FALL 2021

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 courses to enhance the depth and breadth of graduate course offerings at universities across the nation, increasethe 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 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 andstudents and contain some evaluation elements (problem sets, projects, presentations, exams etc.). The instructor at eachstudent's home university will assign a grade based on the student scores and class distribution provided by the module instructor.

The course runs 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

Kent State University
Anne Jefferson | ajeffer9@kent.edu

The Pennsylvania State University
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Tulane University
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University of Alaska
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University of Washington
Jessica Lundquist | jdlund@uw.edu

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

Utah State University
Sarah Null | sarah.null@usu.edu

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

Module Dates and Times

Module 1: September 8 through October 5
Module 2: October 11 through November 4
Module 3: November 10 through December 9

	Module 1 Sept. 8-Oct. 5	**Module 2** Oct. 11-Nov. 4	**Module 3** Nov.10-Dec. 9
Monday/Wednesday 3:30-5:00 p.m. ET	Open and Reproducible Research Computing **Instructor:** Flores	Environmental Objectives in Water Management Models **Instructor:** Null Snow Hydrology: Focus on Modeling **Instructor:** Lundquist	Snow and Snow Cover Physics **Instructor:** Sturm
Monday/Wednesday 5:00- 6:30 p.m. ET		Seminal Papers in Flood Hydrology **Instructor:** Wright	Advances in Drone-Based Hydrology **Instructor:** Tyler
Tuesday/Thursday 11:00 am- 12:30 p.m. ET	Applying Geographic Information Systems for Terrain and Watershed Analysis in Hydrology **Instructor:** Tarboton	Hydrological Catchment Modeling Using Bucket-Type Models **Instructor:** Seibert	Watershed Reactive Transport Processes **Instructor:** Li
Tuesday/Thursday 3:30- 5:00 p.m. ET	Urban and Stormwater Hydrology **Instructor:** Jefferson		Introduction to Open Channel Flow Modeling **Instructor:** Meselhe

How to Register

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

- 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).
- Registration is limited to 15 students per university.
- CUAHSI will handle student registration for individual modules across universities. Fill out this form (https://form.jotform.com/commgr/cuahsi-virtual-university-registrat) to register 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.
- As University of Washington is on the quarter system, students must select two topics from the October and November choices. 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.
- 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. Each module will have an individual syllabus that outlines the expectations and requirements for that component of the course.

Academic Integrity

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

- 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;
- 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.

Evaluation

Your grade will be based on the following:

- 10% On-campus organization, synthesis, and debriefing sessions.
- 30% Module 1
- 30% Module 2
- 30% Module 3

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.

* *Your grade will be based on the number of modules you take. This grading scheme is based on 3-credits for 3 modules.*

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

Students with Disabilities

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

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.

Module Descriptions (in alphabetical order)

Advances in Drone-based Remote Sensing for Hydrologic Applications
Scott Tyler, University of Nevada – Reno

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

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Applying Geographic Information Systems for Terrain and Watershed Analysis in Hydrology
David Tarboton, Utah State University

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.

Prerequisites: 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 3-hour free Predict Deforestation in the Amazon rain forest online lesson from ESRI at https://learn.arcgis.com/en/projects/predict-deforestation-in-the-amazon-rain-forest/. Arrangements will be made for students to use ArcGIS Pro through their university site license.

Environmental Objectives in Water Management Models
Sarah Null, Utah State University

This course focuses on incorporating and improving environmental objectives in water management models. Traditionally, water management models targeted human water uses (water supply, hydropower, flood protection). Environmental objectives in water management models are increasingly needed when water is tightly managed and when environmental water demands compete with human water demands. This course explores representation of environmental objectives, tradeoffs between human and environmental objectives, and evaluating the mathematical characteristics of tradeoffs to identify promising strategies for compromise among competing water users.

Prerequisites: Familiarity with R or GAMS (general algebraic modeling system).

Hydrological Catchment Modelling using Bucket-type Models
Jan Seibert, University of Zurich

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).

