

CIVE 625 QUANTITATIVE ECO-HYDROLOGY

INSTRUCTOR

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Office Hours: MWF 1:00 - 2:00 PM - A222 Engineering Bldg.

CLASS SCHEDULE

Lecture: MWF 10:00 - 10:50 AM – B2 Engineering Bldg.

COURSE DESCRIPTION

Ecohydrology “...is concerned with the effects of hydrological processes on the distribution, structure, and function of ecosystems, and with the effects of biotic processes on elements of the water cycle.”

This course examines the hydrologic and ecological mechanisms underlying climate-soil-vegetation dynamics and soil moisture dynamics, and provides a quantitative understanding of the impacts of soil moisture on vegetation dynamics. Topics will include: soil water dynamics; land surface energy budgets; evapotranspiration; eco-hydrologic optimality; vegetation competition; hydro-climatic variability and ecosystem structure.

REFERENCES

There is no comprehensive eco-hydrology textbook. However, we will base our presentation upon material in the following sources:

1. “*Ecohydrology of Water-Controlled Ecosystems – Soil Moisture and Plant Dynamics*” by Ignacio Rodriguez-Iturbe and Amilcare Porporato. Cambridge University Press, Cambridge, UK, 2004.
2. “*Ecohydrology - Darwinian Expression of Vegetation Form and Function*” by Peter S. Eagleson. Cambridge University Press, Cambridge, UK, 2002.
3. “*Eco-hydrology – Plants and water in terrestrial and aquatic environments*” edited by Andrew J. Baird and Robert L. Wilby. Routledge, NY, 1999.
4. “*Hydroecology and ecohydrology: Past, present and future*”. Edited by Paul J. Wood, David M. Hannah and Jonathan P. Sadler. John Wiley and Sons, Inc., 2007.
5. Class notes and readings from refereed journals, which will be distributed as the course progresses.

COURSE OBJECTIVES

The overarching objective of this course is to investigate the interactions between physical hydrological processes and ecosystem processes, *focusing on soil moisture dynamics and vegetation interactions*. The evolution of terrestrial ecosystems depends on the need of vegetation for inputs of light, water, and nutrients. These inputs are variable in time and space, and their assimilation depends on vegetation characteristics and ecosystem structure. Therefore, the course will emphasize the dynamics of

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soil moisture and water-vegetation interactions, as vegetation is both cause and effect of the space-time dynamics of soil water and climate.

The course will consider a broad range of spatial and temporal scales with emphasis placed on those scales and systems most important for eco-hydrological applications in the solution of real world problems (e.g., eco-engineering and stream restoration, impacts of land use changes on eco-systems, allocation of water among competing uses - water supply and maintenance of ecosystem services, etc.). The course is designed to encourage groups of students from traditionally separate disciplines to collaboratively combine their unique skills and insights to answer multidisciplinary eco-hydrological questions.

INSTRUCTIONAL METHODOLOGY

This course emphasizes the understanding of eco-hydrologic processes and of their mutual interactions from a mechanistic point of view. Interdisciplinary aspects of eco-hydrologic science are presented in a unified framework.

The course will be given in a series of bi-weekly meetings during which advanced topics will be presented and discussed in depth. Each week, a set of papers and other material will be assigned, which students will be expected to read in advance of class. Students will be expected to come to class ready to discuss the specific topic of the day and to take the initiative in leading the discussion.

Presentation will consist of classroom lectures, and may include guest lecturers on certain topics, and presentations by students. Students are expected to read all required material from textbooks or other documents.

EVALUATION

Course evaluation will be based on the following aspects:

- Class participation
- Class presentations
- Term paper

ACADEMIC INTEGRITY AND HONOR PLEDGE

This course will adhere to the Academic Integrity Policy of the Colorado State University General Catalog and the Student Conduct Code. Accordingly, we will use an honor pledge as indicated below.

The honor pledge will be:

“I pledge that I have not given, received, or used any unauthorized assistance.”

“I pledge that I will not give, receive, or use any unauthorized assistance.”

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TOPICS

1. General introduction
 - a. Eco-Hydrologic Science
 - b. Bio-physical climate system: role of water in climate and ecosystem processes
 - c. Feedback processes:
 - i. Earth surface-atmosphere;
 - ii. Ocean-atmosphere;
 - iii. Land-atmosphere;
 - iv. Biophysical land surface coupling
2. The regional-scale water balance
 - a. Annual water balance
 - b. Seasonal water balance
 - c. Vegetation and ecological optimality
3. Hydrologic feedbacks in land-atmosphere interactions
 - a. Land-atmosphere interactions and large-scale water balance
 - b. Soil moisture feedback
 - c. Thermodynamic feedback
 - d. Ground water convergence feedback
 - e. Vegetation feedback
4. Precipitation
 - a. Precipitation recycling
 - b. Soil moisture feedbacks and precipitation
 - c. Interception
 - d. Atmospheric thermodynamics and cloud physics
5. Evaporation and transpiration
 - a. Potential and actual ET
 - b. Regional scale ET: Bouchet's Hypothesis
 - c. Evaporation paradox
 - d. Extremum principles of evaporation and transpiration: Optimality
 - e. Boundary layer physics
6. Non-linear dynamics of soil moisture and water balance
 - a. Bimodality of soil moisture distribution
 - b. Soil moisture feedback
 - c. Thermodynamic feedback
 - d. Soil moisture dynamics and ecosystem structure
7. Seasonal and inter-annual fluctuations in soil moisture dynamics
8. Plant water stress
 - a. Soil-water deficit and plant water stress
 - b. Dynamic water stress
 - c. Environmental controls
 - d. Optimality
9. Coupled dynamics of evaporation, transpiration (and photosynthesis), and soil water balance
10. Hydrologic variability and ecosystem structure
 - a. Climate and soil controls on temporal and spatial vegetation patterns