FALL 2025

CUAHSI VIRTUAL UNIVERSITY

CUAHSI Specialized Online Hydrology Modules

Overview

The Consortium of Universities for the Advancement of the Hydrologic Sciences Inc. (CUAHSI) has organized these inter-university modules to enhance the depth and breadth of graduate course offerings at universities across the nation, increase the rate of uptake of new research, and facilitate networking among our hydrologic sciences community.

The format of the course is designed to give students flexibility to select up to three topics most relevant to you from a list of modules that are being offered by leading faculty from across the country in these specialized research niches. Each module, which is equivalent to one-third of a semester course[1], is designed to facilitate interaction among the instructor and students and contain some evaluation elements (problem sets, projects, presentations, exams etc.). The instructor at each student's home university will assign a grade based on the student scores and class distribution provided by the module instructor.

The course will run from September to December with each module being conducted for 4 weeks.

Instructors

Old Dominion University
Xixi Wang **|** x4wang@odu.edu

University of Idaho
Meetpal Kukal **|** mkukal@uidaho.edu

University of Kansas
Sam Zipper | samzipper@ku.edu

University of Nevada – Las Vegas
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University of Washington
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University of Wisconsin – Madison
Steven Loheide | loheide@wisc.edu

Utah State University
David Tarboton | david.tarboton@usu.edu

Virginia Tech
Landon Marston | lmarston@vt.edu

[1] As University of Washington is on the quarter semester system one module is equivalent to half a quarter.

Modules dates and times

Module 1: September 3 through September 30
Module 2: October 8 through November 4
Module 3: November 10 through December 9

	Module 1 Sep. 3 - Sep. 30	**Module 2** Oct. 8 - Nov. 4	**Module 3** Nov. 10 - Dec. 9
Monday/Wednesday 2:30 pm - 4:00 pm ET	Applying Geographic Information Systems for Terrain and Watershed Analysis in Hydrology *David Tarboton, Utah State University*	Hydrologic Data Visualization *Sam Zipper, University of Kansas*	Uncertainty Quantification, Sensitivity Analyses and Inverse Methods in Hydrology[3] *Zach Perzan, University of Nevada, Las Vegas*
Monday/Wednesday 4:00 pm - 5:30 pm ET	Ecohydrology of Groundwater Dependent Ecosystems[2] *Steven Loheide, University of Wisconsin Madison*		Snow Hydrology: Focus on Modeling[3] *Jessica Lundquist, University of Washington*
Tuesday/Thursday 11:00 am - 12:30 pm ET		Geospatial and Hydrologic Data Catalogs and Processing Using Google Earth Engine *Samapriya Roy, University of Nevada Reno*	Infiltration Process and its Modeling[2,3] *Xixi Wang, Old Dominion University*
Tuesday/Thursday 3:30 pm - 5:00pm ET	Standardized Evapotranspiration modeling for agricultural applications[1] *Meetpal Kukal, University of Idaho*	Sustainable Human-Water Systems[1] *Landon Marston, Virginia Tech*	

ET: Times are given in the US Eastern Time Zone.

[1] These courses are offered as part of an agriculture-focused track
[2] These courses have a focus on groundwater but are not offered as part of a track due to scheduling conflicts
[3] These courses have a focus on modeling but are not offered as part of a track due to scheduling conflicts

Registration and Credit

To register for the CUAHSI Virtual University modules, students must follow these steps:

1. Register with your university during the normal registration period for the course number listed for your university (e.g. CivEng 619 for University of Wisconsin - Madison). Registration is limited to 45 module registrations per university.
2. CUAHSI will handle student sign up for individual modules across universities. Fill out this form to sign up with CUAHSI for the Virtual University. Module sign up is also limited and will be accommodated on a first-come, first-served basis. Registration for a module will close when capacity is met. Each module is limited to 45 students.
3. Students should sign up for one to three modules based on their learning needs and interests, recognizing that three modules typically equate to a full semester course (University of Washington two modules equal a full quarter course). Students should recognize the time demands of these modules and avoid multiple modules in the same four week block unless they are fully confident in having the time to commit to this.
4. The number of university credits given for each module taken will be determined by the home university instructor as credit systems vary among institutions (e.g quarter vs. semester system).
5. Each student will be notified when a Canvas account is established for them. Canvas is the online learning management system that will be used for CUAHSI Virtual University.

