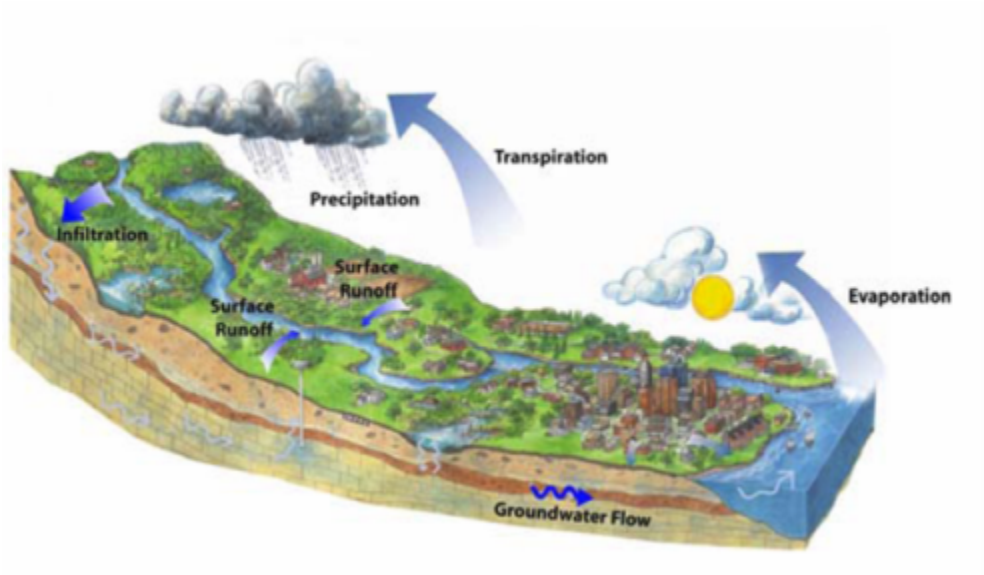
Module 2

Ecohydrology and Water Balance — Case Study on Forested Wetlands



Date: January 30, 2025
Topic: Ecohydrology and Water Balance
Case Study: Effects of land-use change and drought on decadal evapotranspiration and water balance of natural and managed forested wetlands along the southeastern U.S. lower coastal plain (Aguilos et al., 2021)
https://doi.org/10.1016/j.agrformet.2021.108381
Duration: 3 hours total

Session Overview

This session introduces students to ecohydrological principles and water balance dynamics within managed and natural forested wetlands. Using long-term eddy covariance data, students will analyze how land-use conversion, forest age, and climate variability, particularly drought—influence evapotranspiration (ET), drainage, and hydrological resilience. The module bridges theory and practice by engaging students in a data-driven discussion on forest water management under changing environmental conditions.

Learning Objectives (Aligned with 4DEE Framework)

4DEE Dimension	Learning Objective
Core Ecological Concepts	Explain how evapotranspiration, precipitation, and drainage interact to shape the water balance of forested wetland systems.
Ecological Practices	Apply ecohydrological data analysis methods (eddy covariance, water balance modeling) to assess hydrologic fluxes in managed vs. natural forests.
	Identify, describe, and analyze the research problem and the gaps in existing literature related to their topic
Cross-Cutting Themes	Evaluate drought effects on hydrological cycles and carbon-water coupling across forest types and management regimes.
Human–Environment Interaction	Assess land-use change and forest management impacts on water regulation and ecosystem resilience.

Expected Outcomes

1. Demonstrate understanding of forest water balance components and their interdependence.
2. Interpret and discuss eddy covariance and hydrological data within ecological and management contexts.
3. Compare managed and natural forest ecosystems regarding their response to drought.
4. Formulate management recommendations for balancing water use and ecosystem sustainability.
5. Write a clear and coherent problem and gap statement that strengthens the foundation of their research proposal.

Schedule and Activities

Time	Person/s Involved	Activity	4DEE Framework	Description
60 mins.	Guest Lecturer	Ecohydrology and Water Balance by Dr. Ge Sun	Core Ecological Concepts	Determining the basic components of water balance and their drivers.
75 mins.	Group	Case studies on water-related issues (Student-led Discussion) and working with water balance data	Ecological Practices + Cross-Cutting Themes	Analyze and Interpret evapotranspiration and water balance data from the Aguilos et al. study. Identify major hydrologic trends across forest age classes and management types.
15 mins.	Individual	Analytical Reflection	Human-Environment Interactions	Formulate management recommendations for water sustainability
20 mins.	Independent Study	Scientific Writing - The study problems and gaps	Ecological Practices + Cross-Cutting Themes	Identifying problems and gaps on student thesis – draft

				Effective literature gathering/data mining Comparisons to highlight generality vs. context-specificity
170 mins.				

