: the mid-term test in the 8th week and the end-term test in the 15th week. Students have to sit for the tests

- for a grade

The course ends in an **examination**. Based on the average of the grades of the designing tasks and the examination, the exam grade is calculated as an average of them:

- the average grade of the two designing tasks
- the result of the examination

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

- Score Grade
- 0-59 fail (1)
- 60-69 pass (2)
- 70-79 satisfactory (3)
- 80-89 good (4)
- 90-100 excellent (5)
- If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.
- -an offered grade:
- it may be offered for students if the average grade of the two designing tasks is at least satisfactory

- (3) and the average of the mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of them.
Person responsible for course: Dr. István Gyulai, assistant professor, PhD
Lecturer: Dr. István Gyulai, assistant professor, PhD; Dr. Csaba Berta, research assistant fellow, PhD

Title of course: Paleohydrobiology **Code**: TTHMG9211_EN	**ECTS Credit points: 2**

Type of teaching, contact hours

- lecture: -
- practice: 1
- laboratory: -

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:

- lecture: 14 hours
- practice: -
- laboratory: -
- home assignment: 16 hours
- preparation for the exam:

Total: 30 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s):

Further courses built on it: -

Topics of course

This course will introduce the students to analyses the relationships between zooplankton remains and an ancient lake history. Sampling and data collections methods, problems and solutions. Sediment collecting and analysing. Laboratory methods using for analyses different lake sediments. Geochemical analyses. Dating using ^{137}Cs, ^{210}Pb and radiokarbon methods. Subfossil remains responses to climate changes. Verification of lake level changes using subfossil remains.Effects of environmental pollutions in diversity and abundance. Problems of bioturbations. Statistical analyses of results.

Literature

Compulsory:

1. Andrew, S. Cohen 2003: Paleolimnology: The History and Evolution of Lake Systems. OxfordUniversity Press, 528 pp.
2. Binford, M. W., Deevey, E. S. 1983: Paleolimnology: An Historical Perspective on LacustrineEcosystems. Ann. Rev. Ecol. Syst. 14: 255-286.
3. Bjorn, E. Berglund (ed.) 2003: Handbook of Holocene Palaeoecology and Palaeohydrology.The Blackburn Press, 869 pp.
4. Last, W.M. and Smol, J.P. (eds) 2001: Tracking Environmental Change Using Lake Sediments
5. Volume 1 Basin analysis, coring and chronological techniques
6. Smol, J.P., Birks, H.J.B., Last, W.M. (eds) 2001: Tracking Environmental Change Using LakeSediments - Volume 4 Zoologial indicators

Schedule:

1st week. Soft sediment sampling using Hargrave type sampler and gravity corer.

2nd week. Core sampling using Kajak and Russian type samplers.

3rd week. Sliceing of a soft sediment coloumn.

4th week. Sliceing of a hard long sediment coloumn.

5th week. Loss of ignition method for determinating organic material content.

6th week. Loss of ignition method for determinating carbonate content.

7th week. Destruction of organic material content using Potassium Hydroxide.

8th week. Destruction of carbonate content using Hidrogene Cloride.

9th week. Exploration of Cladoceran remains in sediments.

10th week. Exploration of macroscopic invertebrates remains in sediments.

11th week. Sediment exploration for geochemical measurements.

12th week. Microscopic session I. Cladoceran remains analysing.

13th week. Microscopic session II. macroscopic invertebrates remains analysing.

14th week. Case-studies of reconstructions using microscopic remains.

Requirements:

- for a signature

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will notbe signed and the student must repeat the course. A student can't make up any practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented.Missed practice classes should be made up for at a later date, to be discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments of the course to each practice class. Active participation is evaluated by the teacher in every class. If a student's behavioror conduct doesn't meet the requirements of active participation, the teacher may evaluate his/herparticipation as an absence because of the lack of active participation in class.

Students have to **submit all the two designing tasks** as scheduled minimum on a sufficient level.

During the semester there are two tests: the mid-term test in the 8th week and the end-term test in the 15th week. Students have to sit for the tests

- for a grade

The course ends in an **examination**. Based on the average of the grades of the designing tasks and the examination, the exam grade is calculated as an average of them:

- the average grade of the two designing tasks
- the result of the examination

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

- Score Grade
- 0-59 fail (1)
- 60-69 pass (2)
- 70-79 satisfactory (3)
- 80-89 good (4)
- 90-100 excellent (5)
- If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.
- -an offered grade:
- it may be offered for students if the average grade of the two designing tasks is at least satisfactory
- (3) and the average of the mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of them.

Person responsible for course: Dr. István Gyulai, assistant professor, PhD
Lecturer: Dr. István Gyulai, assistant professor, PhD; Dr. Csaba Berta, research assistant fellow, PhD

Title of course: Water Quality Monitoring **Code**:TTHME9212_EN	**ECTS Credit points: 3**

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 64 hours

Total: 120 hours

Year, semester: 3rd semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

During the course the participant should be able to understand and apply: (i) concepts of water quality and pollution processes in various standing and running water types; (ii) apply the different steps of the monitoring cycle in rivers and lakes; (iii) the basic concepts of groundwater quality and monitoring; (iv) apply common statistical techniques for water quality data evaluation; (v) design sustainable freshwater quality monitoring and assessment programmes under specified conditions; (vi) the entire thought process that underlies the planning of an environmentalmonitoring effort and receive systematic planning tools, templates, checklists, labor and budget spreadsheets for use in any future monitoring work.

Literature

1. Bartram J. and Ballance Water Quality Monitoring (1996): A practical guide to the design and implementation of freshwater quality studies and monitoring programmes. United Nations Environment Programme.
2. Ward, R.C., Loftis J. C., Graham B. (2003) Design of Water Quality Monitoring Systems. John Wiley and Sons.
3. Nilgun B., HarmanciogluO., Fistikoglu S.D., Ozkul Vijay Singh M.N., Alpaslan (1999): Water Quality Monitoring Network Design. Springer-Science, Business Media

Schedule:

1st week. Water qualification as a claim and need. The concept of quality and goodness. The historyof water qualification: international and national overview.

2nd week. The ecological indication, indicators. The ethological and ecological sides of theecological water quality.

3rd week. The main types of studies on the basis of the ecological water qualification (taxonomic and occurrence characteristics, coexistential relations, associations).

4th week. Characteristics of biological and ecological based quality assessments. Survey, surveillance and monitoring.

5th week. Assessment of water bodies from nature conservation and environmental protection pointof views. Three-phase workflow for status assessment (status survey, status evaluation, status qualification). Main time, equipment, cost and expertise features of the three work phases.

6th week. European Union (EU) Water Framework Directive (WFD). Internal regulation, policy building and application of the EU. The basic objectives of WFD.

7th week. Obligations of EU member states in relation to surface and groundwater bodies. Separation of natural, highly modified and artificial water bodies.

8th week. Interpretation of the ecological status / potential for the WFD. Determination of the ecological state / potential and the reference state and the meaning of maximum ecological potential.

9th week. Interpretation of the chemical status for the WFD. Determining the chemical state, the factors and indicators preferred by the WFD. Classification of ecological status / potential and chemical state.

10th week. Organism groups preferred by the WFD I: Phytoplankton sampling criteria, sample storage, preparation and data evaluation methods.

11th week. Organism groups preferred by the WFD II: Phytobenthone sampling criteria, sample storage, preparation and data evaluation methods.

12th week. Organism groups preferred by the WFD III: Sampling methods for macroscopic aquatic invertebrate fauna, sample and data processing.

13th week. Organism groups preferred by the WFD IV: Sampling methods for fish fauna, sample and data processing.

14th week. Coordination of chemical and different biological results, practical questions of qualification.

Requirements:

- for a signature

Attendance at lectures is highly recommended, but not compulsory.

- for a grade

During the semester there will be no written tests, there will be an oral exam in the exam period.

Person responsible for course: Dr. habil. István Bácsi, associate professor, PhD

Lecturer: Dr. habil. István Bácsi, associate professor, PhD;
Dr. István Gyulai, assistant professor, PhD

Title of course: Water Quality Monitoring **Code**: TTHMG9212_EN	**ECTS Credit points: 2**

Type of teaching, contact hours

- lecture: -
- practice: -
- laboratory: 1 hours/week

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:

- lecture: -
- practice: -
- laboratory: 14 hours
- home assignment: 16 hours
- preparation for the practices: -

Total: 30 hours

Year, semester: 3rd semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

During the practice the students gain experience in the methods of measuring physical and chemical parameters important in water qualification, they will know the methods of sampling andsample processing, gain insights into the qualification of data obtained from sample processing and to the quality of the given water body.

Literature

1. Bartram J. and Ballance Water Quality Monitoring (1996): A practical guide to the design and implementation of freshwater quality studies and monitoring programmes. United Nations Environment Programme.
2. Ward, R.C., Loftis J. C., Graham B. (2003) Design of Water Quality Monitoring Systems. John Wiley and Sons.
3. Nilgun B., HarmanciogluO., Fistikoglu S.D., Ozkul Vijay Singh M.N., Alpaslan (1999): Water Quality Monitoring Network Design. Springer-Science, Business Media

Schedule:

1st week. Measurement of physical and chemical parameters of water samples (using different typesof multimeters).

2nd week. Measurement of chemical parameters of a water sample in laboratory I (chloride, calcium, magnesium).

3rd week. Measurement of chemical parameters of a water sample in laboratory II (alkalinity, acidity).

4th week. Measurement of chemical parameters of a water sample in laboratory III (iron and manganese).

5th week. Measurement of inorganic nutrient content of water samples I: Nitrogen forms (ammonium, nitrite, and nitrate).

6th week. Measurement of inorganic nutrient content of water samples II: phosphorous; chlorophyll-content as an indicator of inorganic nutrient richness.

7th week. Qualification of the sampled water body using the parameters measured up to now basedon Biological Water Quality Assesment and Hungarian Standard MSZ 12749.

8th week. Qualification of the sampled water body using the parameters measured up to now according to EU WFD.

9th week. Qualification of a given water body based on phytoplankton and phytobenthos data according to EU WFD.

10th week. Qualification of a given water body based on macrophyte data according to EU WFD.

11th week. Qualification of a given water body based on macroinvertebrate data according to EU WFD.

12th week. Qualification of a given water body based on fish data according to EU WFD.

13th week. Comparing the different water qualification systems, discussing the phenomena behindthe differences in quality results.

14th week. Consultation.

Requirements:

- for a signature

Participation at laboratory practices is compulsory. A student must attend the laboratory practices and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

- for a grade

During the semester there will be short written tests on every practice, reports should be prepared after every topic. The final grade will be the average of the grades of written tests and reports.

Person responsible for course: Dr. habil. István Bácsi, associate professor, PhD

Lecturer: Dr. habil. István Bácsi, associate professor, PhD;
Dr. István Gyulai, assistant professor, PhD

Title of course: European Water Framework Directive **Code**: TTHME9218_EN	**ECTS Credit points: 3**

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 64 hours

Total: 120 hours

Year, semester: 2nd year, 2nd semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

This course will introduce the students to monitoring and assessment in the context of the Water Framework Directive. The course focused on the monitoring obligations and most recent assessment criteria of chemical and ecological status in the context of the water framework directive 2000/60/EC. Emerging topics such as the water quality indicators, ecological status assessment of surface waters and the water reuse in the EU. To acquaint participants with the principles and techniques used in fresh water quality description, monitoring and assessment.