Benefits to Students

- Access to national experts in specialized sub-disciplines of hydrologic sciences
- Wider selection of course offerings with greater depth than typically available at a single university
- Networking and collaboration with students and faculty nationwide
- Greater collaboration and community awareness of research activities

Goals

- Evaluate the literature, theory, and/or models associated with distinct advanced topics within hydrologic sciences
- Network and effectively collaborate virtually with peers from multiple institutions
- Share data and resources across the hydrologic community
- Specific learning objectives will be provided in the syllabus for each module

Requirements

- Participate in on-campus organization, synthesis, and debriefing sessions held by instructors at home university.
- Register for and complete one to three modules[2]. Each module will have an individual syllabus that outlines the expectations and requirements for that component of the course.

Evaluation

The evaluation criteria for each module will be outlined in the individual module syllabus. The module instructor will provide a score to each home university instructor for each student as well as the class distribution for their module. Grades at each institution are the responsibility of the home institution instructor, based on input from the instructors for each module. In addition to scheduled modules, there may be campus coordination and synthesis meetings at the beginning and in between modules. Home institution instructors may assign a portion of the grade based on participation in these meetings.

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[2] Flexibility in the number of modules is limited at some universities.

Students with Disabilities

If you need accommodations for a physical or learning disability, please see the instructor at your home university.

Academic Integrity

The Honor Code is a cornerstone of this course. It is an undertaking of the students, individually and collectively:

1. that they will not give or receive aid in examinations; that they will not give or receive unpermitted aid in class work, in the preparation of reports, or in any other work that is to be used by the instructor as the basis of grading;
2. that they will do their share and take an active part in seeing to it that others as well as themselves uphold the spirit and letter of the Honor Code.

Guidelines for Online Etiquette

The goal of these guidelines is to encourage online interaction in a positive and engaging manner. They will be posted and discussed in greater detail on the course website.

- Participate
- Report glitches
- Help others
- Be patient
- Be brief
- Use proper writing style
- Cite your sources
- Refrain from emoticons and texting lingo
- Respect diversity
- No YELLING!
- No flaming
- You can't un-ring the bell

Non-discriminating Environment

CUAHSI is committed to creating a dynamic, diverse, and welcoming learning environment for all students and has a non-discrimination policy that reflects this philosophy. Disrespectful behavior or comments addressed toward any group or individual, regardless of race/ethnicity, sexuality, gender, religion, ability, or any other difference is deemed unacceptable in this class, and will be addressed by the professor.

Code of Conduct

All CUAHSI Virtual University participants are expected to adhere to the CUAHSI Code of Conduct. The full Code can be found here.

Module Descriptions (in alphabetical order)

Applying Geographic Information Systems for Terrain and Watershed Analysis in Hydrology

David Tarboton, Utah State University
Module 1 (Sep. 4 - Sep. 30)
Monday/Wednesday 2:30 - 4:00 pm ET

Digital mapping of hydrology and water resources information using content from publicly available sources such as the US national map, and other climate and hydrography datasets. Hydrologic terrain analysis using digital elevation models (DEMs) and DEM based delineation of channel networks and watersheds. Flood hydrology modeling and inundation mapping based on height above the nearest drainage derived from digital elevation models. There will be four detailed computer exercises that introduce (1) Building a watershed basemap using publicly available hydrography and watershed boundary data in the US; (2) Spatial analysis. Calculation of slope, land use and precipitation over subwatersheds; (3) Watershed delineation from digital elevation models; and (4) Basic GIS Programming using Python, using calculation of river hydraulic properties using height above the nearest drainage (HAND) as an example.

