Course 701-0426-00 “Modelling Aquatic Ecosystems” FS 2025

Lectures: Nele Schuwirth (nele.schuwirth@eawag.ch),
Andreas Scheidegger (andreas.scheidegger@eawag.ch)
Exercises: Emma Chollet Ramampiandra (emma.chollet@eawag.ch),
Chuxinyao Wang (chuxinyao.wang@eawag.ch)

Information and exercises: http://www.eawag.ch/forschung/siam/lehre/modaqecosys

Goals:
The students (you) are able to:

- build mathematical models of aquatic ecosystems that consider the most important physical, chemical, biogeochemical, biological, and ecological processes.
- explain the interactions between these processes, especially between ecological and biogeochemical processes, and the behaviour of the system that results from these interacting processes.
- formulate, implement, and apply simple ecological models.
- consider stochasticity and uncertainty.

The models will be implemented with the statistical computing software R. Experience with this software that is gained during the course will be useful for statistical data analysis in general.

Prerequisites:
Ecology: Basic knowledge about structure and function of aquatic ecosystems.
Mathematics: Basics of analysis, differential equations, linear algebra, and probability.

Literature:
A comprehensive manuscript in English will be provided.

Successful participants will earn 3 ECTS credits conditional on passing a 30 min. oral examination.

Lectures and exercises take place on Wednesdays from 10.15- 12.00 in LFW B 2.
In addition to preparing and attending the lectures and exercises, the students will develop their own model during the semester. Submitting this model is **mandatory** to participate in for the oral exam. The **oral exam will take place in the first two weeks after the semester**. It will partly be based on the model the students developed.

For exercises, you will use your own notebook. You need to install a current version of R (http://www.r-project.org), the editor R-Studio (http://www.rstudio.com), as well as the packages „deSolve“, „stoichcalc“ und „ecosim“ [using the command: `install.packages("ecosim")`] **in advance of the first exercise!**

Course program 2025:

Date	Topic	Type
19.02.25	Introduction and overview of the course (chapter 1 and 2); Mass balance in a mixed reactor (ch. 3.2); Process table (ch. 4.1); Process rates (ch. 4.2); Simple phytoplankton model for a mixed lake (ch. 11.1)	L
26.02.25	Introduction to R and the „ecosim“-package (chapter 17); Review of chapter 4.1-4.2 through the example of chapter 11.1.	E
05.03.25	Extension of the first lake model to a simple phytoplankton-zooplankton model for a mixed lake (chapter 11.2)	E
12.03.25	Process stoichiometry: introduction and analytical solution (chapter 4.3.1 and 4.3.2)	L
19.03.25	Process stoichiometry: general solution from chapter 4.3.3; Introduction to the „stoichcalc“-package (chapter 15), Application of the „stoichcalc“-package	L+E
26.03.25	Biological processes in lakes (ch. 8): mineralization, nitrification, secondary production; Extension of the lake model (sediment, phosphorous, oxygen, nitrogen) (chapter 11.3)	L
02.04.25	Physical processes in lakes; Mass balance in multi-box and continuous systems (chapter 3.3-3.4); Transport and mixing in lakes (ch. 6.1.1); Sedimentation (ch. 6.2); Gas exchange (ch. 6.3); model assignments - choice of topics	L
09.04.25	Spatially structured model for plankton and biogeochemical cycles in lakes (ch. 11.4).	E
16.04.25	Transport and mixing in rivers (ch. 6.1.2); Bacterial growth (ch. 8.8); Model for benthic populations, oxygen and nutrients in rivers (ch. 11.6)	L
30.04.25	Model for benthic populations, oxygen and nutrients in rivers (chapter 11.6)	E
08.05.25	Deadline code submission for assignments	
07.05.25	Uncertainty (chapter 9), Parameter estimation (chapter 10)	L
14.05.25	Parameter estimation (chapter 10)	E
21.05.25	Stochasticity and Uncertainty (chapter 9, chapter 11.7)	L+E
23.05.25	Deadline submission of assignments	
28.05.25	Overview of existing models and their application in research and practice (ch. 13); Preparation of the oral exam; Feedback	L
02. - 13.06.25	Oral exams (exact date to be decided)	

L: Lecture, E: Computer Exercise