Introduction to Open Channel Flow Modeling
Ehab Meselhe, Tulane University

Numerical models are effective and informative research, design, and planning tools. The substantial advancement in computational power has allowed numerical models to be a viable and efficient tool to solve complex problems and improve our understanding of the fundamentals in the water resources field. Therefore, it is critical to provide an in-depth understanding of the basics of numerical modeling techniques and recognize the strengths and limitations of these techniques. This graduate level introductory modeling course will provide general overview of the basics of numerical modeling, model development, and applications. This course will also include opportunities for the students to participate in hands-on applications to examine a research, design or a planning problem and explore ways where numerical models can provide usable information to answer or provide insights into these questions.

Prerequisites: Undergraduate course in hydraulics or hydraulic engineering.

Open and Reproducible Research Computing for Hydrologic Science
Alejandro Flores, Boise State University

The proposed module would introduce students to best practices for using computing in the hydrologic and critical zone sciences. Key concepts include the data life cycle and data management, use of version control for tracking source code, use of Jupyter and R Markdown notebooks for effective visualization. The module will make use of the HydroShare framework and data therein.

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

Seminal Papers in Flood Hydrology
Daniel Wright, University of Wisconsin-Madison

High-impact floods are of enormous—and growing—societal importance. Drawing on a recent U.S. Army Corps of Engineers training document by the same name, this short course will examine twelve foundational papers in riverine flood hydrology within the broader evolution of flood research and practice in the United States. These papers provide the grounding to examine frequency estimation methods, the hydrology and hydraulics of extreme floods, the hydroclimatology of flooding, and the core hydrologic measurements that lie at the center of flood hazard characterization. Students will provide critical syntheses, drawing on the foundational papers, more recent scientific advances, and their own understanding of hydrological and hydrometeorological processes. Specific concepts will be reinforced through analyses of real datasets using the R programming language.

Prerequisites: Undergraduate course in hydrology or water resources engineering; familiarity with R or similar programming language (e.g. Python, Matlab) is recommended but not required.

Snowfall and Snow Cover Physics
Matthew Sturm, University of Alaska, Fairbanks

Starting with clouds and condensation nuclei, we will look at the physical processes that produce snowfall and build up and modify snow on the ground.

Prerequisites: Basic chemistry and physics; some familiarity with snow and snow layers; can be from practical or recreational experiences.

Snow Hydrology: Focus on Modeling
Jennifer Lundquist, University of Washington

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 that incorporates components from most snow models in use 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 well versed in modeling and data assimilation.

Prerequisites: Recommended familiarity with basic programming (python preferred, but any language will help) and basic concepts of mass and energy balance. Ability to navigate a command line environment (or willing to put in extra time to learn).

Urban and Stormwater Hydrology
Anne Jefferson, Kent State University

This module explores the consequences of urbanization and stormwater management on the hydrologic cycle, using literature, empirical data analysis, and hydrological models. We will discuss the ways that stormwater management approaches alter water balances and flow regimes, and we will make comparisons among various types of stormwater control measures. Students will be exposed to the techniques used to evaluate urban hydrology and gain experience working with simple SWMM models through a graphical user interface.

Prerequisites: undergraduate course in hydrology.

Watershed Reactive Transport Processes
Li Li, Penn State University

This module will teach fundamental concepts and principles of reactive transport processes at the watershed scale. It will build on understanding of catchment hydrology, and introduce transport and soil biogeochemical reactions. The class will cover flow paths (shallow versus deep), water transit times, and how they influence biogeochemical reactions and water chemistry in soils, groundwater, and streams. We will discuss two representative and simplified reactions: carbon transformation via soil respiration and chemical weathering. The course will elaborate on concepts of reaction kinetics and thermodynamics and the applications of dimensionless numbers such as Damköhler numbers. Ideally, this module on concepts and principles will be followed by a future module that introduces the application of watershed reactive transport modeling.

Prerequisites: Some fundamental hydrology and chemistry background will help but chemistry background is not required. The instructor will teach the chemistry needed for the class. One goal of this course is to bring reactive transport principles to students who do not have much chemistry background.

Questions?
For questions on the module content, please contact your university instructor. For general questions, please contact Deanna McCay at dmccay@cuahsi.org.