

## **SIOC 209 Special Topics – Land Surface Hydrology**

University of California San Diego  
Scripps Institution of Oceanography

**Spring 2022, Tuesdays and Thursdays, 2:00 – 3:20pm**

**Class Location:** Eckart Building 236, Scripps Institution of Oceanography

### **Instructor:**

Morgan Levy



Office hours: Thursdays, 12:45pm – 1:45pm

Website: <https://mclevy.scrippsprofiles.ucsd.edu/>

### **Description:**

This course provides an introduction to the physical processes that govern water occurrence and transport at the land surface. Covered topics include the global hydrologic cycle, land-surface water balance, runoff, infiltration, subsurface water flow, evaporation and plant transpiration, quantification of hydrologic variability and extremes, water resources measurement and modeling, and contemporary hydrology and water resources topics.

### **Expectations and Pre-requisites:**

This course is intended for an interdisciplinary group of students. Students are expected to have graduate standing or the consent of the instructor; upper division undergraduate students are permitted to enroll in this class with instructor permission. While there are no required courses to participate in this class, previous coursework in introductory calculus, fluid mechanics, and atmospheric and climate science will be beneficial. Some class assignments may be completed more easily and successfully by using a programming language such as MATLAB, Python, or R for data analysis. Please check with the instructor if you have concerns about your background.

### **Course Content and Objectives:**

#### 1. Freshwater measurement, mass balance, and fluxes

- *Topics:* Forms and transformations of water in the environment; hydrologic measurement and units; hydrologic mass balance, control volumes and fluxes; water flow in soils, Darcy's Law, storage-discharge relationships; infiltration, matric potentials, Green and Ampt Equation.
- *Goals:* Understand the components of a water balance, use mass conservation principles to construct simple models of hydrologic systems, and understand how water balances govern the behavior of hydrologic systems.

#### 2. Ecohydrology and the terrestrial water cycle

- *Topics:* Surface energy balance; plant water uptake and plant interactions with the water cycle; transpiration and evaporation; Budyko's curve; introduction to plant hydraulics and ecohydrologic models; hydrologic indices.
- *Goals:* Understand interactions between climate, hydrology, and vegetation at multiple spatial and temporal scales; gain literacy with the data, methods, and models used to analyze these interactions.

### 3. Hydrology as a statistical process

- *Topics:* Random variables, time series analysis, variability in rainfall and streamflow, statistics of extreme events, definition of return periods, intensity-frequency-duration curves.
- *Goals:* Understand the random nature of hydro-climatologic processes, and evaluate the effects of randomness on hydrology and water resources.

### 4. Introduction to hydrologic modeling

- *Topics:* Hydrologic model types; rainfall-runoff modeling; channel flow; linear reservoir models; unit hydrograph and other engineering planning models.
- *Goals:* Understand different types of hydrologic models; understand and apply basic methods for predicting streamflow; understand approaches for incorporating climate change and human influences in hydrologic modeling.

### **Logistics:**

This course uses an online learning management system called *Canvas* to manage content and grades. Navigate to <https://canvas.ucsd.edu/> to locate course content when the quarter commences.

### **Readings:**

Course readings will include select book chapters, academic journal publications, websites, and/or instructor-provided notes. Copies of and/or links to all required readings will be posted on Canvas. There is no textbook for this class. *Optional* hydrology textbooks include (available in print or online through the UCSD Library):

- Hornberger, George M. *Elements of Physical Hydrology*. 2nd ed. Baltimore, Md: Johns Hopkins University Press, 2014.
- Dingman, S. L. *Physical Hydrology*. Third edition. Long Grove, Illinois: Waveland Press, Inc., 2015.
- Brutsaert, Wilfried. *Hydrology: An Introduction*. Cambridge University Press, 2012.

### **Assessment:**

Course assessment is based on homework assignments (Problem Sets), responses to course readings (Reading Discussion posts), and a final exam. Assignment and exam instructions will

be posted to Canvas, and students are expected to submit completed assignments and exams through Canvas, as instructed.

- 20% of course grade: Reading Discussions (RD)
- 40% of course grade: Problem Sets (PS)
- 40% of course grade: Final (take home exam)

For assignments turned in late (*not exams*), there will be a 10% point reduction (from the maximum per-assignment points) per day late, for the first 5 days. For example, for an assignment worth a total of 10 points: an assignment turned in 1 day late would receive a maximum of 9 points; an assignment turned in 2 days late would receive a maximum of 8 points, etc. Assignments turned in more than 5 days late will receive no credit, unless you make arrangements with the instructor *in advance* to receive an extension for valid work and/or personal reasons.

### Software:

No specific software is required for this class. However, some class assignments may be completed more easily and successfully by using a programming language such as MATLAB, Python, or R for data analysis. The instructor and TAs are not expected to assist students with questions regarding the use of software. For assistance with software (i.e., GIS programs for mapping, R/Python/Stata for data analyses), students should request consultations through the UCSD Data & GIS Lab (<https://library.ucsd.edu/computing-and-technology/data-and-gis-lab/>).