Literature

1. Kaika, M. (2003). The Water Framework Directive: A New Direct ive for a Changing Social, Political and Economic European Framework. European Planning Studies, 11 (3).
2. The Water Framework Directive 2000/60/EK
3. Furse M.T, Hering D., Brabec K., Buffagni A., Sandin L., Verdonschot P.F.M. (eds), (2006) The Ecological Status of European Rivers. Hydrobiologia 566. Kluvier.
4. European Environmental Bureau RSPB and Pond Conservation. 2006. European Environmental NGO Technical Review of the Water Framework Directive Intercalibration Process. http://www.eeb.org/activities/water/200609-NGO-review-WFD-Intercalibration.pdf

Schedule:

Lectures:

1st week. Introduce the qualification systems of water bodies.

2nd week. Description and characterization of types of surface water bodies.

3rd week. Theoretical basics of the EU Water Framework Directive.

4th week. Introduce the cornerstones of creation, relevance and priority of the EU Water Framework Directive.

5th week. Interpretation of the stated goals and definitions.

6th week. General aspects of the EU Water Framework Directive.

7th week. Hydrogeology, physical, physicochemical and chemical aspects of the EU Water Framework Directive.

8th week. Process of the reference conditions for different types of surface water bodies.

9th week. Detail of the elements of water quality for classification of ecological status.

10th week. Impacts of human activities on groundwater.

11th week. Monitoring of the status of surface and ground waters.

12th week. Monitoring of the status of protected water bodies.

13th week. Responsibilities of the government administration with commitment of EU Water Framework Directive and their interests of environmental and nature conservation.

14th week. Grade-offering exam.

Requirements:
Lecture:

The minimum requirement for the examination is 50% from the midterm and closing tests. Based on the summarized score of the test the grade for the examination is given according to the following table:

Score	Grade
0-49%	fail (1)
50-59%	pass (2)
60-72%	satisfactory (3)
73-84%	good (4)
85-100%	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Krisztián Nyeste, assistant professor, PhD

Lecturer: Dr. Krisztián Nyeste, assistant professor, PhD

Title of course: European Water Framework Directive **Code**: TTHMG9218_EN	**ECTS Credit points: 2**

Type of teaching, contact hours

- lecture: -
- practice: 1 hours/week
- laboratory: -

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:

- lecture: -
- practice: 14 hours
- laboratory: -
- home assignment: 16 hours
- preparation for the exam: -

Total: 30 hours

Year, semester: 2nd year, 2nd semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

This course will introduce the students to monitoring and assessment in the context of the Water Framework Directive. The course focused on the monitoring obligations and most recent assessment criteria of chemical and ecological status in the context of the water framework directive 2000/60/EC. Emerging topics such as the water quality indicators, ecological status assessment of surface waters and the water reuse in the EU. To acquaint participants with the principles and techniques used in fresh water quality description, monitoring and assessment.

Literature

1. Kaika, M. (2003). The Water Framework Directive: A New Direct ive for a Changing Social, Political and Economic European Framework. European Planning Studies, 11 (3).
2. The Water Framework Directive 2000/60/EK
3. Furse M.T, Hering D., Brabec K., Buffagni A., Sandin L., Verdonschot P.F.M. (eds), (2006) The Ecological Status of European Rivers. Hydrobiologia 566. Kluvier.
4. European Environmental Bureau RSPB and Pond Conservation. 2006. European Environmental NGO Technical Review of the Water Framework Directive Intercalibration Process. http://www.eeb.org/activities/water/200609-NGO-review-WFD-Intercalibration.pdf

Schedule:

Lectures:

1st week. Hydrogeology and hydromorphology.

2nd week. Water physics and chemistry.

3rd week. Presentation about phytoplankton.

4th week. Presentation about phytobenthos.

5th week. Presentation about macrophytes.

6th week. Presentation about macroinvertebrates.

7th week. Presentation about fishes.

8th week. Field measurement methods.

9th week. Laboratory measurement methods.

10th week. Applicability of toxicology.

11th week. Usage of microscope.

12th week. Sample processing and evaluation of results I.

13th week. Sample processing and evaluation of results II.

14th week. Grade-offering exam.

Requirements:

Practice:

Participation at classes is compulsory. A student must attend the courses and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

During the semester there is one practical test. It can be completed in the 14th week.

The minimum score is 50%. Based on the score of the test, the grade for the test is given accordingto the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-72	satisfactory (3)
73-84	good (4)
85-100	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: : Dr. Krisztián Nyeste, Senior Lecturer, PhD

Lecturer: Dr. Krisztián Nyeste, Senior Lecturer, PhD

Title of course: Nature Conservation **Code**: TTHME9217_EN	**ECTS Credit points: 3**

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the practices: 64 hours

Total: 120 hours

Year, semester: 3rd semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

This course is designed to provide students a broad, interdisciplinary background for developing their understanding of environmental and resource problems and what sustainable solutions are needed to solve them. It also provides a solid foundation for the development of critical thinking skills. The program is designed to ensure that graduates possess broad-based, integrated knowledgeof how local and global ecological systems work as well as an understanding of the interdependency between people and the environment. Topics include current issues, management techniques, a history of the conservation movement in the Europe and some countries all over theworld as well as underlying principles of environmental conservation.

Literature

1. Alexander M. (2013): Management Planning for Nature Conservation: A Theoretical Basis &Practical Guide. Springer-Science, Business Media
2. Forbes S., Kendle T. (1997) Urban Nature Conservation: Landscape Management in the UrbanCountryside. Thompson Professional.

Schedule:

1st week. Preparation, training and outcome requirements, thematics and schedule, selected bibliography,aims and tasks of the course.

2nd week. Ecological background of nature conservation, background sciences. Connection of nature conservation, landscape protection and environmental protection, interdisciplinary connections.

3rd week. Development and history of conservation ecology, its place among biological sciences. Hierarchyof supra-individual systems, spatial and temporal patterns.

4th week. Ecological methods in nature conservation, landscape protection and environmental protection. Basics in conservation biology. Principles of nature conservation management,

management practice methods.

5th week. History and development of nature conservation. Early years, preservation of natural resources. From the first idea of conservation till the establishment of the first national park. Evolution of thenational institution of nature conservation from the first law on forests.

6th week. Nature conservation becoming independent. Establishment of the National Conservation Comittee. The role of science, forestry and social initiatives (ornithology) in the development of nature conservation.

7th week. The development of the modern nature conservation from the establishment of the first national park until the 1984 Act on nature conservation. Development of the network of national parks in Hungary, international background of the development.

8th week. Legal instruments in nature protection, development until nowadays. Nature protection categories.International conventions.

9th week. The nature conservation strategy of the European Union. EU Birds Directive and Habitats Directive. The Natura 2000 network and its regulations in Hungary.

10th week. Practice of nature conservation management, I. Preservation, conservation, rehabilitation, reconstruction and creation. The role of the natural disturbance processes in the maintenance of the biological diversity. Fragmentation and mosaic structures. Migration and natural re-populationprocesses.

11th week. Practice of nature conservation management, II. Wetland habitats, wetland management and restoration.

12th week. The significance of the landscape-scale approach in the nowadays nature conservation practice. Lanscsape-scale habitat restoration and reconstruction programmes.

13th week. Land-use and nature conservation conflicts. Nature conservation issues concerning agriculture areas.

14th week. Assessment.

Requirements:

- for a signature

Participation at laboratory practices is compulsory. A student must attend the laboratory practices and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

- for a grade

During the semester there will be short written tests on every practice, reports should be prepared after every topic. The final grade will be the average of the grades of written tests and reports.

Person responsible for course: Szilvai Gőri, ecologist

Lecturer: Szilvai Gőri, ecologist

Title of course: Nature Conservation **Code**: TTHMG9217_EN	**ECTS Credit points: 2**

Type of teaching, contact hours

- lecture: -
- practice: 1 hours/week
- laboratory: -

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:

- lecture: -
- practice: 14 hours
- laboratory: -
- home assignment: 16 hours
- preparation for the practices: -

Total: 30 hours

Year, semester: 3rd semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

The students understand the principle of international agreements that evolve with the developmentof environmental protection. Familiar with the main international conventions and their causes and inefficiency. Uunderstand the main contexts, directions, some of the basic common features of the environmental protection conventions, aspects of domestic international tasks.

Literature

1. Alexander M. (2013): Management Planning for Nature Conservation: A Theoretical Basis &Practical Guide. Springer-Science, Business Media
2. Forbes S., Kendle T. (1997) Urban Nature Conservation: Landscape Management in the UrbanCountryside. Thompson Professional.
3. Kratochwil A. (1999): Biodiversity in ecosystems: principles and case studies of differentcomplexity level. Springer-Science, Business Media
4. Primack, R. B. (1993): Essentials of Conservation Biology. Sinauer Associates, Sunderland,Massachusetts.
5. Shrader–Frechette, K. S., and McCoy, E. D. (1993): Method in ecology. Strategies for Conservation. Cambridge University Press, Cambridge, UK

Schedule:

1st-7th weeks. wetland habitats; types, threats, nature conservation management, rehabilitation; field work in the Hortobágy National Park.

8th-14th weeks. grassland habitats; types, threats, nature conservation management and land use; field work in the Hortobágy National Park.

Requirements:

- for a signature

Participation at laboratory practices is compulsory. A student must attend the laboratory practices and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

- *for a grade* During the semester there will be short written tests on every practice, reports should be prepared after every topic. The final grade will be the average of the grades of written tests and reports.
Person responsible for course: Szilvai Gőri, ecologist
Lecturer: Szilvai Gőri, ecologist

Title of course: Water Microbiology **Code**: TTHME9301_EN	**ECTS Credit points: 3**

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 64 hours

Total: 120 hours

Year, semester: Facultative from 2nd to 4th semester

Its prerequisite(s): General Hydrobiology; Water Chemistry

Further courses built on it: -

Topics of course

The course gives an overview of the organization, taxonomy (morphology, DNA and RNA based classification), evolution and ecology of bacteria and heterothrophic eukaryotes (protozoa and fungus-like organisms) from hydrobiological point of view. Activity of prokaryotic and heterothrophic eukaryotic microorganisms will be discussed on the basis of their role in nutrient cycles. The course shows the interactions among bacteria and between bacteria and eukaryotic microorganisms, deals with their roles in the life of aquatic habitats, furthermore, it introduces the formation and functions of biofilms.

