

EV 351: Hydrology | Block 3 2019

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Goals and Scope of the Course | This course provides a quantitative, process-based understanding of hydrologic processes in the context of watersheds, using data analysis and statistics. In addition, the course introduces the very real water resource challenges locally, regionally, and facing more than a billion people, globally using the lens of ecosystem services. My hope is that by the end of the class all students will be able to do the following:

- critically evaluate information (also known as thinking!),
- acquire fundamental knowledge about the water cycle, its key processes, and storage reservoirs,
- to quantitatively understand and calculate hydrologic variables relevant to a water budget,
- to recognize and understand the inequity inherent in water resource challenges.

Class Structure | Classes will begin at 9 AM and will involve a mix of lectures, labs, and discussions. Please note the days we have afternoon lab and/or optional help sessions. I strongly encourage you to block out even the *optional* times in your schedule so you can take advantage of the time if you need it. In addition to these help sessions and my office hours, please utilize Arielle and the QRC for additional assistance.

In class, I will introduce new concepts, and we will usually do a few exercises during the day to reinforce these concepts. There will be occasions where you will need to be able to answer questions on this reading and/or material covered in previous classes – these short exercises serve multiple purposes: it provides me feedback on concepts you may be having trouble with, helps keep you engaged with the material outside of the classroom, and provides you a way to assess how you are doing (answering these questions will count towards your grade). Every evening as a review, you should look over your notes (and potentially the reading for that day) and make notes on anything that still confuses you. I will always go over any questions you have before going on to new material – so if you have a question, please ask! Keep in mind that study groups are a great way to learn and review the different concepts we cover. I encourage you to work with your classmates on all problem sets and labs, unless expressly told otherwise.

Attendance. We will be covering a lot of material in this course, with every day building on the previous day. In order to learn from and with each other and include all voices, attendance at all class meetings is expected. It is your responsibility to contact me directly if you are unable to attend class due to an emergency. Please note that if you get sick during the block I will do everything I can to help you catch up on the material – but you need to have a note from Boettcher or another doctor for an *excused* absence.

If you need to miss class for any justifiable reason during the block (e.g., athletic team travel, religious observance), please notify me **on the first day of class** so we can arrange on how you will receive the material for that day.

Note about assignment deadlines and student-teacher-human well-being. I am dedicated to providing you thorough and specific feedback to help you improve your work; this means I have dedicated time in my own schedule for reviewing assignments. Sometimes life gets in the way, and we have to submit something we know is not our best work. I would much rather have you turn in something that is a work in progress than delay and become overwhelmed with too many overdue assignments at the end of the block. I am not a huge fan of taking “points off” for lateness, as it contradicts the developmental and human-focused commitments I have made as an educator. I have set deadlines in a way that I hope provides you the maximum flexibility in completing assignments yet keeps you on pace to not get behind in the necessary “practice” of working with scientific concepts. I will usually be able to accommodate a day or two extension (please note exceptions*), but keep in mind that the pace of the block is unforgiving, and things WILL build up. In addition, if you turn something in *after* the deadline, feedback could be

delayed (potentially significantly). I highly encourage you to schedule time off on the weekends to spend with your friends or family, engaging in creative and activist endeavors, going outside for a hike, or to the movies, or to simply relax. Whenever possible the course schedule encourages said “mental breaks.”

Commitment to Diversity, Equity, & Inclusion. I am committed to making the classroom a place that enhances all students' learning, a place where students feel both respected and challenged. To the best of my abilities, I seek to make pedagogical choices that advance this goal. Outside of class, I run [mentoring programs](#) aimed at increasing the retention of women in earth and environmental sciences and conduct [bystander intervention trainings for faculty](#) to improve workplace climate. My commitment to diversity, equity, and inclusion does not mean I think I am perfect - all of us make mistakes. I will do my best to acknowledge these, along with my privilege and biases; I ask that you do the same. This is not easy. It is uncomfortable. I recommend using “ouch and educate” as a way to let your peers know that you are hurt and why. Colorado College is our community and it is up to each of us to make it a safe and welcoming place for all to learn and succeed.

Required Reading

- Hendriks, Martin R. 2010. Introduction to Physical Hydrology. Oxford University Press (available at the bookstore and on Amazon)
- readings posted on Canvas

Field Trips | We will have one all day field trip (Tuesday, 11/5 to Denver to meet up with Drs [Anne Jefferson](#) & [Aditi Bhaskar](#) to learn about urban geomorphology and hydrology) and several half days (usually the afternoon) in the field. Please check the syllabus and come dressed to be outside. We will outfit everyone with chest waders.

Office hours | I will have office hours on many afternoons (in addition to the course help sessions) throughout the block. You can sign up for time [here](#). Please note, scheduled help sessions in the classroom are so that I can assist many of you at once, I strongly recommend adding them to your schedule even if you intend on never attending. If these times do not work for you, please talk with me before, after class, or via email.