### Schedule outline:

This schedule outline provides an approximate timeline for the material covered in the course, and is subject to change. Updates to the schedule will be communicated through Canvas.

| Week # | Topic                                                     | Date      | Day      | Assignment Out | Assignment In |
|--------|-----------------------------------------------------------|-----------|----------|----------------|---------------|
| 1      | Introduction to surface water hydrology                   | 3/29/2022 | Tuesday  |                |               |
| 1      | Water states, quantities, measurements                    | 3/31/2022 | Thursday |                |               |
| 2      | Water balance, control volumes, fluxes                    | 4/5/2022  | Tuesday  | RD1            |               |
| 2      | "                                                         | 4/7/2022  | Thursday |                |               |
| 3      | Water in soils (part 1): saturated and unsaturated flow   | 4/12/2022 | Tuesday  |                |               |
| 3      | Water in soils (part 2): infiltration, soil water balance | 4/14/2022 | Thursday |                | RD1           |
| 4      | Ecohydrology and the terrestrial water cycle              | 4/19/2022 | Tuesday  | PS1            |               |
| 4      | "                                                         | 4/21/2022 | Thursday |                |               |
| 5      | "                                                         | 4/26/2022 | Tuesday  |                |               |
| 5      | Hydrology as a statistical process                        | 4/28/2022 | Thursday |                |               |
| 6      | "                                                         | 5/3/2022  | Tuesday  | RD2            | PS1           |
| 6      | "                                                         | 5/5/2022  | Thursday |                |               |
| 7      | "                                                         | 5/10/2022 | Tuesday  |                |               |
| 7      | Introduction to hydrologic modeling                       | 5/12/2022 | Thursday |                | RD2           |
| 8      | "                                                         | 5/17/2022 | Tuesday  |                |               |
| 8      | "                                                         | 5/19/2022 | Thursday | PS2            |               |
| 9      | Guest speaker (Dr. Ming Pan)                              | 5/24/2022 | Tuesday  |                |               |
| 9      | Hydrologic modeling cont.                                 | 5/26/2022 | Thursday |                |               |
| 10     | "                                                         | 5/31/2022 | Tuesday  |                |               |
| 10     | Review (last day of class)                                | 6/2/2022  | Thursday |                | PS2           |
| 10     | Final exam released                                       | 6/3/2022  | Friday   | Final          |               |
| 11     | Final exam due                                            | 6/9/2022  | Thursday |                | Final         |

### Academic Integrity:

Assignments and take-home exams will be submitted via Canvas. Students are expected to submit individual and original work for all assignments and exams. *Working in groups on problem sets is encouraged*, but every student must write up and submit his/her work. Students are expected to work *independently only* on the final exam, and are not permitted to discuss or share information within or about that exam. Evidence of exam information-sharing, non-independent work on exams, and/or plagiarism will be referred to the Office of Academic Integrity. More information is available at: <https://academicintegrity.ucsd.edu/>.

### Accommodations:

If you have a disability for which you are or may be requesting accommodations, please contact the Office for Students with Disabilities (OSD) (<https://osd.ucsd.edu/>). You must have documentation from the OSD before accommodations can be granted. Students are encouraged to discuss authorized accommodations with the instructor early in the term.

### Intellectual Property:

Lectures and course materials (including those of any guest lecturers), including slides/presentations, problem sets, exams, and similar materials, are protected by U.S. copyright law and by University policy. Instructors are the exclusive owners of the copyrights of the materials they create. You may take notes and make copies of course materials for your own use. You may also share those materials with another student who is enrolled in or auditing this course. You may not reproduce, distribute or display (post/upload) lecture notes or recordings or course materials in any other way —whether or not a fee is charged — without the appropriate express prior written consent of the instructor. You also may not allow others to do so. If you do so, you may be subject to student conduct proceedings under the UC San Diego Student Code of Conduct. Similarly, you own the copyright to your original writing (your submitted problem sets, reading discussion posts, and exams). If the instructor is interested in posting your submitted assignments to the course web site (e.g., as an example), the instructor will ask for your written permission. See: <https://copyright.universityofcalifornia.edu/resources/systemwide-resources.html>.

### Commitment to Open Discussion and Privacy:

Please note that class sessions may be recorded and posted to Canvas to accommodate students who cannot attend class in real time. The instructor is committed to free inquiry and open discussion. However, with everything recorded and made available online, please be aware that your record of in-class participation may be accessible to unintended audiences. If you are concerned about this, please contact the instructor to discuss alternative ways of participation for privacy protections during class.

### Other Resources:

Other resources available to students, in-person and/or remotely, include:

- UCSD Teaching and Learning Commons (<https://commons.ucsd.edu/for-students/>)
- UCSD Mental Health Services (<https://caps.ucsd.edu/>)
- SIO Equity, Diversity, and Inclusion resources (<https://scripps.ucsd.edu/diversity/resources>)
- SIO Information Technology (<https://scripps.ucsd.edu/it>)