Literature

1. Allison DG, Gilbert PL, Lappin-Scott HM, Wilson M (2000) Community Structure and co-operation in biofilms. Cambridge University Press, Cambridge, ISBN: 0-521- 79302- 5.
2. Sigee DC (2005) Freshwater Microbiology. John Wiley & Sons Inc., ISBN: 0-471-48529-2 3. Hausmann, K., Hülsmann, N., Radek, R. (2003) Protistology. E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart, ISBN: 3-510-65208-8
3. Patterson DJ (1996) Free-living Freshwater Protozoa: A Color Guide. Manson PublishingLtd., ISBN-10: 1874545405; ISBN-13: 978-1874545408
4. Cai L, Hyde KD, Tsui CKM (2014) Freshwater Fungi and Fungal-like Organisms. Walterde Greuter GmbH, Berlin/Boston, ISBN: 978-3-11-033345-9

Schedule:

1st week. Classification of life forms, status of microorganisms. The main groups of microorganisms, their phylogenetic relationships.

2nd week. The structure of the prokaryotic cell, its components: "nucleus", cytoplasm, ribosomes, plasmids, membrane, cell wall, flagellae, pili, seath.

3rd week. The most important nutrient cycle and ecological groups of bacteria, the main characteristics of their occurrence.

4th week. Influence of environmental factors on bacteria: temperature, pH, oxidation-reduction

potential and oxygen, pressure, salt concentration, light and radiation effects - phototoxicity, phototropism, chemical composition of the environment - chemotaxis.

5th week. The formation and structure of biofilm. Interactions of bacterial populations.

6th week. Structure of eukaryotic cell, itscomponents: Membranes, membrane systems; microfilaments, microtubules; centrioles and basal body; micro bodies; contractile vacuoles; extrusomes. The endosymbiont theory. The nucleus. The emergence of sexual reproduction.

7th week. Movement types among protozoans. Amoboid movement. The structure and function of the flagella and the cilia. Behavior movements. The nutrition of protozoans. Types of food intake: pinocytosis, phagocytosis. The path of the diet taken in the cell. Dietary preferences.

8th week. Impact of environmental factors on protozoans. Distribution, settling. Cyst formation and reactivation. Habitats of protozoans. Open water and protozoan plankton. Soil and moss protozoans. Special associations. Interactions of protozoans.

9th week. Practical significance of protozoans. Protozoans as water quality indicators. The role of protozoans in wastewater treatment.

10th week. Definition of the term "fungi". An overview of the structure of the eukaryotic fungus- like organisms.

11th week. Evolution of fungi in aquatic environments. Impact of environmental factors on growth, tolerance of extreme environmental conditions.

12th week. Organic nutrient-degrading communities of fungi - saprophytic fungi. Parasitic fungi: parasites of aquatic photosynthetic organisms (algae, plants) and animals.

13th week. The ecological role of fungi in lentic ecosystems. Fungal communities in watercourses. Mycorrhiza in aquatic habitats.

14th week. Consultation.

Requirements:

- for a signature

Attendance at lectures is highly recommended, but not compulsory.

- for a grade

During the semester there will be no written tests, there will be an oral exam in the exam period.

Person responsible for course: Dr. habil. István Bácsi, associate professor, PhD

Lecturer: Dr. habil. István Bácsi, associate professor, PhD

Title of course: Water Microbiology **Code**: TTHMG9301_EN	**ECTS Credit points: 2**

Type of teaching, contact hours

- lecture: -
- practice: 1 hours/week
- laboratory: -

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:

- lecture: -
- practice: 14 hours
- laboratory: -
- home assignment: 16 hours
- preparation for the exam: -

Total: 30 hours

Year, semester: Facultative from 2nd to 4th semester

Its prerequisite(s): General Hydrobiology; Water Chemistry

Further courses built on it: -

Topics of course

The course gives an overview of the organization, taxonomy (morphology, DNA and RNA based classification), evolution and ecology of bacteria and heterothrophic eukaryotes (protozoa and fungus-like organisms) from hydrobiological point of view. The main taxons, their main representatives and their ecological role in aquatic habitats.

Literature

1. Allison DG, Gilbert PL, Lappin-Scott HM, Wilson M (2000) Community Structure and co-operation in biofilms. Cambridge University Press, Cambridge, ISBN: 0-521- 79302- 5.
2. Sigee DC (2005) Freshwater Microbiology. John Wiley & Sons Inc., ISBN: 0-471-48529-2 3. Hausmann, K., Hülsmann, N., Radek, R. (2003) Protistology. E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart, ISBN: 3-510-65208-8
3. Patterson DJ (1996) Free-living Freshwater Protozoa: A Color Guide. Manson Publishing Ltd., ISBN-10: 1874545405; ISBN-13: 978-1874545408
4. Cai L, Hyde KD, Tsui CKM (2014) Freshwater Fungi and Fungal-like Organisms. Walterde Greuter GmbH, Berlin/Boston, ISBN: 978-3-11-033345-9

Schedule:

1st week. The history of classification of bacteria, the basis for the modern taxonomy of bacteria.

2nd week. Photosynthetic bacteria: Halobacteria, purple and green bacteria, cyanobacteria.

3rd week. Chemolitotrophic bacteria: Bacteria involved in the cycles of nitrogen and sulfur and / or transformation of metals.

4th week. Saprophytic bacteria.

5th week. The formation and structure of biofilm. Interactions of bacterial populations.

6th week. The history of the classification of eukaryotes, including the Protists. A general overview of the modern filogenetic system of Protists, with particular reference to groups of protozoans.

7th week. The flagellated protozoans and the traditional and modern system of sporozoans and their ecological significance.

8th week. The main groups of ciliates and their ecological significance.

9th week. Position of eukaryotic fungus-like organisms and true fungi in the system of living organisms.

10th week. The slime molds: cellular slime molds (Acrasiomycota, Dictyosteliomycota), real slime molds (Mixomycota) and parasitic slime molds (Plasmodiophoromycota).

11th week. "Phycomycetes": characteristics of the groups Hyphochytridiomycota, Labyrinthulomycota and Oomycota, their main representatives.

12th week. Water molds (Chytridiomycota) and zygosporic fungi (Zygomycota).

13th week. Major groups of sac fungi (Ascomycota) and basidiosporic fungi (Basidiomycota) with special regard to their representatives in wetland habitats.

14th week. Consultation.

Requirements:

- for a signature

Participation at practices is compulsory. A student must attend the practices and may not miss more than three times during the semester. In case a student does so, the subject will not be signed,and the student must repeat the course.

- for a grade

During the semester there will be three short written tests. Additionally, every student must prepare a short (10-15 min) presentation in each topic. The final grade will be the average of thegrades of written tests and presentations.

Person responsible for course: Dr. habil. István Bácsi, associate professor, PhD

Lecturer: Dr. habil. István Bácsi, associate professor, PhD

Title of course: Algology **Code**: TTHME9305_EN	**ECTS Credit points: 3**

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 64 hours

Total: 120 hours

Year, semester: Facultative from 2nd to 4th semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

Course provides a comprehensive overview of classical and contemporary aspects of freshwater algae biology and ecology and takes full advantage of excellent range of aquatic habitats to providean introduction to their recognition, identification and ecology. Emphasis will be placed on the useof the microscope and taxonomic keys for the identification to generic and species level and their ecological importance.

Literature

1. John D. M., Whitton B. A., Bro A. J. 2002: The Freshwater Algal Flora of the British Isles – An Identification Guide to Freshwater and Terrestrial Algae. Cambridge University Press.
2. Lee R. E. 1999: Phycology. – Unicersity Press, Cambridge.
3. Van den Hoek C., Mann D. G., Jahns H. M. 1995: Algae, An introduction to phycology. – Unicersity Press, Cambridge.

Schedule:

1st week. "Definition" of algae. The difference between the prokaryotic and eukaryotic oxygen-producing photosynthetic organisms. Origin of the chloroplast.

2nd week. Structure of algae by cell number and morphology. Asexual and sexual reproduction of algae, alternations of generations.

3rd week. The basics of classification of eukaryotic algae - types of flagellae and cell division.

4th week. Nutrients, nutrition. Nutritional strategies of eukaryotic algae.

5th week. Habitats, algal communities - phytobenthos, phytoplankton.

6th week. Vertical structure of phytoplankton communities.

7th week. Possibilities of functional grouping of photosynthetic organisms. *8th week.* Interactions of algal populations. *9th week.* The effects of diurnal cycle, weekly and monthly environmental periods on algal communities. Plankton Ecology Group model of phytoplankton succession. *10th week.* Phytoplankton based ecological status assessment. *11th week.* Phytobenthos based ecological status assessment. *12th week.* Biotechnological significance of algae I: Bioremediation, wastewater treatment. *13th week.* The biotechnological significance of algae II: From the use of the entire biomass to high-value biomolecules. *14th week.* Consultation.
Requirements: *- for a signature* Attendance at lectures is highly recommended, but not compulsory. *- for a grade* During the semester there will be no written tests, there will be an oral exam in the exam period.
Person responsible for course: Dr. habil. István Bácsi, associate professor, PhD
Lecturer: Dr. habil. István Bácsi, associate professor, PhD

Title of course: Algology **Code**: TTHMG9305_EN	**ECTS Credit points: 2**

Type of teaching, contact hours

- lecture: -
- practice: 1 hours/week
- laboratory: -

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:

- lecture: -
- practice: 14 hours
- laboratory: -
- home assignment: 16 hours
- preparation for the exam: -

Total: 30 hours

Year, semester: Facultative from 2nd to 4th semester

Its prerequisite(s): General Hydrobiology; Water Chemistry

Further courses built on it: -

Topics of course

The course gives an overview of the organization, taxonomy (morphology, DNA and RNA based classification), evolution and ecology of cyanobacteria and eukaryotic algae. The main taxons, their main representatives and their ecological role in aquatic habitats.

Literature

1. John D. M., Whitton B. A., Bro A. J. 2002: The Freshwater Algal Flora of the British Isles – An Identification Guide to Freshwater and Terrestrial Algae. Cambridge University Press.
2. Lee R. E. 1999: Phycology. – Unicersity Press, Cambridge.
3. Van den Hoek C., Mann D. G., Jahns H. M. 1995: Algae, An introduction to phycology. – Unicersity Press, Cambridge.

Schedule:

1st week. Prokaryotic "algae": the phylum Cyanobacteria I: members of the previously integrated order of Chroococcales and the order Pleurocapsales.

2nd week. Prokaryotic "algae": the phylum Cyanobacteria II: the orders Oscillatoriales and Nostocales).

3rd week. Prokaryotic "algae": the phylum Cyanobacteria III: the previously independent order Stigonematales members of the previously separated phylum Chloroxybacteria.

4th week. Glaucophytes and the red algae (Rhodophyta).

5th week. Heterokonts: The phylum Ocrophyta (earlier Heterokontophyta) I: Chrysophyceae and Xanthophyceae.

6th week. Heterokonts: The phylum Ocrophyta (earlier Heterokontophyta) II: the brown algae (Phaeophyceae) and others (Eustigmatophyceae, Raphidophyceae, Dictyochophyceae).

7th week. Diatoms (Bacillariophyta).

8th week. Haptophytes or "golden algae" and cryptophytes (Haptophyta and Cryptophyta).

9th week. Dinoflagellates (Miozoa, earlier Dinophyta).

10th week. Euglenids and "green amoebas": the phyla Euglenozoa (earlier Euglenophyta) and Chlorarachniophyta.