Case Study Summary (Aguilos et al., 2021)
This study investigates how land-use change and drought jointly influence long-term evapotranspiration (ET) and ecosystem water use in a subtropical watershed. By analyzing decadal hydrologic records alongside satellite-based vegetation metrics, the authors show that conversion of natural vegetation to agriculture significantly altered surface water fluxes, while recurring droughts further suppressed ET by reducing plant water availability and ecosystem productivity. The case demonstrates that ET responds not only to climatic variability but also to human-driven landscape modification, with the combined effects amplifying watershed-scale hydrologic change and affecting long-term water resource sustainability.

Discussion Prompts/Assessment Guide

Core Ecological Concepts

Talking Point:
Forested wetlands regulate hydrology through evapotranspiration, drainage, and storage. ET links water and energy cycles, and its variability under land-use change influences ecosystem functioning.

Thought-Provoking Questions:
1. How do evapotranspiration and drainage interact in maintaining water balance?
2. Why do older pine plantations show higher ET than younger stands or natural forests?

Assessment (Individual, 20 points):
Explain how drought and land-use change influence evapotranspiration and drainage in coastal plain forests.

Ecological Practices

Talking Point:
Eddy covariance and hydrological modeling provide tools to quantify ecosystem-scale water fluxes.

Thought-Provoking Questions:
1. How does the eddy covariance technique measure evapotranspiration and energy fluxes?
2. What are the strengths and challenges of long-term water balance monitoring?

Assessment (Group, 20 points):
Analyze and Interpret evapotranspiration and water balance data from the Aguilos et al. study. Identify major hydrologic trends across forest age classes and management types.

Cross-Cutting Themes

Talking Point:
Drought and land-use conversion reshape hydrological patterns and carbon-water coupling in coastal forest ecosystems.

Thought-Provoking Questions:
1. What mechanisms allow mature forests to maintain ET under drought?
2. How can ecohydrological data guide adaptive forest management?

Assessment (Group, 20 points):
Develop a conceptual diagram showing how precipitation, evapotranspiration, and drainage vary across land-use types and climate scenarios.

Human–Environment Interaction

Talking Point:
Managed pine plantations alter water cycling through ditching and harvesting practices, influencing downstream hydrology and ecosystem services.

Thought-Provoking Questions:
1. How do management and hydrological modifications affect regional water availability?
2. What policy or management actions could balance timber production with hydrological stability?

Assessment (Individual, 20 points):
Write a policy brief recommending practices to sustain hydrological stability and water quality under increased drought conditions.

Scaffolded Writing Series: The Research Problems and Gaps
(Individual, 20 points)

In this session, students learn how to identify, describe, and analyze the research problem and the gaps in existing literature related to their topic. Through a guided and systematic approach, they will explore what is already known, what remains unclear, and why addressing these gaps is necessary for advancing knowledge in their field.

Assessment Summary

Assessment Type	Description	Targeted 4DEE Dimension
Short Written Response (20 pts)	Explain how drought and land-use change influence evapotranspiration and drainage in coastal plain forests.	Core Ecological Concepts
Group Analysis (40 pts)	Interpret evapotranspiration and water balance data from the Aguilos et al. study. Identify major hydrologic trends across forest age classes and management types.	Ecological Practices + Cross-Cutting Themes
Individual Reflection (20 pts)	Write a at most 250-word reflection on the ecological and societal implications of forest water management under drought conditions.	Human–Environment Interaction
Scaffolded Writing Series – The Problem and Gaps (20 points)	Define the research problems and identify gaps	Core Ecological Concepts

Reference

Aguilos, M., Noormets, A., Gavazzi, M. J., Sun, G., Domec, J.-C., McNulty, S. G., King, J. S., Amatya, D. M., & Skaggs, R. W. (2021). Effects of land-use change and drought on decadal evapotranspiration and water balance of natural and managed forested wetlands along the southeastern U.S. lower coastal plain. Agricultural and Forest Meteorology, 308–309, 108381. https://doi.org/10.1016/j.agrformet.2021.108381