Canvas | I will use Canvas extensively throughout the course. I will do my best to have readings posted multiple days in advance. In addition, there will occasionally be writing prompts on Canvas that you must complete. The goals of these questions/prompts is for me to (1) assess your comprehension on material, (2) to get you to start thinking about the material prior to classroom discussions, and (3) introduce you to how I ask questions so you are better prepared for quizzes.

Exams & Assignments | There will be one **midterm** (Friday 11/1) and a comprehensive **oral exam** (Tuesday 11/12). The exams will ask you to integrate material covered in lecture, discussions, and labs, as well as material from the textbook and readings. The biggest difference (other than format) between the exams is that the midterm will focus on problem solving and the oral final will focus on concepts and data interpretation.

During the first three weeks of class you will have multiple **problem sets, labs, and discussion questions** to complete that reinforce many of the ideas we discuss in class. I always expect the work you turn in to *be your own*, but you are welcome to discuss ideas and problem-solving techniques with each other. All students will **present one article**. These articles are a chance for us to have brief discussions about water resource challenges, linking them back to what we are learning in class.

You will work in 3-4 small groups to investigate a specific question using **water isotopes** ($\delta^{18}\text{O}$ & $\delta^2\text{H}$ of H_2O) within our managed water system. You will write the results up individually using peer reviewed literature and present the results as a group. These presentations (last Wednesday of class) will test both your understanding of hydrology and water isotopes, but also your ability to communicate science to an intelligent but uninformed audience (i.e. Professor Sarah Schantz and the students in Geomorphology class).

Grading:

Midterm exam	25%
Oral Final exam	20%
Isotope Project	25%
Labs, Discussion Questions, Problem Sets	25%
Engagement	5%

Grade Assignments:

93 ≤ A	73 ≤ C < 77
90 ≤ A- < 93	70 ≤ C- < 73
87 ≤ B+ < 90	(S ≥ 70)
83 ≤ B < 87	65 ≤ D < 70 (CR)
80 ≤ B- < 83	NC < 65
77 ≤ C+ < 80	

Grades of D+, D, CR, and NC do not fulfill EV Department major requirements.

Honor Code | Failure to properly document sources in papers, plagiarism, copying from other student's work, or turning in assignments that have already been submitted for credit in other courses are among some of the actions considered intellectual theft under the Colorado College Honor System. I encourage you to work together and talk through problems and assignments, but **your final work must be your own**, unless noted on the assignment (e.g. some labs you are welcome to turn in joint assignments). We will give you further information on how the honor code applies to specific assignments as we go. If you are uncertain about the Honor Code's application to a particular project, please ask. If you have questions or to read further details of the Honor Code see:

<http://www.coloradocollege.edu/other/honorcouncil/constitution-bylaws/constitution.dot>

Disability Accommodations | If you have a disability and require accommodations for this course, please speak with me privately today or tomorrow so that your needs may be appropriately met. You may also simply email me your accommodations letter; if I have any questions, I will ask you directly. If you have not already done so, you will need to register with Accessibility Resources (Learning Commons in Tutt Library, 227-8285), the office responsible for coordinating accommodations and services for students with disabilities.

My goal is to make this course successful for all. If you have a need for classroom / course accessibility that is not covered by the above statement or disability accommodations, you are welcome (not required) to discuss with me how I can best support you and your success in this class.

Tentative Course Schedule | the syllabus and schedule are **subject to change**. As you all know – the success of the class requires an investment in time from everyone, the professor AND the students – please do your part.

Week 1

Day 1 – Introduction, Water Cycle

- Hendriks 1.1 -1.3
- **PS #1*** hydrologic unit conversions **due 10/22 9 AM**
- *Optional Help Session w/Arielle 2 – 4 PM, Tutt Science 107*

Day 2 – Water Balance, Residence Time, Hydrologic Services, Intro to precipitation

- Hendriks 1.4, 2.1
- Brauman et al. 2007 Annual Review of Environment & Resources
- **Discussion Question #1** Popular Press Article & Hydrologic Ecosystem Services **due 10/23**
- **PS #2*** water balance & thermodynamics **due 10/23 9 AM**
- *Optional Help Session w/Arielle 2 – 4 PM, Tutt Science 107*

Day 3 – Atmospheric Water & Precipitation

- Hendriks 2.1-2.4
- Lab, Tutt Science 107: 1:30 – 3 PM
- **Lab #1:** Precipitation Across Watersheds **due 10/25**
- *Optional Help Session w/Arielle 3 – 4 PM, Tutt Science 107*

Day 4 – Runoff Ratio, Energy Balance, ET

- Hendriks Box 2.12 (note this is multiple pages)
- Lab, Tutt Science 107: 1:30 – 3 PM
- **Lab #2:** Colorado Orographic Precipitation **due 10/27**
- *Optional Help Session w/Arielle 3 – 4 PM, Tutt Science 107*

Day 5 – ET/PET Energy Flux

- Hendriks 2.6
- **PS #3*** Energy Balance **due 10/28 9 AM**
- *Optional Help Session w/Arielle 1-2:30 PM, Tutt Science 107*

Sat/Sun.