11th week. Green algae I (Chlorophyta / Chlorodendrophyceae, Chlorophyceae).

12th week. Green algae II (Chlorophyta / Ulvophyceae: Cladophorales, Bryopsidales).

13th week. Green algae III (Chlorophyta / Ulvophyceae: Dasycladales, Trentepohliales).

14th week. Green algae characterized by conjugation: the phylum Conjugatophyta.

Requirements:

- for a signature

Participation at practices is compulsory. A student must attend the practices and may not miss more than three times during the semester. In case a student does so, the subject will not be signedand the student must repeat the course.

- for a grade

During the semester there will be three short written tests. Additionally, every student has to prepare a short (10-15 min) presentation in a given topic. The final grade will be the average of thegrades of written tests and presentations.

Person responsible for course: Dr. habil. István Bácsi, associate professor, PhD

Lecturer: Dr. habil. István Bácsi, associate professor, PhD

Title of course: Macrophytes **Code**: TTHME9304_EN	**ECTS Credit points: 3**

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 64 hours

Total: 120 hours

Year, semester: Facultative from 2nd to 4th semester

Its prerequisite(s):

Further courses built on it: -

Topics of course

The goals of this course are: to learn the basic taxonomy of common aquatic plants; to become familiar with the habitats where aquatic plants are commonly found; to understand the functioningof nutrient cycles in aquatic systems; become familiar with control and management of aquatic plants in perturbed and man-made ecosystems, become familiar with aquatic nuisance plant speciesand their role in the environment.

Literature

Compulsory:

1. Casper, S.J., Krausch, H-D. 1981: Pteridophyta und Anthophyta, 2. Teil. Süßwasserflora von Mitteleuropa, Band 24. VEB Gustav Fischer Verlag, Jena, Germany,
2. Bornette G., Puijalon S. (2009):Macrophytes: Ecology of Aquatic Plants. Wiley Online Press.
3. Caffrey, J.M., Dutartre, A., Haury, J., Murphy, K.M., Wade, P.M. (2006): Macrophytesin Aquatic Ecosystems: From Biology to Management. Springer.
4. Cook, C.D.K., Gut, B.J., Rix, E.M., Schneller, J. 1974: Water Plants of the World. A Manual for the Identification of the Genera of Freshwater Macrophytes. 576 pp., ISBN: 90-6193-024-3
5. Jeppesen, E.; Sondergaard, M.; Sondergaard, M.; Christofferson, K. (eds.) 1997: The Structuring Role of Submerged Macrophytes in Lakes. Series: Ecological Studies, Vol. 131. 452 pp., ISBN: 0-387-98284-1

Schedule:

1st week. Definition of water macrophytes. Taxonomy of water plants.

2nd week. Form of life categories of water palnts.

3rd week. Emerged macrophytes.

4th week. Submerged macrophytes.

5th week. Floating leaf macrophytes.

6th week. Floating macrophytes.

7th week. Life in open water, characteristic algae species.

8th week. Habitat types of shorelines.

9th week. Characteristic plant species of floodplains and swamps.

10th week. Characteristic plant species of marshlands.

11th week. Macrophytes as a biological indicators of European Water Framework Directives.

12th week. Macrophytes like stress specific indicators.

13th week. Macrophytes as a part of ecological state.

14th week. Using geoinformatics methods to analyzing macrophytes coverages.

Requirements:

- for a signature

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will notbe signed and the student must repeat the course. A student can't make up any practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented.Missed practice classes should be made up for at a later date, to be discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments of the course to each practice class. Active participation is evaluated by the teacher in every class. If a student's behavioror conduct doesn't meet the requirements of active participation, the teacher may evaluate his/herparticipation as an absence because of the lack of active participation in class.

Students have to **submit all the two designing tasks** as scheduled minimum on a sufficient level.

During the semester there are two tests: the mid-term test in the 8th week and the end-term test in the 15th week. Students have to sit for the tests

- for a grade

The course ends in an **examination**. Based on the average of the grades of the designing tasks and the examination, the exam grade is calculated as an average of them:

- the average grade of the two designing tasks
- the result of the examination

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

-an offered grade:

it may be offered for students if the average grade of the two designing tasks is at least satisfactory (3) and the average of the mid-term and end-term tests is at least satisfactory (3). The offered gradeis

the average of them.
Person responsible for course: Dr. István Gyulai assistant professor, PhD
Lecturer: Dr. István Gyulai assistant professor, PhD

Title of course: Macrophytes **Code**: TTHMG9304_EN	**ECTS Credit points: 2**

Type of teaching, contact hours

- lecture: -
- practice: 1 hours/week
- laboratory: -

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:

- lecture: -
- practice: 14 hours
- laboratory: -
- home assignment: 16 hours
- preparation for the exam: -

Total: 30 hours

Year, semester: Facultative from 2nd to 4th semester

Its prerequisite(s):

Further courses built on it: -

Topics of course

The practice part will focus on to get a practice on identification of various macrophyte specie and use this knowledge for ecosystem study. During the short field trips to local wetlands we improve the knowledge, and familiarization with field instruments and water quality measurments based on macrophyte species.

Literature

Compulsory:

1. Casper, S.J., Krausch, H-D. 1981: Pteridophyta und Anthophyta, 2. Teil. Süßwasserflora vonMitteleuropa, Band 24. VEB Gustav Fischer Verlag, Jena, Germany,
2. Bornette G., Puijalon S. (2009):Macrophytes: Ecology of Aquatic Plants. Wiley Online Press.
3. Caffrey, J.M., Dutartre, A., Haury, J., Murphy, K.M., Wade, P.M. (2006): Macrophytes inAquatic Ecosystems: From Biology to Management. Springer.
4. Cook, C.D.K., Gut, B.J., Rix, E.M., Schneller, J. 1974: Water Plants of the World. A Manualfor the Identification of the Genera of Freshwater Macrophytes. 576 pp., ISBN: 90-6193-024-3
5. Jeppesen, E.; Sondergaard, M.; Sondergaard, M.; Christofferson, K. (eds.) 1997: The Structuring Role of Submerged Macrophytes in Lakes. Series: Ecological Studies, Vol. 131. 452pp., ISBN: 0-387-98284-1

Schedule:

1st week. Collecting of emerged macrophytes.

2nd week. Identification of merged macrophytes.

3rd week. Collecting of submerged macrophytes.

4th week. Identification of submerged macrophytes.

5th week. Collecting of floating leaf macrophytes.

6th week. Identification of floating leaf macrophytes.

7th week. Collecting of floating lmacrophytes.

8th week. Identification of floating macrophytes.

9th week. Taxonomy of swamps macrophytes.

10th week. Taxonomy of marshland macrophytes.

11th week. Caractristic macrophytes of an oligotrophic lake.

12th week. Caractristic macrophytes of a mesotrophic lake.

13th week. Caractristic macrophytes of a eutrophic lake.

14th week. Monitoring of water plants using macrophytes habitat categories.

Requirements:

- for a signature

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will notbe signed and the student must repeat the course. A student can't make up any practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented.Missed practice classes should be made up for at a later date, to be discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments of the course to each practice class. Active participation is evaluated by the teacher in every class. If a student's behavioror conduct doesn't meet the requirements of active participation, the teacher may evaluate his/herparticipation as an absence because of the lack of active participation in class.

Students have to **submit all the two designing tasks** as scheduled minimum on a sufficient level.

During the semester there are two tests: the mid-term test in the 8th week and the end-term test in the 15th week. Students have to sit for the tests

- for a grade

The course ends in an **examination**. Based on the average of the grades of the designing tasks and the examination, the exam grade is calculated as an average of them:

- the average grade of the two designing tasks
- the result of the examination

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

-an offered grade:

it may be offered for students if the average grade of the two designing tasks is at least satisfactory (3) and the average of the mid-term and end-term tests is at least satisfactory (3). The offered gradeis the average of them.

Person responsible for course: Dr. István Gyulai assistant professor, PhD

Lecturer: Dr. István Gyulai assistant professor, PhD

Title of course: Zooplankton **Code**: TTHME9403_EN	**ECTS Credit points: 3**

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 64 hours

Total: 120 hours

Year, semester: Facultative from 2nd to 4th semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

Zooplankton importance. Structure of freshwater and marine zooplankton. Main systematic groups. Ecology of zooplankton (feeding, life cycle, habitat, behavior). Zooplankton and water quality. Zooplankton and fish interaction. Zooplankton methodology, collection and identification.Indicator and test organisms. Habitat attachment of zooplakton. Using planctonic and littoral cladocera species for reconstruction lake-level changes.

Literature

Compulsory:

1. G. E. Likens (2010): Plankton of Inland Waters. Academic Press ISBN 9780123819949
2. I.M. Suthers, D. Rissik (2009): Plankton. A guide to their ecology and monitoring for waterquality. CSIRO Publishing, Australia
3. M. Omori (1992): Methods in Marine Zooplankton Ecology. Krieger Pub. Co. ISBN-10: 0894646532
4. R.P. Harris, P.H. Wiebe, J. Lenz, H.R. Skjoldal, M. Huntley (2000): ICES Zooplankton Methodology Manual. Academic Press ISBN 0-12-327645-4

Schedule:

1st week. The members of the zooplankton community, their taxonomic classification, their lifestyle, their occurence in aquatic ecosystems.

2nd week. The role of zooplankton in aquatic food web and in material cycle.

3rd week. Study of zooplankton: aspects of representative sampling, collection methods, tools, sample preservation, transport, storage.

4th week. Species identification, major anatomical characteristics, typical sex and seasonal morphologicaldifferences.

5th week. Ecology of zooplankton species, indicator species, common species, rare species.

6th week. Investigation and monitoring of zooplankton community: quantitative characteristics

(number ofindividuals, biomass).

7th week. Investigation and monitoring zooplankton community: quality characteristics (species composition, dominance, diversity, functional groups), evaluation of results.

8th week. The importance of zooplankton organisms: water qualification and fish farming aspects.

9th week. Laboratory breeding and application of zooplankton organisms in ecotoxicology.

10th week. Planktonic crustaceans (Cladocera, Copepoda) in freshwaters.

11th week. Characteristics of marine zooplankton.

13th week. Zooplankton researches - case studies.

12th week. The impact of climate change on zooplankton.

14th week. Consultation or exam.

Requirements:

- for a signature

Attendance at lectures is recommended, but not compulsory.

- for a grade

The lecture ends with a written examination. 2 (Pass) Grade: 50% of the maximum points available. If the score of any test is below 50%, students can take a retake test.

-an offered grade:

There are at least two tests during the semester, and the offered grade is the average of them.

Person responsible for course: Dr. Csaba Berta, research assistant fellow, PhD

Lecturer: Dr. Csaba Berta, research assistant fellow, PhD;

Dr. István Gyulai, assistant professor, PhD

Title of course: Zooplankton **Code**: TTHMG9403_EN	**ECTS Credit points: 2**

Type of teaching, contact hours

- lecture: -
- practice: 1 hours/week
- laboratory: -

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:

- lecture: -
- practice: 14 hours
- laboratory: -
- home assignment: 16 hours
- preparation for the exam: -

Total: 120 hours

Year, semester: Facultative from 2nd to 4th semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

The target is to know the main zooplankton groups (Rotatoria, Cladocera, Copepoda), methods of preparation, identification of animals using a microscope.

