**Terrestrial Hydrology**
GEOG C136/ESPM C130, 4.0 units
Spring 2017
Professor Laurel Larsen, laurel@berkeley.edu
TTh 11-12:30, Barrows 122

**GSI:** Mollie van Gordon, mvangordon@berkeley.edu

**Office Hours:**
Professor Larsen: Tuesday 12:30 – 2:00 pm, 595 McCone Hall, or by appointment
Mollie van Gordon: Thursday 12:30 – 2:00 pm, 199 McCone Hall

**Description:**
A quantitative introduction to the hydrology of the terrestrial environment including lower atmosphere, watersheds, lakes, and streams. All aspects of the hydrologic cycle, including precipitation, infiltration, evapotranspiration, overland flow, streamflow, and groundwater flow. An introduction to the chemistry of groundwater and surface water. Development of quantitative insights through problem solving and use of simple models. This course is also a capstone course for the campus-wide data science initiative. What this means is that, throughout the course, you will reinforce your understanding of hydrologic principles through the use and manipulation of actual hydrologic data. This will culminate with your group project, which will be to work in interdisciplinary teams to improve the hydrologic component of a model that is currently being used by a nonprofit research foundation to simulate malaria transmission, in order to design better strategies for its eradication.

**Prerequisites:**
Listed as Chemistry 1A, Math 1A-1B, Physics 7A, or consent of instructor. There will be a lot of math in the class, but mostly it will just be algebra. Chemistry and physics are helpful, but as long as you are comfortable with using equations, the material taught in this course will stand alone. Also note that we will be using the programming language Python for some assignments and the final project. But don't worry if you don't have any experience with Python yet. We will go through a tutorial together, and you will also have ample opportunity to learn from your peers in group work.

**Reading:**
You will get the most out of this course if you do the required readings. The textbook is:

Elements of Physical Hydrology, Second Edition (2014)
by George Hornberger, Patricia L. Wiberg, Jeffrey P. Raffensperger, and Paolo D'Odorico.
ISBN: 9781421413730

A copy will be placed on reserve in the Earth Science Library in the basement of McCone Hall. Note that the first edition also contains most of the reading material we will cover.

Additional supplemental reading materials will be posted on bCourses.

**Classroom Expectations:**
You are expected to come to class. For some of the class, we will employ a "flipped classroom" strategy of learning, meaning you will do some reading or watch a short video presentation before coming to class, and then work on projects and applied problems in groups during class time. We are in an Active Learning Classroom to facilitate this work. If you have a laptop, you will need to bring it to class, especially on dates for which assignments are issued. Please contact the professor or GSI if this is not possible, and we will work with you to make alternative arrangements.

Note that no food or drink is allowed in the Active Learning Classroom.

**Requirements and Grading Policy**
Hydrology is best learned by grappling with problems. Therefore, the majority of your grade will come from your performance on assignments and a final project. Assignments carry variable weight; some will be completed in class as a "flipped classroom" activity, whereas others will require substantial investment of your time outside of class. There will be no exams, but there will be six cumulative quizzes to reinforce learning, as listed on the syllabus. Quizzes will take no more than 10 minutes. You will do best on the quizzes by reviewing your notes and looking over the review section and examples at the end of the assigned book chapters, as well as by reviewing any in-class assignments or activities. The final project is an important part of this class, and the intent is for you to apply your classroom learning to the solution of this real-world challenge throughout the semester. Further information about the final project will be distributed separately.

Assignments: 41%
Final project: 40%
Journal paper responses and discussions: 7%
Quizzes: 12% (2 pts each)

All deliverables will be penalized by one full point each day they are late. Contact Professor Larsen *in advance* if you have a valid reason for missing a quiz.

The standard scale for grades is as follows: A+: 97-100%, A: 93-96%, A-: 90-92%, B+: 87-89%, B: 83-86%, B-: 80-82%, C+: 77-79%, C: 73-76%, C-:70-72%, D+: 67-69%, D: 63-66%, D-:60-62%, F: <60%. Quizzes and assignments will be curved if needed. For students taking the class pass/fail, a "pass" will be given for scores 70% and higher.

**Academic Integrity**
Students are expected to uphold the campus honor code at all times. You are a member of an academic community at one of the world's leading research universities. Universities like Berkeley create knowledge that has a lasting impact in the world of ideas and on the lives of others; such knowledge can come from an undergraduate paper as well as the lab of an internationally known professor. One of the most important values of an academic community is the balance between the free flow of ideas and the respect for the intellectual property of others. Researchers don't use one another's research without permission; scholars and students always

use proper citations in papers; professors may not circulate or publish student papers without the writer's permission, and students may not circulate or post materials (handouts, exams, syllabi—any class materials) from their classes without the written permission of the instructor.