- Finish up the lab(s)
- Go over your notes; are there things you do not understand? Please ask me questions! Send me an email; it will help me prepare my review for Monday.
- Take a break and recuperate!

Week 2

Day 6 – Water Isotopes, Flow Paths, & Fractionation

- Gat 2000 Atmospheric water balance – the isotopic perspective *Hydrological Processes* [Canvas]
- McGuire & McDonnell Chapter 11: Stable isotope tracers in watershed hydrology [Canvas]
- SAHRA website <http://web.sahra.arizona.edu/programs/isotopes/oxygen.html>
- **Sampling for Isotope Project**, meet at 1 PM in Tutt Science 107. Note, you will likely be busy past 3 or 3:30 PM today. Plan accordingly
- **Discussion Question #2:** As a group post the question you are hoping to answer with your sampling due by end of the day (10/28)

Day 7 – Groundwater: Hydraulic Head & Porosity

- Hendriks 3.1-3.5
- **PS #4*** Groundwater **due 10/30**
- *Optional Help Session w/Arielle 2 – 4 PM, Tutt Science 107*

Day 8 – Groundwater: Darcy's Law & Hydraulic Gradient

- Hendriks 3.6-3.7
- *Optional Review Session w/Arielle 2 – 4 PM, Tutt Science 107*

Day 9 (Halloween) – Midterm

- In class **midterm exam** starting at **9:00 AM**, bring a calculator (your cell phone is ok)

Day 10 – Groundwater: Aquifers

- Hendriks 3.7-3.13
- **Lab #3:** Groundwater Flow Model Pump Test (in class), **due 11/4**
- *Optional Help Session w/Arielle 1 – 2:30 PM, Tutt Science 107*

Sat/Sun

- Take a break! Go for a hike; veg out in your room. I beg of you, do something that helps you rejuvenate for the last week and a half of the block!
- Have you started gathering peer reviewed literature for your isotope project? Have you formulated your predictions? Check out the extra readings posted on Canvas.

Week 3

Day 11 – Fluvial Geomorphology & Discharge

- Allen Stream Ecology Chapter 3: Fluvial Geomorphology
- Hendriks 5.2-5.3
- **Lab #4:** Characterizing the channel and calculating flow on Monument Creek **due 11/6** – meet in Tutt Science 107 at 1:30 PM, be prepared to be outside.
 - Additional reference: Gore, Chpt 3 from Methods in Stream Ecology

*Day 12 – Urban Hydrogeomorphology **Denver Field Trip***

- Meet at **8 AM** on the east side of Tutt Science (i.e. circle off Nevada Ave). Please bring a lunch, water, and dress for being outside most of the day.
- Kaushal & Belt 2012 Urban Ecosystems
- **Discussion Question #3*:** Urban Streams **due 7 AM**

Day 13 – Hydrographs, Rating Curves, Flow Regime

- Hendriks 5.2-5.3
- **Lab #5:** Calculating discharge with salt! – meet in Tutt Science 107 at 1:00 PM, be prepared to be outside. We are headed to Mesa Creek (within Sondermann Park) a small tributary of Monument Creek. **due 11/8**

Day 14 – Controls on Solutes & Water Isotopes

- Webster & Valett, Chapter 8 from Methods in Stream Ecology
- **Discussion Question #4*:** As a group post your prediction of the isotopic values of your samples (**11/8 9 AM**) reading for tomorrow will help! Note: You will be assessed on your line of thinking not how close you get to the measured values.

Day 15 – Isoscapes & Isotope Project Workday

- Gibson, Fekete, & Bowen 2010 Chpt 18: Stable Isotopes in Large Scale Hydrological Applications
 - *Further background reading: Bowen 2010 Chpt 7, White 2005 Chpt 9*
- Exploring data in GIS – we will spend the morning in the GIS Lab, 1st Floor Tutt Library

Week 4

Day 16 – Isotope Project Workday & Review

- GIS Lab in Tutt Library reserved for our class 9 AM to 3 PM
- Review Session with Arielle, *time: TBA*

Day 17 – Oral Final, Professor Barnes' Office

- Sign up for your **Oral Final*** time slot (<https://docs.google.com/document/d/1LkHBDN6bpA-ZScvXmf-wBcliiNhCKTcJT0csOH7J310/edit>).

Day 18 – SciComm Project Presentations

- **Isotope Project Presentations*** in conjunction with Professor Sarah Schantz's Geomorphology class, *location TBD*
- **Isotope Project Write Up*** (individual) due 12 PM