Literature

Compulsory:

1. J. Moore 2006: An Introduction to the Invertebrates. Cambridge University Press. ISBN: 9780521674065
2. M Suthers, D. Rissi 2009: Plankton - A Guide to their Ecology and Monitoring for Water Quality. CSIRO ISBN: 9780643090583
3. Bledzki, L.A., Rybak, J.I. 2016: Freshwater Crustacean Zooplankton of Europe. SpringerInternational Publishing, Switzerland ISBN 978-3-319-29871-9

Schedule:

1st week. Recognizing the main taxonomic groups of zooplankton.

2nd week. Characteristics and major genera of the Monogononta class (Rotatoria).

3rd week. Identification of features required to determine the rotifers' species, preparation of mastax.

4th week. Identification of rotifer species I.

5th week. Identification of rotifer species II.

6th week. The most important genera of Cladocera.

7th week. Identification of features required to determine the cladocerans' species, preparation methods.

8th week. Identification of cladoceran species I.

9th week. Identification of cladoceran species II

10th week. Separation of the three orders of Copepoda, the recognition of the most important species.

11th week. Preparation of the 5th toracic leg of cyclopoid copepods, identification of species.

12th week. Breeding of Daphnia magna in laboratory.

13th week. Evaluation of results of zooplankton investigations on the basis of given species lists.

14th week. Consultation.

Requirements:

- for a signature

Participation at practice classes is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will notbe signed and the student must repeat the course. In case of further absences, a medical certificateneeds to be presented.

- for a grade

The practice ends with submitting a term paper.

Person responsible for course: Dr. Csaba Berta, research assistant fellow, PhD

Lecturer: Dr. Csaba Berta, research assistant fellow, PhD;

Dr. István Gyulai, assistant professor, PhD

Title of course: Macroinvertebrates **Code**: TTHME9302_EN	**ECTS Credit points: 3**

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 64 hours

Total: 120 hours

Year, semester: Facultative from 2nd to 4th semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

This course presents practices and concepts of using macroinvertebrates to monitor the environmental health or integrity of freshwater ecosystems.

The course objectives are to know and describe: (i) the body plan and the life history strategies of macroinvertebrate taxa; (ii) habits and trophic group types; (iii) macroinvertebrate patterns of abundance based on physical and chemical habitat templates. Discuss effect of impairment on assemblage composition. Correctly use a variety of sampling gears. Use proper collecting, labeling, and preservation techniques and correctly identify specimens by following methods demonstrated in the course..

Literature

Compulsory:

1. Voshell J. R (2002): A Guide to Common Freshwater Invertebrates of North America,McDonald and Woodward Publishing Company;
2. Peckarsky B. (1990): Freshwater Macroinvertebrates of Northeastern North America, CornellUniversity Press
3. Lancaster J. and Downes B. J. (2013) :Aquatic Entomology, Oxford University Press
4. Hynes, H.B.N. (1970): The Ecology of Running Waters, Liverpool Uneversity Press

Schedule:

1st week. Types of aquatic macroinvertebrates: sessile, hemisessile and vagile species. Biophages andhylophages, filters, breakers, collectors, scrapers. Phytophag, carnivor and omnivor species.

2nd week. Body plan, activities, nutrion and reproduction of sponges and cnidarians. The most importantfreshwater and marine taxa.

3rd week. Body plan and life-styles of flatworms. Waterbound parasitic faltworms (weeds and gallbladder)and their life-styles. Their importance pf flatworms in freshwater and seas. Kamptozoans.

4th week. Annelid worms: body plan and life-style. Free living and parasitic taxa. Rotifers and bryosoans.

5th week. Molluscs: body plan and life style. Snails, bivalves and cephalopods and their importance in thewater animal assemblages.

6th week. General body structure of arthropods. Body plan of macroscopic crustaceans. The most important freshwater and marine taxa. Invasive species.

7th week. Body plan of bugs. The most important taxa living on surface of water, or in the water. Characterization of families of caddyflies.

8th week. Separation of myflies and dragonflies at family level. Their importance in the water animalassemblages. The most important taxa

9th week. General body structure of the beetles. Separation of water and water-bound beetles at family level.The mos important taxa.

10th week. General body structure of dipterans. Separation of dipteran larvae at family level.

11th week. Macroinvertebrate assemblages of facial, pelagial and fital. Trophic relationships.

12th week. Macroinvertebrate assemblages of bental, stigal és freatal. Trophic relationships.

13th week. Macroinvertebrate assemblages of springs and watercourses. Adaptations to running water.

14th week. Presentation of the most important methods used to collect aquatic macroinvertebrates. Labeling,and preservation techniques.

Requirements:

- for a signature

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. In case of further absences, a medical certificate needs to be presented.

- for a grade

The course ends in an written **examination**. 2 (Pass) Grade: 50% of the maximum points available. If the score of any test is below 50%, students can take a retake test.

-an offered grade:

There are at least two test during the semester, and the offered grade is the average of them.

Person responsible for course: Dr. habil. László Antal, associate professor, PhD

Lecturer: Dr. habil. László Antal, associate professor, PhD

Title of course: Macroinvertebrates **Code**: TTHMG9302_EN	**ECTS Credit points: 2**

Type of teaching, contact hours

- lecture:
- practice: 1 hours/week
- laboratory: -

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:

- lecture:
- practice: 14 hours
- laboratory: -
- home assignment: 16 hours
- preparation for the exam: - hours

Total: 30 hours

Year, semester: Facultative from 2nd to 4th semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

This course presents practices and concepts of using macroinvertebrates to monitor the environmental health or integrity of freshwater ecosystems.

The course objectives are to know and describe: (i) the body plan and the life history strategies of macroinvertebrate taxa; (ii) habits and trophic group types; (iii) macroinvertebrate patterns of abundance based on physical and chemical habitat templates. Discuss effect of impairment on assemblage composition. Correctly use a variety of sampling gears. Use proper collecting,labeling, and preservation techniques and correctly identify specimens by following methods demonstrated in the course..

Literature

Compulsory:

1. Voshell J. R (2002): A Guide to Common Freshwater Invertebrates of North America,McDonald and Woodward Publishing Company;
2. Peckarsky B. (1990): Freshwater Macroinvertebrates of Northeastern North America, CornellUniversity Press
3. Lancaster J. and Downes B. J. (2013) :Aquatic Entomology, Oxford University Press
4. Hynes, H.B.N. (1970): The Ecology of Running Waters, Liverpool Uneversity Press

Schedule:

1st week. Types of aquatic macroinvertebrates: sessile, hemisessile and vagile species. Biophages and hylophages, filters, breakers, collectors, scrapers. Phytophag, carnivor and omnivor species.

2nd week. Presentation the most important taxa and species of sponges and cnidarians living in freshwater and marine.

3rd week. Presentation the most important taxa and species of flatworms living in freshwater and marine habitats. Medical importance of parasitic flatworms.

4th week. Presentation the most important taxa and species of annelids living in freshwater and marine The most important rotifer and bryosoan species.

5th week. Presentation the most important taxa and species of molluscs living in freshwater and marine adaptation to waving. Invasive species in the freshwaters.

6th week. The most important representatives of the macroscopic crabs. Invasive species in the freshwater habitats.

7th week. Presentation the bug species living on surface of water, or in the water. Presentation of caddyflies larvae and imagoes.

8th week. The most important taxa of myflies and dragonflies. Presentation the larvae and imagoes.

9th week. The most important taxa of beetles living in freshwaters.

10th week. Presentation the most important taxa and species of dipterans living in freshwater.

11th week. Macroinvertebrate assemblages of facial, pelagial and fital. Trophic relationships.

12th week. Macroinvertebrate assemblages of bental, stigal és freatal. Trophic relationships.

13th week. Macroinvertebrate assemblages of springs and watercourses. Adaptations to running water.

14th week. Presentation of the most important methods used to collect aquatic macroinvertebrates. Labeling, and preservation techniques.

Requirements:

- for a signature

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. In case of further absences, a medical certificate needs to be presented.

- for a grade

The course ends in an written **examination**. 2 (Pass) Grade: 50% of the maximum points available. If the score of any test is below 50%, students can take a retake test.

-an offered grade:

There are at least two test during the semester, and the offered grade is the average of them.

Person responsible for course: Dr. habil. László Antal, associate professor, PhD

Lecturer: Dr. habil. László Antal, associate professor, PhD

Title of course: Fishes **Code**: TTHME9306_EN	**ECTS Credit points: 3**

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 64 hours

Total: 120 hours

Year, semester: Facultative from 2nd to 4th semester

Its prerequisite(s): TTHME9104_EN

Further courses built on it: -

Topics of course

This is an comprehensive subject about fishes: Taxonomy; Evolution; Organization; Morphological and meristic characters; Anatomy; Freshwater Fish fauna; Reproductive biology; Ecology; Diet; Diseases; Conservation biology; Migration; Fisheries management; Biomanipulation.

Literature

Compulsory:

1. Nelson, J.S., 2006. Fishes of the World. 4th Edition, John Wiley & Sons, Inc., Hoboken, NewJersey, ISBN: 978-0-471-25031-9

2. *Recommended:*

3. Cowx, I.G., 2002. Management and Ecology of Lake and Reservoir Fisheries. Wiley-Blackwell,ISBN: 978-0852382837
4. Kottelat, M., Freyhof, J., 2007. Handbook of European Freshwater Fishes. Publications Kottelat,Cornol, Switzerland. ISBN: 9782839902984
5. Leppäkoski, E., Gollasch, S., Olenin, S., (Eds.), 2010. Invasive Aquatic Species of Europe.Distribution, Impacts and Management. Springer, ISBN: 978-9048161119.
6. Lucas, M., Baras, E., 2001. Migration of Freshwater Fishes. Wiley-Blackwell, ISBN: 978-0632057542
7. Scheffer, M. 2004. Ecology of Shallow Lakes. DeAngelis DL, Manly BFJ. Springer, ISBN 978-1-4020-2306-4

Schedule:

1st week. Taxonomy of Fishes.

2nd week. Evolution of Fishes.

3rd week. Anatomy of Fishes.

4th week. Organization of Fishes.

5th week. Morphological and meristic characters of Fishes.

6th week. Freshwater Fish fauna.

7th week. Reproductive biology of Fishes.

8th week. Ecology of Fishes.

9th week. Diet of Fishes.

10th week. Diseases of Fishes.

11th week. Conservation biology.

12th week. Migration of Fishes.

13th week. Fisheries management.

14th week. Biomanipulation.

Requirements:

- for a signature

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will notbe signed and the student must repeat the course. A student can't make up any practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented.Missed practice classes should be made up for at a later date, to be discussed with the tutor. Active participation is evaluated by the teacher in every class. If a student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.

- for a grade

- The course ends in an **examination**.

