FALL 2022

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 community.

The format of the course is designed to give you flexibility to select the three[1] topics most relevant to you from a list of modules that are being offered by leading faculty in these specialized research niches from across the country. Each module, which is equivalent to one-third of a semester course, 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 November with each module being conducted for 4 weeks and takes place in *Eastern Time.*

Instructors

Boise State University
Alejandro Flores | lejoflores@boisestate.edu

Indiana University
Adam Ward | adamward@indiana.edu

University of Kansas
Samuel Zipper | samzipper@ku.edu

University of Nevada – Reno
Scott Tyler | styler@unr.edu

University of Washington
Erkan Istanbulluoglu | erkani@uw.edu

University of Wisconsin – Madison
Steven Loheide | loheide@wisc.edu

University of Zurich
Jan Seibert | jan.seibert@geo.uzh.ch

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

[1] As University of Washington is on the quarter semester system, students must select two topics from the second and third modules , starting in October and November, respectively. For other universities, if you have an extenuating circumstance where you need to take fewer credits, you must speak with your home university instructor.

Modules dates and times

Module 1: September 7 through October 4
Module 2: October 10 through November 3
Module 3: November 9 through December 8

	Module 1 Sep. 7 - Oct. 4	**Module 2** Oct. 10 - Nov. 3	**Module 3** Nov. 9 - Dec. 8
Monday/Wednesday 11:00am - 12:30pm ET	Crop-Groundwater Interactions Instructor: Loheide		
Monday/Wednesday 3:30 - 5:00pm ET	Open and Reproducible Research Computing Instructor: Flores	Stream Solute Tracers: What, why, & how? Instructor: Ward	Hydrological Catchment Modeling Using Bucket-Type Models Instructor: Seibert
Tuesday/Thursday 11:00am - 12:30pm ET		Hydrologic Data Visualization Instructor: Zipper	Applications of Drones and UAS in Hydrology Instructor: Tyler
Tuesday/Thursday 3:30 - 5:00pm ET	Applying Geographic Information Systems for Terrain and Watershed Analysis in Hydrology Instructor: Tarboton		
Tuesday/Thursday 5:00 - 6:30pm ET			Modeling Watershed Dynamics Using Landlab Instructor: Istanbulluoglu

How to Register

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. SPEA-E 710 for Indiana University).
    a. Registration is limited to 15 students 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.
    a. 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.
    b. As University of Washington is on the quarter system, students select two modules: one from the October session and one from November. UW students may sign up for a third module during the September time block as an auditor. For other universities, if you have an extenuating circumstance where you need to take fewer credits, you must speak with your home university instructor.
3. 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 hydrology
- 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 three distinct advanced topics within hydrology
- Network and effectively collaborate virtually with peers across the country
- 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 instructor at home university.
- Register for and complete 3 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.

Students with Disabilities

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

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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)

Applications of Drones and UAS in Hydrology

Scott Tyler, University of Nevada – Reno
Module 3 (Nov. 9 – Dec. 8)
Tuesday/Thursday 11:00am – 12:30pm ET

This module focuses on the integration of remote sensing data into hydrology, specifically addressing recent advances in unmanned aircraft systems (UAS), or drones, to obtain high resolution, repeat imagery. We will begin the course with an overview of remote sensing capabilities and their integration in UAS

platforms. We will then explore topographic analysis from photogrammetry and the development of high-resolution Digital Elevation Models (DEMs) to compliment in-stream and groundwater measurements.

The module will next focus on infrared sensing, both near-IR for vegetation density and stress, as well as repeated thermal IR for both stream and land surface temperature. Students will have access to photogrammetry and other remote sensing software as well as a suite of data sets.

Prerequisites: Undergraduate or graduate level introductory hydrology

Applying Geographic Information Systems for Terrain and Watershed Analysis in Hydrology

David Tarboton, Utah State University
Module 1 (Sep. 7 – Oct. 4)
Tuesday/Thursday 3:30pm – 5:00pm 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: 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 2.5 hour free Getting Started with ArcGIS Pro 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 or student licenses valid for 1 year.

Crop-Groundwater Interactions

Steve Loheide, University of Wisconsin-Madison
Module 1 (Sep. 7 – Oct. 4)
Monday/Wednesday 11:00am – 12:30pm ET

Groundwater has played a critical supporting role in the economic development of the US by enhancing the reliability of food systems. This course will document the role of groundwater in supporting agriculture through irrigation and will provide tools for irrigation scheduling. In addition, the course will develop a conceptual and quantitative framework by which shallow groundwater can subsidize crop yield through direct root water uptake and decrease yield by causing oxygen stress (waterlogging). We will develop and utilize methods for quantifying drainage rates from agricultural lands to design tile drainage systems. Finally, we will investigate landscape scale interactions among cropland, groundwater systems, and semi-natural landcover types and their effect on the provisioning of groundwater related ecosystem services. By further developing our understanding of crop-groundwater interactions and feedback mechanisms they cause throughout the critical zone, we can better manage our agricultural landscapes to improve environmental sustainability as well as food and water security.

Prerequisites: Undergraduate course in hydrology or hydrogeology.

