FALL 2019

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, 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 Daylight Time.

Instructors

Boise State University
H.P. Marshall | hpmarshall@boisestate.edu
Course Number: GEOPH 597

Indiana University
Adam Ward | adamward@indiana.edu
Course Number: SPEA-E 710

Michigan State University
David Hyndman | hyndman@msu.edu
Anthony Kendall | kendal30@msu.edu
Course Number: GLG 893

San Diego State University
Hilary McMillan | hmcmillan@sdsu.edu
Course Number: GEOG 696

University of Florida
Samuel Smidt | ssmidt@ufl.edu
Course Number: SWS 6932

University of Nevada-Reno
Scott Tyler | styler@unr.edu
Course Number: GEOL 765

University of Washington
Jessica Lundquist | jdlund@uw.edu
Course Number: CEWA 599

University of Wisconsin-Madison
Steven Loheide | loheide@wisc.edu
Course Number: CEE 619

Utah State University
David Tarboton | dtarb@usu.edu
Course Number: CEE 6930

Module Dates and Times

	Sept 3-30	Oct 2-29	Nov 4-Dec 3
M/W 3:30-5:00 p.m. EDT / 12:30-2:00 p.m. PDT	Measuring stream transport and transformation with tracers		Hydrology & Policy: Actions, Implications, and Solutions
M/W 5:00-6:30 p.m. EDT / 2:00-3:30 p.m. PDT	Ecohydrology of Groundwater Dependent Ecosystems	Snow Hydrology: Focus on Modeling	
T/Th 3:30-5:00 p.m. EDT / 12:30-2:00 p.m. PDT		Global Change, Crop Production, and Impacts on Hydrology	Forecasting river flows and floods using hydrologic models
T/Th 5:00-6:30 p.m. EDT / 2:00-3:30 p.m. PDT	Geographic Information Systems in Water Resources	Advances in Drone-based Remote Sensing for Hydrologic Applications	Microwave Radar Remote Sensing: Theory and Applications

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

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 registration for individual modules across universities. Fill out Google Form to register 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 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.
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.

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.

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

Evaluation

Your grade[3] 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.

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.

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

Module Descriptions (in alphabetical order)

Advances in Drone-based Remote Sensing for Hydrologic Applications
Course Number: GEOL 765
Scott Tyler, University of Nevada-Reno

This module focuses on the integration of remote sensing data into groundwater/surface water exchange, 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.

At the outset of class, students should download a 30-day free trial version of Agisoft PhotoScan at: http://www.agisoft.com/downloads/request-trial/

Prerequisites: Undergraduate course in geology.

Measuring stream transport and transformation with tracers
Course Number: SPEA-E 710
Adam Ward, Indiana University

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: Comfort working with data in Matlab (several toolboxes and models will be provided to the participants).

Ecohydrology of Groundwater Dependent Ecosystems
Course Number: CEE 619
Steven Loheide, University of Wisconsin Madison

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.

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

Forecasting river flows and floods using hydrologic models
Course Number: GEOG 696
Hilary McMillan, San Diego State University

This module will explore contemporary modeling methods for predicting river flows, an essential task for accurate forecasting of water resources and flood hazards. The module will include hands-on computer lab experience in setting up a rainfall-runoff model, inputting rainfall data, producing a river flow forecast, testing forecast accuracy, calibrating the model and estimating the uncertainty in the forecast. We will discuss how these methods lead to robust risk analysis and efficient water management. We will explore model evaluation methods including trade-offs between different requirements of a model, and new ideas for evaluating models using a hydrologic signature approach that focuses on hydrologic processes. The course objective is for students to be able to analyze the needs and outcomes of a flow forecasting application, and translate these into practical methods and recommendations to set up a hydrologic model.

Prerequisites: Undergraduate course in hydrology. Familiarity with, or willingness to learn, basic Python or Matlab functions with help from the instructor.

Geographic Information Systems in Water Resources
Course Number: CEE 6930
David Tarboton, Utah State University

Application of Geographic Information Systems (GIS) in Water Resources. Digital mapping of 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.

Global Change, Crop Production, and Impacts on Hydrology
Course Number: GLG 893
David Hyndman & Anthony Kendall, Michigan State University

This module explores the influence of crop production and global change on fluxes of water sustainability across the surface and through the subsurface. The course will span the interdisciplinary nexus of food, energy, and water in a manner that examines process based models of land surface processes, along with the data that are required to drive these models, and the types of analyses that can be performed. This course synthesizes current research on the likely impacts on hydrologic systems and water use of agricultural systems due to projected global change drivers. Latest generation climate change assessments are surveyed, along with impact studies on various domains of the hydrologic sciences. The impacts of global change on agricultural systems are detailed. Underlying models, data, and assumptions are examined and discussed. Climate data, model outputs, and downscaling are discussed from the standpoint of driving hydrologic and agronomic models.

Prerequisites: Course in hydrogeology or groundwater. Familiarity with, or willingness to learn, basic Matlab, Python, or R functions with tips from the instructor

Hydrology & Policy: Actions, Implications, and Solutions
Course Number: SWS 6932
Samuel Smidt, University of Florida

During this module, students will (1) investigate and analyze the hydrological implications of political actions, (2) identify how hydrology drives policy, and (3) contemplate future hot topics in water resources regulation. Specifically, students will explore hydrologic principles through a series of case studies such as flood management during Hurricane Harvey, irrigation use across the High Plains Aquifer, and municipal challenges in Flint, Michigan, and Cape Town, South Africa. Students will examine both national and global issues with a predominant focus on the intersection of humans and hydrology. This module culminates with big-picture solutions and recommendations for future water-related policy.

Prerequisites: Ability to process data in a computing program (e.g., Excel, Matlab, Python, R). Undergraduate course in earth or environmental science.

Microwave Radar Remote Sensing: Theory and Applications
Course Number: GEOPH 597
Hans-Peter Marshall, Boise State University

Remote sensing can cover large spatial scales, but typically does not directly measure the earth property (e.g. soil moisture, snow, albedo, rain, temperature) that we want. Optical remote sensing has the advantage of being more intuitive, because as humans, we have a lifetime of experience interpreting reflected light at optical frequencies; however clear skies are required. Microwave radar has the advantage of penetrating clouds and observing the earth surface regardless of weather, in addition to high spatial resolution capability. The relationship between the radar observations (phase, amplitude, polarization) and the surface or atmospheric properties of interest, however, is much more complex. This course will provide an overview of microwave radar theory, along with hands-on exercises using microwave radar data from ground, airborne, and satellite platforms, for the specific case of estimating snow properties. Many of the concepts can be applied to remote sensing of other properties of interest for hydrologists.

Prerequisites: Programing experience in Matlab or R or Python, calculus-based physics, linear algebra, statistics

Snow Hydrology: Focus on Modeling
Course Number: CEWA 599
Jessica 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: Familiarity with basic computer programming (e.g., Matlab, R, or Python). Ability to navigate in a command line (e.g., Linux or Unix) work environment.

Questions?

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

For general questions, please contact Elizabeth Tran at etran@cuahsi.org.