The course ends in an examination. The minimum requirement for the test and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. László Antal associate professor, PhD

Lecturer: Dr. László Antal, associate professor, PhD

Dr. Krisztián Nyeste, assistant professor, PhD

Title of course: Fishes **Code**: TTHMG9306_EN	**ECTS Credit points: 2**

Type of teaching, contact hours

- lecture: -
- practice: 1 hours/week
- laboratory: -

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:

- lecture: -
- practice: 14 hours
- laboratory: -
- home assignment: 16 hours
- preparation for the exam: -

Total: 120 hours

Year, semester: Facultative from 2nd to 4th semester

Its prerequisite(s): TTHME9104_EN

Further courses built on it: -

Topics of course

The aim of the course is to the students enable to identifying the most important characteristics of fishes. The students be able to independently determine the various fish species whether they are in field conditions or from photographs. They have the ability to apply decoding keys individually,to be able to test the most important morphometric and meristine features.

Literature

Compulsory:

1. Nelson, J.S., 2006. Fishes of the World. 4th Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, ISBN: 978-0-471-25031-9

Recommended:

1. Cowx, I.G., 2002. Management and Ecology of Lake and Reservoir Fisheries. Wiley-Blackwell, ISBN: 978-0852382837
2. Kottelat, M., Freyhof, J., 2007. Handbook of European Freshwater Fishes. Publications Kottelat, Cornol, Switzerland. ISBN: 9782839902984
3. Leppäkoski, E., Gollasch, S., Olenin, S., (Eds.), 2010. Invasive Aquatic Species of Europe. Distribution, Impacts and Management. Springer, ISBN: 978-9048161119.
4. Lucas, M., Baras, E., 2001. Migration of Freshwater Fishes. Wiley-Blackwell, ISBN: 978-0632057542
5. Scheffer, M. 2004. Ecology of Shallow Lakes. DeAngelis DL, Manly BFJ. Springer, ISBN 978-1-4020-2306-4

Schedule:

1st week. Taxonomic practice I. (principles).

2nd week. Taxonomic practice II. (predatory fishes).

3rd week. Taxonomic practice III. (not predatory fishes).

4th week. Anatomical practice I.

5th week. Anatomical practice II.

6th week. Fish diseases practice (ectoparasites).

7th week. Fish diseases practice (endoparasites).

8th week. Natural nutrients I.

9th week. Natural nutrients II.

10th week. Industrial nutrition I.

11th week. Industrial nutrition II.

12th week. Research fishing methods.

13th week. Industrial fishing methods I.

14th week. Industrial fishing methods II.

Requirements:

- for a signature

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will notbe signed and the student must repeat the course. A student can't make up any practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented.Missed practice classes should be made up for at a later date, to be discussed with the tutor. Active participation is evaluated by the teacher in every class. If a student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.

- for a grade

The course ends in an **examination**.

The course ends in an examination. The minimum requirement for the test and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. László Antal, associate professor, PhD

Lecturer: Dr. László Antal, associate professor, PhD

Dr. Krisztián Nyeste, assistant professor, PhD

Title of course: Research project management **Code**: TTHME9418_EN	**ECTS Credit points: 3**

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 64 hours

Total: 120 hours

Year, semester: Facultative from 2nd to 4th semester

Its prerequisite(s):

Further courses built on it: -

Topics of course

Basics of project planning: the research question, surveying the literature, setting the research hypotheses. Choosing study species, area and methodology. Principles of data collecting: design of sampling, experimental and observational studies, basics of statistical design and analyses. Writing up: structure of scientific communications (talks, posters and papers), the publishing machinery. Writing grant proposals.

Literature

Compulsory:
course material

Recommended:

1. Paul D. Leedy, Jeanne E. Ormrod : Practical Research: Planning and Design (11th Edition).Prentice Hall, 2015.
2. Crawley, Michael J. Statistics : an introduction using R / Michael J. Crawley. Second edition.Wiley. 2015.
3. William R. Shadish, Thomas D. Cook, Donald T. Campbell: Experimental and Quasi-Experimental Designs for Generalized Causal Inference. Wadsworth Publishing 2001.
4. John W. Creswell: Research Design: Qualitative, Quantitative, and Mixed Methods Approaches,4th Edition. SAGE Publications Inc, 2013.
5. Joshua Schimel . Writing Science: How to Write Papers That Get Cited and Proposals That GetFunded? Oxford University Press 2011.

Schedule:

1st week. The scientific method. Generating hypotheses and drawing predictions.

2nd week. Approaching a new scientific question. How to survey the literature.

3rd week. Choosing study subjects, area and methodology

4th week. Principles of data collection: sampling designs, difference between experimental and observational studies.

5th week. Controlling for confounders. Spurious correlations.

6th week. Experimental protocols. Randomization, standardization, the importance of a controlgroup. Blinding.

7th week. Experimental protocols. Randomized block design, Latin square, factorial design.

8th week. Analysing collected data - 1. Continuous variables.

9th week. Analysing collected data – 2. Comparing groups.

10th week. Analysing collected data – 3. Other methods.

11th week. Organizing research data. Data structures and reproducible research.

12th week. Writing up: structure of scientific communications (talks, posters and papers).

13th week. Publishing: from manuscript submission to peer review.

14th week. Writing grant proposals.

Requirements:

- for a signature

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will notbe signed and the student must repeat the course. A student can't make up any practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented.Missed practice classes should be made up for at a later date, to be discussed with the tutor.

During the semester there are two tests: the mid-term test in the 8th week and the end-term test in the 15th week. Students have to sit for the tests

- for a grade

The course ends in an **examination**. Based on the average of the grades of the designing tasks and the examination, the exam grade is calculated as an average of them:

- the average grade of home assignments
- the result of the examination

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

-an offered grade:

it may be offered for students if the average grade of the two designing tasks is at least satisfactory (3) and the average of the mid-term and end-term tests is at least satisfactory (3). The offered gradeis

the average of them.
Person responsible for course: Dr. habil. Ádám Z. Lendvai, associate professor, PhD
Lecturer: Dr. habil. Ádám Z. Lendvai, associate professor, PhD

Title of course: Research Project Management **Code**: TTHMG9418_EN	**ECTS Credit points:** 2

Type of teaching, contact hours

- lecture: -
- practice: 1 hours/week
- laboratory: -

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:

- lecture: -
- practice: 14 hours
- laboratory: -
- home assignment: 16 hours
- preparation for the exam: -

Total: 30 hours

Year, semester: Facultative from 2nd to 4th semester

Its prerequisite(s):

Further courses built on it: -

Topics of course

Basics of project planning: the research question, surveying the literature, setting the research hypotheses. Choosing study species, area and methodology. Principles of data collecting: design of sampling, experimental and observational studies, basics of statistical design and analyses. Writing up: structure of scientific communications (talks, posters and papers), the publishing machinery. Writing grant proposals.

Literature

Compulsory:

1. course material

Recommended:

1. Paul D. Leedy, Jeanne E. Ormrod : Practical Research: Planning andDesign (11th Edition). Prentice Hall, 2015.
2. Crawley, Michael J. Statistics : an introduction using R / Michael J. Crawley. Second edition.Wiley. 2015.
3. William R. Shadish, Thomas D. Cook, Donald T. Campbell: Experimentaland Quasi-Experimental Designs for Generalized Causal Inference.
4. Wadsworth Publishing 2001.
5. John W. Creswell: Research Design: Qualitative, Quantitative, and MixedMethods Approaches, 4th Edition. SAGE Publications Inc, 2013.
6. Joshua Schimel . Writing Science: How to Write Papers That Get Cited and Proposals That GetFunded? Oxford University Press 2011.

Schedule:

1st week. Generating hypotheses and drawing predictions in everyday life questions.

2nd week. Looking up papers with specific criteria.

3rd week. Practical aspects of study subject selection.

4th week. Full random and stratified random sampling.

5th week. Do storks bring babies? Investigating causation in correlational data sets.

6th week. Designing a placebo-controlled randomized double-blind study.

7th week. Experimental protocols. Randomized block design, Latin square, factorial design.

8th week. Correlations, linear regression.

9th week. T-test, Parametric and non-parametric analysis of variance.

10th week. Ordination and cluster analysis.

11th week. Organizing research data. Data structures and reproducible research.

12th week. How to make a good (and a bad) talk. How to write a research paper.

13th week. Submitting a manuscript. Perform a peer review.

14th week. Writing grant proposals.

Requirements:

- for a signature

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will notbe signed and the student must repeat the course. A student can't make up any practice with another group.

During the semester there are two tests: the mid-term test in the 8th week and the end-term test in the 15th week. Students have to sit for the tests

- for a grade

The course ends in an **examination**. Based on the average of the grades of the designing tasks and the examination, the exam grade is calculated as an average of them:

- the average grade of home assignments
- the result of the examination

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

-an offered grade:

it may be offered for students if the average grade of the two designing tasks is at least satisfactory (3) and the average of the mid-term and end-term tests is at least satisfactory (3). The offered gradeis the average of them.

Person responsible for course: Dr. habil. Ádám Z. Lendvai, associate professor, PhD

Lecturer: Dr. habil. Ádám Z. Lendvai, associate professor, PhD

Title of course: Tropical Ecology **Code**: TTHME9406_EN	**ECTS Credit points: 3**

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 64 hours

Total: 120 hours

Year, semester: Facultative from 2nd to 4th semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

This course will provide students with a general overview of tropical ecology. Students will gain insight about basic ecological concepts and be able to explore a variety of ecosystems, their animals and the multiple and complex ecological interactions that can be found in these areas. Brazil is a tropical country with an immensely rich biodiversity and for this reason a very representative area to these studies. Emphasis will be given to the study of the ecosystems found in Brazil, but others will be discussed as well. The course objectives is: become acquainted with the concepts and issues addressed to tropical ecology; learn the characteristics of the major tropical ecosystems on earth; observe different ecosystems and seek examples of important interactions. Students become familiar with the biodiversity of the tropics; understand the importance of the balance and the harmony among different types of tropical ecosystems; understand the natural and human made impacts on natural ecosystems in tropical area; comprehend the importance of conservation and management of natural systems.

Literature

1. Michael, G., Mirian, L. C., Efrem, G. F. (1998): Rio Negro, rich life in poor water – SPB Academic Publishing bv, Hague, Netherland,
2. Wilhelm, F. (1987): Hydrogeographie, Braunschweig,
3. John Kricher (2011): Tropical Ecology. Princeton University Press,
4. Montagnini, F., Carl F. J. (2005): Tropical Forest Ecology (The Basis for Conservation and Management)

Schedule:

Lectures:

1st week. The tropics and their location on Earth.

2nd week. Characterization of white, black and transparent waters of tropical watercourses.

3rd week. Oligotrophy in tropical waters.

4th week. Problems of water load and water pollution in the tropics.

5th week. Tropical watercourses in the savannah belt.

6th week. Characteristics of topical standing waters.

7th week. Interaction between tropical watercourses and the oceans.

8th week. The littoral region of the tropical seas.

9th week. The wildlife of the Pantanal.

10th week. The ecological features of Pantanal.

11th week. Harmonization of nature conservation, recreation and economic interests on tropics.

12th week. Water system of the Amazonas River.

13th week. The wildlife of the Amazonas.

14th week. Amazonas as a natural value and as an economic potential.