Prerequisite(s): This course will use ArcGIS Pro from ESRI. The prerequisite is basic knowledge of GIS through any prior GIS course or self-preparation through the free Get started with ArcGIS Pro online lesson from ESRI at https://learn.arcgis.com/en/projects/get-started-with-arcgis-pro/. Arrangements will be made for students to use ArcGIS Pro through their university site license

Ecohydrology of Groundwater Dependent Ecosystems

Steven Loheide, University of Wisconsin - Madison
Module 1 (Sep. 4 - Sep. 30)
Monday/Wednesday 4:00 - 5:30 pm ET

Ecohydrologic research investigates the effects of hydrological processes on the distribution, structure, and function of ecosystems, and the effects of biotic processes on elements of the water cycle. Groundwater dependent ecosystems are ecosystems that have their species composition and natural ecologic processes determined by groundwater processes. In this class, we discuss and quantify ecohydrologic processes in groundwater dependent ecosystems. We will develop techniques to exploit the signal contained within diurnal watertable fluctuations to quantify the groundwater component of ET. We will explore a variety of approaches for quantitatively describing how groundwater controls vegetation composition. We will integrate the understanding we develop about the ecohydrologic functioning of groundwater dependent ecosystems to simulate coupled hydrologic and ecologic processes for prediction of vegetation patterning.

Prerequisite(s): Course in hydrogeology or groundwater. Data processing experience (Matlab will be the preferred platform; R can be used but without instructor support).

Geospatial and Hydrologic Data Catalogs and Processing Using Google Earth Engine

Samapriya Roy, University of Nevada - Reno & Desert Research Institute
Module 2 (Oct. 8 - Nov. 4)
Tuesday/Thursday 11:00 am - 12:30 pm ET

This module focuses on the complete lifecycle of hydrological data - from collection and conversion to analysis and application. As the volume and variety of Earth observation data continue to grow exponentially, understanding best practices in data management becomes crucial for efficient scientific workflows. This course will guide students through the process of working with diverse data sources, implementing FAIR (Findable, Accessible, Interoperable, Reusable) data principles, and leveraging cloud-native formats and platforms for hydrological applications. Students will learn how to properly collect, transform, and integrate data from multiple sources including gridded satellite and climate, and ground-based sensor data archives.

The course will focus on preparing data for use across platforms with a focus on introducing and using Google Earth Engine, Climate Engine and other applications for large-scale data processing and application development. The course will cover data conversion workflows, optimization techniques, and best practices for creating shareable, reproducible analysis pipelines that address real-world hydrological challenges. Student support will be focused around students' research topics to maximize learning and application potential.

Prerequisite(s): A Google Earth Engine account is required to access datasets, run analyses, and develop applications. Basic programming knowledge, preferably in JavaScript or Python, will help in understanding and implementing data processing workflows.

Hydrologic Data Visualization

Sam Zipper, University of Kansas
Module 2 (Oct. 8 - Nov. 4)
Monday/Wednesday 2:30 - 4:00 pm ET

A picture is worth 1000 words, but only if the graphic is well-designed to convey the appropriate message to the target audience of the visualization. This module will provide hydrology-oriented training in effective visualization techniques that will help students understand the hydrologic phenomena they are investigating and clearly convey their findings. Students will get hands-on experience with the development of figures that are common in hydrologic applications including conceptual models and quantitative plots, with a focus on best practices for designing effective, accessible, and reproducible visualizations. The module will include strategies to overcome the unique challenges associated with hydrologic data visualization such as working with skewed data and complex, multivariate systems, and how visualizations can be designed to meet the needs of different target audiences (scientists, stakeholders, public) and presentation formats (paper, report, poster, web). Module participants will develop and improve figures using their own data, provide peer-to-peer feedback, and leave the course with a portfolio of visualizations and strategies that can be used in future presentations and publications.

Prerequisite(s): Familiarity with a programming-based approach to data analysis and visualization (R, Python, MATLAB, etc.).

Infiltration Process and its Modeling

Xixi Wang, Old Dominion University
Module 3 (Nov. 10 - Dec. 9)
Tuesday/Thursday 11:00 am - 12:30 pm ET

Infiltration is a critical hydrologic process that influences soil water and shallow groundwater dynamics. In this module, students will explore the factors controlling infiltration and learn commonly used models for calculating both total infiltration and infiltration rates as a function of time. To enhance their understanding, students will complete two assignments and a take-home exam. By the end of this module, students are expected to confidently apply the class materials to solve practical problems or undertake research projects.

