ENV-411

Ecohydrological modeling

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Cursus	Sem.	Type
Civil & Environmental Engineering		Obl.
Environmental Sciences and Engineering	MA2, MA4	Opt.

Language of teaching	English
Credits	4
Session	Summer
Semester	Spring
Exam	Written
Workload	120h
Weeks	14
Hours	**4 weekly**
Lecture	2 weekly
Project	2 weekly
Number of positions	

Summary

This course provides the theoretical basis for understanding and modeling the interactions between the hydrologic cycle, vegetation, soil, climate, and human society.

Content

We will look at the dynamics of water, energy, carbon, and nutrient transport within the soil-plant-atmosphere continuum and we will introduce the tools necessary for their mathematical modelling. We will consider ecohydrological interactions from local to regional and global scales, as well as at daily to seasonal and annual time scales. The focus on multiple spatio-temporal scales will allow us to introduce a number of mathematical models, from analytical derivations to plot and catchment scale deterministic and stochastic approaches as well as global scale terrestrial biosphere models. We will conclude by presenting topical issues in ecohydrological research and applications, with particular focus on agricultural land use, climate regulation, food security, and environmental sustainability.
Course content:

- Introduction (soil-plant-atmosphere system, scales, ecohydrology and society)
- The soil (soil hydraulic properties, infiltration)
- The plant (water potentials, roots, xylem, leaves and stomata, transpiration, photosynthesis)
- The atmosphere (water/energy/carbon fluxes, atmospheric boundary layer dynamics)
- (Stochastic) soil moisture dynamics
- Soil carbon and nitrogen cycles
- Vegetation patterns
- Terrestrial biosphere modeling
- Model uncertainty
- Ecohydrology for forestry, agriculture, climate
- Food-water nexus, crop production and climate change

Keywords

Ecohydrology, modeling, soil-plant-atmosphere, soil moisture dynamics, terrestrial biosphere modeling

Learning Prerequisites

Required courses

Hydrology for Engineers (ENV-221)
Soil science (ENV-222)

Recommended courses
Fundamentals in Ecology (ENV-220)

Important concepts to start the course
Numerical modeling is required

Learning Outcomes
By the end of the course, the student must be able to:
- Assess / Evaluate key linkages and feedbacks between hydrological and ecological processes.
- Describe how coupling between physical, chemical, and biological processes controls ecosystem structure and function.
- Carry out numerical simulations of soil-plant-atmosphere dynamics with models of different complexity.
- Analyze critically recent scientific literature on the subject.

Transversal skills
- Plan and carry out activities in a way which makes optimal use of available time and other resources.
- Set objectives and design an action plan to reach those objectives.
- Use a work methodology appropriate to the task.
- Communicate effectively, being understood, including across different languages and cultures.
- Demonstrate the capacity for critical thinking
- Make an oral presentation.
- Use both general and domain specific IT resources and tools
- Take account of the social and human dimensions of the engineering profession.

Teaching methods
- Weekly frontal lectures at the blackboard and with the aid of projected material.
- Tutorials on the construction, setup, and use of different ecohydrological models.
- Work in teams on a group project for the entire duration of the course.

Assessment methods
- Mid-term exam (15%)
- Group project (30%)
- Final written exam (55%)

Supervision
Office hours	Yes
Assistants	Yes
Forum	Yes
Others	Please contact the teacher by e-mail to fix an appointment

Resources
Bibliography
Slides/Class Notes

Relevant scientific articles
Books:

• Porporato, A. and Yin, J., 2022. *Ecohydrology: Dynamics of life and water in the critical zone*. Cambridge University Press.
• Bonan, G., 2019. *Climate change and terrestrial ecosystem modeling*. Cambridge University Press.

Ressources en bibliothèque

• Ecohydrology: Dynamics of life and water in the critical zone / Porporato, Yin
• Climate change and terrestrial ecosystem modeling / Bonan

Notes/Handbook

Essentials for completion of the course will be self-contained in the Class notes and the relevant scientific literature (uploaded weekly through the Moodle Platform).

Moodle Link

• https://go.epfl.ch/ENV-411