Requirements:
Lecture:

The minimum requirement for the examination is 50% from the midterm and closing tests. Based on the summarized score of the test the grade for the examination is given according to the following table:

Score	Grade
0-49%	fail (1)
50-59%	pass (2)
60-72%	satisfactory (3)
73-84%	good (4)
85-100%	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. habil. Alex Sándor Nagy, Senior Research Fellow, PhD

Lecturer: Dr. habil. Alex Sándor Nagy, Senior Research Fellow, PhD

Title of course: Tropical Ecology **Code**: TTHMG9406_EN	**ECTS Credit points: 2**

Type of teaching, contact hours

- lecture: -
- practice: 1 hours/week
- laboratory: -

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:

- lecture: -
- practice: 14 hours
- laboratory: -
- home assignment: 16 hours
- preparation for the exam: -

Total: 30 hours

Year, semester: Facultative from 2nd to 4th semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

This course will provide students with a general overview of tropical ecology. Students will gain insight about basic ecological concepts and be able to explore a variety of ecosystems, their animals and the multiple and complex ecological interactions that can be found in these areas. Brazil is a tropical country with an immensely rich biodiversity and for this reason a very representative area to these studies. Emphasis will be given to the study of the ecosystems found in Brazil, but others will be discussed as well. The course objectives is: become acquainted with the concepts and issues addressed to tropical ecology; learn the characteristics of the major tropical ecosystems on earth; observe different ecosystems and seek examples of important interactions. Students become familiar with the biodiversity of the tropics; understand the importance of the balance and the harmony among different types of tropical ecosystems; understand the natural and human made impacts on natural ecosystems in tropical area; comprehend the importance of conservation and management of natural systems.

Literature

1. Michael, G., Mirian, L. C., Efrem, G. F. (1998): Rio Negro, rich life in poor water – SPB Academic Publishing bv, Hague, Netherland,
2. Wilhelm, F. (1987): Hydrogeographie, Braunschweig,
3. John Kricher (2011): Tropical Ecology. Princeton University Press,
4. Montagnini, F., Carl F. J. (2005): Tropical Forest Ecology (The Basis for Conservation and Management)

Schedule:

Lectures:

1st week. Modelling an example tropical territory based on data series.

2nd week. All of the students' needs to demonstrate a freely chosen tropical watercourse.

3rd week. Comparing the different types of trophy, focusing on the oligotrophy.

4th week. Group discussion about the advantages and disadvantages of water-load and pollution.

5th week. Modelling the effects of water courses in the savannah belt using data series.

6th week. Comparing the tropical standing water bodies to temperate water bodies.

7th week. The students' needs to find different interaction between water courses and the ocean around the Earth (just in tropical region).

8th week. Mapping the needs of those non-living and living creatures that have a connection to the littoral region of the tropical seas.

9th week. Grouping the wildlife of the Pantanal, based on literature.

10th week. Unravel the secrets behind the ecological functions of the Pantanal.

11th week. Based on literature, every student has to make a presentation about the different usageof the tropical region.

12th week. Making a model about the main tributaries of the Amazonas River, and connecting it to different hypothesis about the possible water polluting sources.

13th week. Indicating all the major flora and fauna of the Amazonas River (from microscopic togiant) based on literature and own knowledge.

14th week. Group discussion about whether the main function of the Amazonas River is nature conservation (living, space of living, etc.) or the economy (power plants, fishing, etc.).

Requirements:

Practice:

Participation at classes is compulsory. A student must attend the courses and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

During the semester there is one practical test. It can be completed in the 14th week.

The minimum score is 50%. Based on the score of the test, the grade for the test is given accordingto the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-72	satisfactory (3)
73-84	good (4)
85-100	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. habil. Alex Sándor Nagy, Senior Research Fellow, PhD

Lecturer: Dr. habil. Alex Sándor Nagy, Senior Research Fellow, PhD

Title of course: Fundamentals of Geoinformation Systems for Water Management **Code**: TTHME9203_EN	**ECTS Credit points: 3**

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 64 hours

Total: 120 hours

Year, semester: Facultative from 2nd to 4th semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

Definition, function, types and content of the information systems. Geotagged information. Geoinformatics and spatial information systems. Elements of geoinformation systems. Vector and raster data models. Development of geospatial systems (cadastres, military, topography and thematic maps). Dimensions and specifications of geospatial systems; application possibilities, levels and system planning. Steps of geospatial model building. Model requirements and characteristics. Theoretical models, entities, connection types. Logical models, object characteristics, thematic and geometrical dimensions. Geometric basic shapes, scale- and resolution-dependency. Vector, raster and hybrid systems. Vector-raster and raster-vector transformation. Topological models, geometric connections of objects. Point, line and polygon topology. Data types, attributes, metadata, sampling. Geometric and attribute data collection and extraction. Theory of visual interpretation of remotely sensed data. Raster data processing techniques.

Literature

1. Huisman, O., de By, R.A. 2009. Principles of Geographic Information Systems. ITC Educational Textbook Series, No. 1., https://webapps.itc.utwente.nl/librarywww/papers_2009/general/PrinciplesGIS.pdf

2. de Smith, M.J., Goodchild, M.F., Longley, P.A. 2018. Geospatial Analysis. 6th Edition online:http://www.spatialanalysisonline.com/HTML/index.html

3. Graser, A. 2016. Learning QGIS, PACKT Publishing, ISBN-13: 978-1785880339

Schedule:

1st week. Definition, function, types and content of the information systems. Geotagged information. Geoinformatics and spatial information systems.

2nd week. Elements of geoinformation systems. Vector and raster data models.

3rd week. Development of geospatial systems (cadasters, military, topography and thematic maps).

4th week. Dimensions and specifications of geospatial systems; application possibilities, levels and system planning.

5th week. Steps of geospatial model building. Model requirements and characteristics. Theoretical models, entities, connection types.

6th week. Logical models, object characteristics, thematic and geometrical dimensions. Geometric basic shapes, scale- and resolution-dependency.

7th week. Midterm exam (test).

8th week. Vector, raster and hybrid systems. Vector-raster and raster-vector transformation.

9th week. Topological models, geometric connections of objects. Point, line and polygon topology.

10th week. Data types, attributes, metadata, sampling.

11th week. Geometric and attribute data collection and extraction.

12th week. Theory of visual interpretation of remotely sensed data.

13th week. Raster data processing techniques.

14th week. Obligatory test, semester closing.

Requirements:

The minimum requirement for the examination is 50% from the midterm and closing tests. Based on the summarized score of the test the grade for the examination is given according to the following table:

Score	Grade
0-49%	fail (1)
50-59%	pass (2)
60-72%	satisfactory (3)
73-84%	good (4)
85-100%	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Prof. Dr. habil. Szilard Szabó, university professor, DSc

Lecturer: Prof. Dr. habil. Szilárd Szabó, university professor, DSc;
Dr. László Bertalan, assistant professor, PhD

Title of course: Fundamentals of Geoinformation Systems for Water Management **Code**: TTHMG9203_EN	**ECTS Credit points: 2**

Type of teaching, contact hours

- lecture: -
- practice: -
- laboratory: 1 hours/week

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:

- lecture: -
- practice: -
- laboratory: 14 hours
- home assignment: 16 hours
- preparation for the exam: -

Total: 30 hours

Year, semester: Facultative from 2nd to 4th semester

Its prerequisite(s): -

Further courses built on it: -

Topics of course

The course aims to provide detailed information about the basics of geoinformatics (GIS). Data models (vector and raster) are the first steps to learn and the students learn a GIS software. The main focus is on the capability of field data collection, i.e. to understand the background of positioning systems such as GPS devices, total stations and their accuracy. Aerial photos, orthophotographs and satellite images are also important topics of this course especially from theaspect of water detection, mapping and analysis.

Literature

1. QGIS Training Manual - https://docs.qgis.org/2.8/en/docs/training_manual/
2. Sutton, T., Dassau, O., Sutton, M. 2009. A gentle introduction in GIS, https://docs.qgis.org/2.8/en/docs/gentle_gis_introduction/index.html
3. Graser, A. 2016. Learning QGIS, PACKT Publishing, ISBN-13: 978-1785880339

Schedule:

1st week. Introduction to GIS and the QGIS software environment.

2nd week. Maps and projections - practice

3rd week. Basic operations, layer management, table management.

4th week. Creation of point objects.

5th week. Creation of line objects.

6th week. Creation of polygon objects.

7th week. Thematic maps.

8th week. Summary, practice.

9th week. Query by attribute data.

10th week. Basics of raster data, aerial and satellite images.

11th week. Visual interpretation of remotely sensed data

12th week. Hybrid data visualization and analysis.

13th week. Test. Offered grading.

14th week. Obligatory test, semester closing.

Requirements:

Participation at classes is compulsory. A student must attend the courses and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

During the semester there is one practical test. It can be completed in the 13th or 14th week.

The minimum score is 50%. Based on the score of the test, the grade for the test is given accordingto the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-72	satisfactory (3)
73-84	good (4)
85-100	excellent (5)

-an offered grade:

it may be offered for students if the test written in the 13th week is at least satisfactory (3).

- in case an offered grade cannot be given, or it is not convenient for the student there is a possibilityto repeat in the last week

Person responsible for course: Prof. Dr. Szilard Szabó, university professor, DSc

Lecturer: Prof. Dr. Szilárd Szabó, university professor, DSc;
Dr. László Bertalan, assistant professor, PhD

Title of course: Aquatic invasions **Code**: TTHME9424_EN	**ECTS Credit points:** 3

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: –
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: –
- laboratory: -
- home assignment: 20 hours
- preparation for the exam: 10 hours

Total: 48 hours

Year, semester: 1st and 2nd year, 1st semester

Its prerequisite(s): –

Further courses built on it: -

Topics of course

This is a comprehensive subject about aquatic invasions: Terms of aquatic invasions, alien species, invasive species. Invasive routes and vectors. Spontaneous and semi-spontaneous spreading, introducing of alien invasive species. Success of the invasion. Spreading ecology of invasive species. Ecological effects, risk assessment and management of invasions. Analysis of invasion success, and the role of natural enemies. Resistance of native communities against biological invasions. Protection and prevention against invasive species. Most common invasive species in Europe and in Hungary. Case studies.

Literature

Compulsory:

1. Nentwig, W., 2008. Biological Invasions. Springer-Verlang Berling and Heidelberg GmbH & Co. KG.

Recommended:

1. Lockwood, J.L. 2013. Invasion Ecology. John Wiley and Sons Ltd.
2. Cowx, I.G., 2002. Management and Ecology of Lake and Reservoir Fisheries. Wiley-Blackwell,ISBN: 978-0852382837
3. Leppäkoski, E., Gollasch, S., Olenin, S., (Eds.), 2010. Invasive Aquatic Species of Europe.Distribution, Impacts and Management. Springer, ISBN: 978-9048161119.

Course objective/intended learning outcomes

a) Knowledge

- He/she fundamentally knows risks and ecological features of biological invasions of freshwater habitats.
- He/she expansively knows the main properties of aquatic invasions.

b) Abilities

- He/she is able to plan for protection and prevention of ecological effects of invasive species.

c) Attitude

- He/she is open to learn and accept professional improvement and innovation in his/her profession.