Prerequisite(s): Calculus I, Microsoft Excel

Snow Hydrology: Focus on Modeling
Jessica Lundquist, University of Washington
Module 3 (Nov. 10 - Dec. 9)
Monday/Wednesday 4:00 - 5:30 pm ET

Modeling the hydrologic regime in snow-dominated ecosystems requires an understanding of data sources (to drive the model, to update the model, and to evaluate the model's performance); of model architecture (how to set up the model, run the model and make decisions regarding model parameters and model physics); and how to optimally combine data and modeling (data assimilation and model evaluation). The course objective is to learn modeling concepts with hands-on experience, as opposed to being a tutorial on how to run a particular model. We will use a modular modeling framework, SUMMA, which incorporates components from most snow models used in land surface and hydrologic modeling today. The class will include hands-on computer laboratory exercises using existing datasets and models. The target audience is people who will benefit from an understanding of snow modeling but who are not already experts.

Prerequisite(s): We will be using python to run a snow model. Some background in computer programming or snow science will be very useful but is not required.

Standardized ET modeling for agricultural applications
Meetpal Kukal, University of Idaho
Module 1 (Sep. 4 - Sep. 30)
Tuesday/Thursday 3:30 - 5:00 pm ET

This module will educate students on the standardized approaches to simulate water use in irrigated agriculture, which is usually the largest and most uncertain component of the hydrologic budgets in many ecosystems. The module will start with an overview of hydrologic budgets in agricultural fields and how they are impacted by variation in soils, environment, and management. Next, each student will select a field of interest and obtain open source datasets of soils (Web Soil Survey) and weather (Climate Engine) for their sites. They will simulate hydrologic budget components for their sites, including effective precipitation, evapotranspiration, and deep percolation under different water management regimes and stress conditions. We will use recently published OpenET data to compare students' simulations of crop evapotranspiration. To maximize reach, the simulations will be carried out using both spreadsheet models as well as Python-based tools. The intent of the module is that the students understand soil-crop-atmospheric relationships and its relationships with typical management practices on an agricultural field.

Prerequisite(s): None. All physical processes will be explained with sufficient detail in class. As for coding skills, these are not required. There will be an option to use spreadsheets to model the hydrological budgets, as well as Python-based coding to achieve the same.

Sustainable Human-Water Systems
Landon Marston, Virginia Tech
Module 2 (Oct. 8 - Nov. 4)
Tuesday/Thursday 3:30 - 5:00 pm ET

"Sustainable Human-Water Systems" is a course that examines the relationship between humans and water resources, with a focus on developing and implementing sustainable water management practices in agricultural settings. Throughout the course, students will learn about the various ways in which water is used and managed, including two-way feedback and dynamics between social (e.g., policy, regulation, institutions, economics, behavior) and environmental (e.g., groundwater, surface water, ecosystems) systems. Students will also explore the environmental, social, and economic impacts of different water management practices and the challenges of balancing the needs of society with those of the natural environment. This transdisciplinary course will blend theory, empirical data, and modeling to explore topics such as water scarcity, groundwater governance and management, human behavior and institutions, and the evolution of cooperation, decision-making, and social dilemmas. Throughout the course, students will have the opportunity to engage with case studies, participate in group discussions and debates, and work on group projects that involve developing and evaluating sustainable water management strategies. By the end of the course, students will have gained a deep understanding of the complex interplay between humans and water resources and the skills and knowledge necessary to develop and implement sustainable water management practices.

Prerequisite(s): None

Uncertainty Quantification, Sensitivity Analyses, and Inverse Methods in Hydrology

Zach Perzan, University of Nevada - Las Vegas
Module 3 (Nov. 10 - Dec. 9)
Monday/Wednesday 2:30 - 4:00 pm ET

This module dives into the quantitative methods used to understand and manage uncertainties in hydrologic modeling. It begins with an introduction to the concepts of uncertainty quantification and sensitivity analysis, exploring their utility in extracting mechanistic understanding from large sets of complex simulations. Students will learn various techniques to assess model sensitivity and how to implement these techniques in diverse types of model simulations. The course will also cover inverse methods, focusing on how these approaches can enhance model reliability and fidelity. Through Python-based assignments, practical sessions will include the application of Bayesian statistics, Monte Carlo simulations, and global sensitivity analysis using modern software tools.

Prerequisite(s): Undergraduate course in hydrology. Prior experience using Python or a similar programming language (e.g., R or Matlab) is highly recommended but not required.

Questions?

For questions on the module content, please contact the instructor.

For questions related to specifics about your Institution (such as grading policies), contact the CVU instructor at your home Institution.

For general questions, please contact commgr@cuahsi.org