Hydrological catchment modeling using bucket-type models
Jan Seibert, University of Zurich
Module 3 (Nov. 9 – Dec. 8)
Monday/Wednesday 11:00am – 12:30pm ET

Hydrological models are essential tools for decision making at the catchment scale. These models are crucial for forecasting hydrological conditions, ranging from the short-term forecasts of flooding in the coming hours or days to long-term forecasts of hydrological climate change impacts. This module will focus on bucket-type models as a representation of catchment hydrology using the HBV model as an example. After a general overview and motivation, the history of catchment models and a detailed introduction to the HBV model, we will address issues like model uncertainties, automatic model calibration, model-performance measures, multi-criteria calibration, the value of data. Furthermore, we will address the use of models to quantify land-use und climate changes and will discuss how tracer data can be included into this type of models. Hands-on modelling exercises will provide further opportunities to get familiar will typical modelling issues.

Prerequisites: Undergraduate course in hydrology. Ability to process data in a computing program (e.g., Matlab, Python, R).

Hydrologic data visualization
Samuel Zipper, University of Kansas
Module 2 (Oct. 10 – Nov. 3)
Tuesday/Thursday 11:00am – 12:30pm 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.

Prerequisites: Completion of Hydrologic Data Science Module 1 ("Open and Reproducible Computing"), and/or past experience with git and a programming-based approach to data analysis and visualization (R, Python, MATLAB, etc.).

Modeling Watershed Dynamics Using Landlab
Erkan Istanbulluoglu, University of Washington
Module 3 (Nov. 9 – Dec. 8)
Tuesday/Thursday 5:00pm – 6:30pm ET

This course will present key processes that shape watershed echohydrologic and geomorphic response and their interactions using Landlab, a Python-based modeling toolkit for building, coupling, and exploring two-dimensional numerical models of Earth-surface dynamics (http://landlab.github.io/#/). We will first review the model structure of Landlab, and its raster and network model grid classes with examples. In each lesson, we will introduce theory and give examples of watershed hydrologic, ecologic and geomorphic processes and their implementation in Landlab. Examples will include routing of surface overland flow, mapping soil moisture and evapotranspiration, echohydrologic simulations of vegetation dynamics using cellular automation rules for plant competition, mapping landslide risk, and landscape evolution modeling. Model forcing of climate will be retrieved from existing gridded data sets using Landlab utilities, local weather stations, or through stochastic storm generation. Homework assignments will utilize Landlab models in examples that will require some basic code manipulation to incorporate additional process loops and data input and output.

Prerequisites: Undergrad course in hydrology/environmental sciences and some basic Python skills.

Open and Reproducible Research Computing for Hydrologic Science
Alejandro Flores, Boise State University
Module 1 (Sep. 7 – Oct. 4)
Monday/Wednesday 3:30pm – 5:00pm ET

Computing underlies much of what water scientists do, whether in the field, laboratory, office. Among other things we use computing to: (1) wrangle, clean, and quality control data from in situ sensors, (2) manage, analyze, and visualize data collected from aircraft and satellites, and (3) develop, calibrate, and evaluate numerical models. This module introduces students to some effective practices for using computing in the hydrologic and critical zone sciences. At the end of this module you will be able to effectively manage data throughout the entirety of its life cycle, use version control to maintain and track source code, create and share Jupyter notebooks to document reproducible and transferable workflows, and set up and maintain an effective scientific computing environment. The module makes use of the HydroShare framework and data therein to demonstrate how to effectively share data, present computational workflows, and contribute to the broader water science community.

Prerequisites: Undergraduate course in hydrology, some familiarity with statistical concepts like mean, variance, and correlation.

Stream Solute Tracers: What, Why, & How?
Adam Ward, Indiana University
Module 2 (Oct. 10 – Nov.3)
Monday/Wednesday 3:30 – 5:00pm ET

Stream solute tracers are a common research technique to assess transport and transformation in the environment. Still, execution of a well-conceived field experiment and responsible interpretation of the data remain challenging. This module will cover:

1. design and execution of stream solute experiments, including common pitfalls and challenges;
2. interpretation of recovered field data using time series analyses, water and solute mass balances, ranked Storage Selection interpretation, separation of mass involved in advection-dispersion vs. transient storage mechanisms, and breakthrough curve extension;
3. forward and inverse modeling approaches using the Transient Storage Model, including Monte Carlo extensions to assess parameter identifiability and sensitivity. Upon completion of the module, participants will be able to successfully conduct a field tracer study and interpret the recovered solute tracer timeseries using state-of-the-science techniques and approaches. The instructor will make field equipment freely available for participants to conduct experiments at their own field sites as needed.

Prerequisites:

1. A background in hydrology, fluid mechanics, and/or water resources will be valuable to the student, but ultimately you can be successful here without an extensive background.
2. Students will manipulate time-series data. Training will be provided on a Python-based toolbox hosted on CUAHSI's HydroShare as the primary tool for data analysis. Minimal programming is required. Students may benefit from familiarity with another software package so they can complete calculations on their own or as part of their own workflow (i.e., replicating tools in their preferred language).

Questions?

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

For general questions, please Veronica Sosa-Gonzalez at vgonzalez@cuahsi.org