- He/she makes a decision in complex and unexpected decision cases by completely taking into account legal and ethical norms.

d) Autonomy and responsibility

- Even in unexpected decision-making situations he/she is capable of considering complex, fundamental questions from his/her professional field.

He/she is open to critical remarks which are professionally well-founded.

Schedule:

1st week. Introduction to invasion ecology.

2nd week. Transport vectors and pathways.

3rd week. Trend in bumbers of invaders.

4th week. Propagules.

5th week. Disturbance.

6th week. Establishment success: the influence of biotic interactions.

7th week. Modeling the geographical spread of invasive species.

8th week. Ecological processes and the spread of non-native species.

9th week. Ecological impacts of invasive species.

10th week. Impact synthesis.

11th week. Evolution of invaders.

12th week. Predicting and Preventing Invasion.

13th week. eradication and Control of Invaders.

14th week. Global Climate Change and Invasive Species.

Requirements:

- for a signature

Attendance at **lectures** is recommended, but not compulsory.

- for a grade

- The course ends in an **examination**.

The course ends in an examination. The minimum requirement for the test and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Krisztián Nyeste, assistant professor, PhD

Lecturer: Dr. Krisztián Nyeste, assistant professor, PhD

Title of course: Aquatic invasions **Code**: TTHMG9424_EN	**ECTS Credit points:** 2

Type of teaching, contact hours

- lecture: –
- practice: 1 hours/week
- laboratory: -

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:

- lecture:
- practice: 14 hours
- laboratory: -
- home assignment: 16 hours
- preparation for the exam: - hours

Total: 30 hours

Year, semester: 1st and 2nd year, 1st semester

Its prerequisite(s): –

Further courses built on it: -

Topics of course

During the practice the subjects of the main lectures are presented in case studies: Terms of aquatic invasions, alien species, invasive species. Invasive routes and vectors. Spontaneous and semi-spontaneous spreading, introducing of alien invasive species. Success of the invasion. Spreading ecology of invasive species. Ecological effects, risk assessment and management of invasions. Analysis of invasion success, and the role of natural enemies. Resistance of native communities against biological invasions. Protection and prevention against invasive species. Most common invasive species in Europe and in Hungary.

Literature

Compulsory:

1. Nentwig, W., 2008. Biological Invasions. Springer-Verlang Berling and Heidelberg GmbH & Co. KG.

Recommended:

1. Lockwood, J.L. 2013. Invasion Ecology. John Wiley and Sons Ltd.
2. Cowx, I.G., 2002. Management and Ecology of Lake and Reservoir Fisheries. Wiley-Blackwell,ISBN: 978-0852382837
3. Leppäkoski, E., Gollasch, S., Olenin, S., (Eds.), 2010. Invasive Aquatic Species of Europe.Distribution, Impacts and Management. Springer, ISBN: 978-9048161119.

Course objective/intended learning outcomes

a) Knowledge

- He/she fundamentally knows risks and ecological features of biological invasions of freshwater habitats.
- He/she expansively knows the main properties of aquatic invasions.

b) Abilities

- He/she is able to plan for protection and prevention of ecological effects of invasive species.

d) Attitude

- He/she is open to learn and accept professional improvement and innovation in his/her profession.

- He/she makes a decision in complex and unexpected decision cases by completely taking into account legal and ethical norms.

d) Autonomy and responsibility

- Even in unexpected decision-making situations he/she is capable of considering complex, fundamental questions from his/her professional field.

He/she is open to critical remarks which are professionally well-founded.

Schedule:

1st week. Introduction to invasion ecology – practice, case studies

2nd week. Transport vectors and pathways – practice, case studies.

3rd week. Trend in bumbers of invaders – practice, case studies.

4th week. Propagules – practice, case studies.

5th week. Disturbance – practice, case studies.

6th week. Establishment success: the influence of biotic interactions – practice, case studies.

7th week. Modeling the geographical spread of invasive species – practice, case studies.

8th week. Ecological processes and the spread of non-native species – practice, case studies.

9th week. Ecological impacts of invasive species – practice, case studies.

10th week. Impact synthesis – practice, case studies.

11th week. Evolution of invaders – practice, case studies.

12th week. Predicting and Preventing Invasion – practice, case studies.

13th week. eradication and Control of Invaders – practice, case studies.

14th week. Global Climate Change and Invasive Species – practice, case studies.

Requirements:

Practice:

Participation at classes is compulsory. A student must attend the courses and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

During the semester there is one practical test. It can be completed in the 14th week.

The minimum score is 50%. Based on the score of the test, the grade for the test is given accordingto the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-72	satisfactory (3)
73-84	good (4)
85-100	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Krisztián Nyeste, assistant professor, PhD

Lecturer: Dr. Krisztián Nyeste, assistant professor, PhD

Title of course: Water pollution **Code**: TTHME9425_EN	**ECTS Credit points:** 3

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: –
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: –
- laboratory: -
- home assignment: 20 hours
- preparation for the exam: 10 hours

Total: 48 hours

Year, semester: 1st and 2nd year, 1st semester

Its prerequisite(s): –

Further courses built on it: -

Topics of course

This is a comprehensive subject about water pollution: Main terms of aquatic pollution. Pollution, contamination. Main types of pollution and contamination of ground water and surface water. Main sources of pollutions. Effects of pollutions on the aquatic assemblages. Bioaccumulation and biomagnification. Bioindication, using of bioindicator species for investigation and risk assessment. Endangered status, vulnerability of aquatic organisms, biomonitoring. Tools of the water quality management and protection. Hungarian and international case studies.

Literature

1. Nentwig, W., 2008. Biological Invasions. Springer-Verlang Berling and Heidelberg GmbH & Co. KG.

Recommended:

1. Lockwood, J.L. 2013. Invasion Ecology. John Wiley and Sons Ltd.
2. Cowx, I.G., 2002. Management and Ecology of Lake and Reservoir Fisheries. Wiley-Blackwell,ISBN: 978-0852382837
3. Leppäkoski, E., Gollasch, S., Olenin, S., (Eds.), 2010. Invasive Aquatic Species of Europe.Distribution, Impacts and Management. Springer, ISBN: 978-9048161119.

Course objective/intended learning outcomes

a) Knowledge

- He/she fundamentally knows the main properties of water pollution.
- He/she expansively knows the impacts and prevention of water pollution.

b) Abilities

- He/she is able to plan for investigation, protection, and prevention of water pollution.

c) Attitude

- He/she is open to learn and accept professional improvement and innovation in his/her profession.
- He/she makes a decision in complex and unexpected decision cases by completely taking into account legal and ethical norms.

d) Autonomy and responsibility

- Even in unexpected decision-making situations he/she can consider complex,fundamental

questions from his/her professional field.
He/she is open to critical remarks which are professionally well-founded.

Schedule:

1st week. Definitions and classification of environmental pollution.

2nd week. Sources and transport of pollutants.

3rd week. Fresh and marine water pollutants.

4th week. Consequences of sewage pollution: treatment, disposal and impacts.

5th week. Nutrients and eutrophication.

6th week. Oil pollution in the marine environment.

7th week. Biological pollutants.

8th week. Plastics as pollutants.

9th week. Metals as pollutants.

10th week. Monitoring of aquatic contaminations.

11th week. Bioindicator species.

12th week. Case studies I.

13th week. Case studies II.

14th week. Summary and conclusions, revision and feedback.

Requirements:

- for a signature

Attendance at **lectures** is recommended, but not compulsory.

- for a grade

The course ends in an **examination**.

The course ends in an examination. The minimum requirement for the test and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Krisztián Nyeste, assistant professor, PhD

Lecturer: Dr. Krisztián Nyeste, assistant professor, PhD

Title of course: Water pollution **Code**: TTHMG9425_EN	**ECTS Credit points: 2**

Type of teaching, contact hours

- lecture: –
- practice: 1 hours/week
- laboratory: -

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:

- lecture:
- practice: 14 hours
- laboratory: -
- home assignment: 16 hours
- preparation for the exam: - hours

Total: 30 hours

Year, semester: 1st and 2nd year, 1st semester

Its prerequisite(s): –

Further courses built on it: -

Topics of course

During the practice the subjects of the main lectures are presented in case studies: Pollution, contamination. Main types of pollution and contamination of ground water and surface water. Main sources of pollutions. Effects of pollutions on the aquatic assemblages. Bioaccumulation and biomagnification. Bioindication, using of bioindicator species for investigation and risk assessment. Endangered status, vulnerability of aquatic organisms, biomonitoring. Tools of the water quality management and protection. Hungarian and international case studies.

Literature

1. Nentwig, W., 2008. Biological Invasions. Springer-Verlang Berling and Heidelberg GmbH & Co. KG.

Recommended:

1. Lockwood, J.L. 2013. Invasion Ecology. John Wiley and Sons Ltd.
2. Cowx, I.G., 2002. Management and Ecology of Lake and Reservoir Fisheries. Wiley-Blackwell,ISBN: 978-0852382837
3. Leppäkoski, E., Gollasch, S., Olenin, S., (Eds.), 2010. Invasive Aquatic Species of Europe.Distribution, Impacts and Management. Springer, ISBN: 978-9048161119.

Course objective/intended learning outcomes

a) Knowledge

- He/she fundamentally knows the main properties of water pollution.
- He/she expansively knows the impacts and prevention of water pollution.

b) Abilities

- He/she is able to plan for investigation, protection, and prevention of water pollution.

d) Attitude

- He/she is open to learn and accept professional improvement and innovation in his/her profession.
- He/she makes a decision in complex and unexpected decision cases by completely taking into account legal and ethical norms.

d) Autonomy and responsibility

- Even in unexpected decision-making situations he/she can consider complex,fundamental

questions from his/her professional field.
He/she is open to critical remarks which are professionally well-founded.

Schedule:

1st week. Definitions and classification of environmental pollution. – Practice, case studies

2nd week. Sources and transport of pollutants. – Practice, case studies

3rd week. Fresh and marine water pollutants. – Practice, case studies

4th week. Consequences of sewage pollution: treatment, disposal and impacts. – Practice, case studies

5th week. Nutrients and eutrophication. – Practice, case studies

6th week. Oil pollution in the marine environment. – Practice, case studies

7th week. Biological pollutants. – Practice, case studies

8th week. Plastics as pollutants. – Practice, case studies

9th week. Metals as pollutants. – Practice, case studies

10th week. Monitoring of aquatic contaminations. – Practice, case studies

11th week. Bioindicator species. – Practice, case studies

12th week. Case studies I.

13th week. Case studies II.

14th week. Summary and conclusions, revision and feedback.

Requirements:

Practice:

Participation at classes is compulsory. A student must attend the courses and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

During the semester there is one practical test. It can be completed in the 14th week.

The minimum score is 50%. Based on the score of the test, the grade for the test is given accordingto the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-72	satisfactory (3)
73-84	good (4)
85-100	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Krisztián Nyeste, assistant professor, PhD

Lecturer: Dr. Krisztián Nyeste, assistant professor, PhD