Any test, paper, or report submitted by you and that bears your name is presumed to be your own original work that has not previously been submitted for credit in another course unless you obtain prior written approval to do so from your instructor. In all of your assignments, including your homework or drafts of papers, you may use words or ideas written by other individuals in publications, web sites, or other sources, but only with proper attribution. If you are not clear about the expectations for completing an assignment or taking a test or examination, be sure to seek clarification from your instructor or GSI beforehand. Finally, you should keep in mind that as a member of the campus community, you are expected to demonstrate integrity in all of your academic endeavors and will be evaluated on your own merits. The consequences of cheating and academic dishonesty—including a formal discipline file, possible loss of future internship, scholarship, or employment opportunities, and denial of admission to graduate school—are simply not worth it.

A zero-tolerance policy for cheating or plagiarism in any form will be strictly enforced. Any student caught cheating or plagiarizing will receive a score of zero for that assignment or test and be reported to Student Affairs.

**Scheduling conflicts:**
Please notify me by the second week of the term about any known or potential extracurricular conflicts (such as religious observances, graduate or medical school interviews, or team activities). I will try my best to help you with making accommodations but cannot promise them in all cases.

**Tentative schedule of lecture and readings**
This schedule is subject to change. The most current version will be on bcourses!

| Date | Topic | Reading | Deliverables and deadlines |
|---|---|---|---|
| 1/17/2017 | Intro to course, water terminology, and water cycle | Chapter 1, appendices 1 and 2 | |
| 1/19/2017 | Water balances. Mono Lake case study | Chapter 1, appendices 1 and 2 | Assignment 1 distributed (4 pts) |
| 1/24/2017 | Intro to the case study: hydrology in health modeling | Eckhoff, 2016; Eckhoff et al. 2015 | Journal paper reading response due (2 pts); reading assignment for 1/26 distributed |
| 1/26/2017 | Introduction to Jupytyr Notebooks and Python | Handout on bCourses. Must be done BEFORE this class period! | Assignment 1 due; assignment 2 distributed (4 pts) |
| 1/31/2017 | Precipitation, humidity, fog, interception | Chapter 2 | |
| 2/2/2017 | Precipitation, humidity, fog, interception | Appendix 3 | Assignment 2 due; quiz |
| 2/7/2017 | Evaporation and transpiration | Chapter 2 | |

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| 2/9/2017 | Evaporation and transpiration | Chapter 2 | Assignment 3 distributed (4 pts) |
| 2/14/2017 | Fluid statics basics and the Bernoulli equation | Chapter 3 (up to p. 76) | Quiz |
| 2/16/2017 | Hydrologic maps: watershed delineation, spatial interpolation | Online material | Assignment 3 due; assignment 4 distributed (6 pts) |
| 2/21/2017 | Principles of open channel flow 1: fluid mechanics | Chapter 4 | |
| 2/23/2017 | Principles of open-channel flow 2: measuring discharge | Chapter 4 | Assignment 4 due; quiz |
| 2/27/2017 | Strawberry Creek streamflow exercise | | Assignment 5 distributed (8 pts) |
| 3/2/2017 | Strawberry Creek streamflow exercise | | |
| 3/7/2017 | Floods | Chapter 5, excluding section 5.4 | Assignment 5 due; assignment 6 distributed (4 pts) |
| 3/9/2017 | Infiltration | Chapter 8 | Quiz |
| 3/14/2017 | Hydrographs | Chapter 10.1-10.3 | Assignment 6 due; assignment 7 distributed (4 pts) |
| 3/16/2017 | Overland flow | Chapter 10.4-10.6 | Assignment 7 due |
| 3/21/2017 | Discussion of Bomblies et al. malaria hydrology paper | Bomblies et al. | Journal paper reading response due (3 pts) |
| 3/23/2017 | Project intermediate progress reports | | Project progress report due |
| 3/28/2017 | Spring recess | | |
| 3/30/2017 | Spring recess | | |
| 4/4/2017 | Water in porous media | Chapter 6, up to p. 159 | |
| 4/6/2017 | Journal paper discussion | TBD | Journal paper reading response due (3 pts) |
| 4/11/2017 | Darcy's Law and steady groundwater flow | Chapter 6, up to p. 159 | Quiz |
| 4/13/2017 | Flow nets | p. 159-185 | Assignment 8 distributed (3 pts) |
| 4/18/2017 | Flow to wells, aquifer tests, and aquifer properties | Chapter 7 and handout | Assignment 8 due; Assignment 9 distributed (4 pts) |
| 4/20/2017 | Group work period | | |
| 4/25/2017 | Flow to wells, aquifer tests, and aquifer properties continued | Chapter 7 and handout | |
| 4/27/2017 | Groundwater contamination and remediation | Chapter 7 and handout | Assignment 9 due; quiz |
| 5/2/2017 | Final project presentations | | |
| 5/4/2017 | Final project presentations | | Final project due |