

Introduction to Physical Hydrology

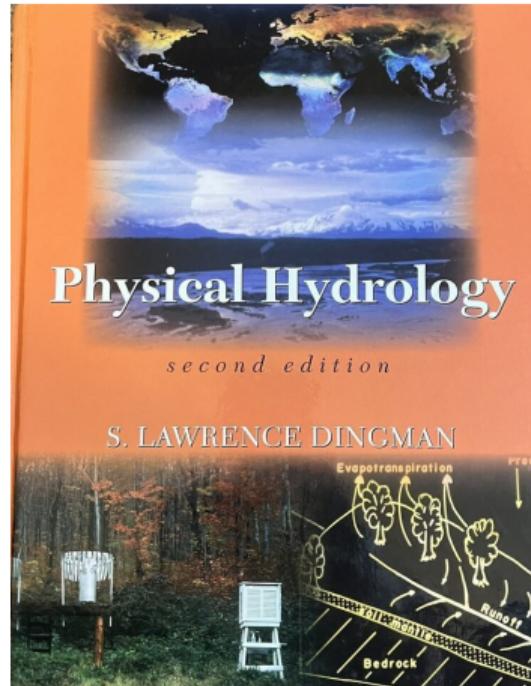
Katie Markovich, EPS 522/ ENVS 423L (Fall 2025)

Welcome!



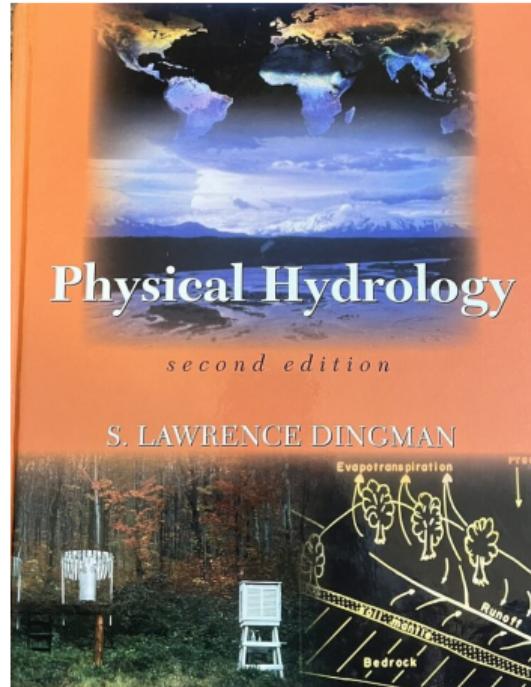
Learning Objectives

- 1 To explain, diagnose, and predict the physical processes that govern:
 - ▶ The spatial and temporal characteristics of water in its various storage reservoirs (terrestrial, atmospheric, oceanic).
 - ▶ The corresponding fluxes of water between these reservoirs.
- 2 To be able to read and interpret the scientific literature on physical hydrology.
- 3 To be able to work with modern hydrologic datasets using modern tools.



Learning Objectives

Topics will include the hydrologic cycle, atmospheric thermodynamics and circulation, precipitation and snow processes, unsaturated flow, evapotranspiration, groundwater flow, runoff and streamflow, and watershed modeling.



Grading Procedures

ENVS 423L	
Homeworks	60%
Midterm	20%
Final	20%

EPS 522	
Homeworks	40%
Midterm	20%
Final	20%
Term Project	20%

- Homeworks are weekly (ish) and due to Canvas by midnight of the due date.
- You can submit a homework up to a week late for 50% of the grade.
- The final will be comprehensive.
- For both tests, you can bring a "Notes" sheet (equations, constants, etc.).
- Term project will consist of a report and a presentation to the class.

Course Schedule

Class is roughly divided into "above" and "below" surface.

Physical Hydrology Schedule (subject to change)				
Date	Topic	Reading	Due dates/notes	
19-Aug	Tue	Introduction	Ch. 1	
21-Aug	Thur	Working with python and git		Bring laptop
26-Aug	Tue	Hydrologic Concepts	Ch. 2	HW1
28-Aug	Thur	Climate System	Ch. 3	
2-Sep	Tue	Climate System	Ch. 3	HW2
4-Sep	Thur	Precipitation	Ch. 4	
9-Sep	Tue	Precipitation	Ch. 4	HW 3
11-Sep	Thur	Snow and snowmelt processes	Ch. 5	
16-Sep	Tue	Evapo(transpiration)	Ch. 7	HW 4
18-Sep	Thur	Evapo(transpiration)	Ch. 7	
23-Sep	Tue	Streamflow	Ch. 9	HW 5
25-Sep	Thur	Streamflow	Ch. 9	Project proposal due
30-Sep	Tue	Streamflow	Ch. 9	HW 6
2-Oct	Thur	Review		
7-Oct	Tue	Exam #1		
9-Oct	Thur	No class, Fall Break		

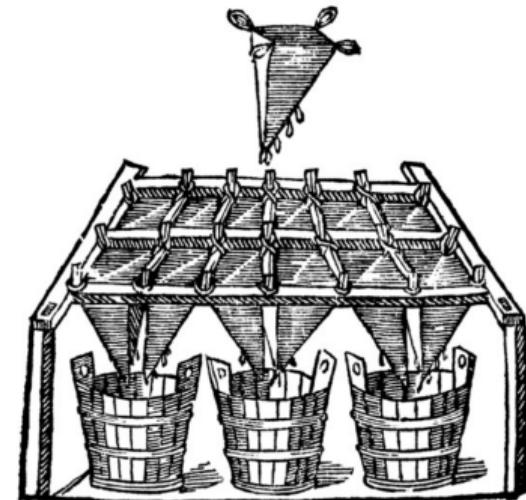
14-Oct	Tue	Vadose Zone	Ch. 6	
16-Oct	Thur	Vadose Zone	Ch. 6	
21-Oct	Tue	Groundwater	Ch. 8	HW 7
23-Oct	Thur	Groundwater	Ch. 8	
28-Oct	Tue	Groundwater	Ch. 8	HW 8
30-Oct	Thur	Groundwater	Ch. 8	
4-Nov	Tue	Hydrologic Modeling	Ch.2.9, 9.5-6	HW 9
6-Nov	Thur	Hydrologic Modeling		
11-Nov	Tue	Hydrologic Modeling		HW 10
13-Nov	Thur	Climate change impacts to hydrology	Ch. 10	
18-Nov	Tue	Water Resources Management	Ch. 10	HW 11
20-Nov	Thur	Water Resources Management		
25-Nov	Tue	TBD		
27-Nov	Thur	No class, Thanksgiving holiday		
2-Dec	Tue	Project presentations		Project reports due
4-Dec	Thur	Project presentations and exam review		
?	?	Comprehensive Exam		

What is Hydrology?

"Hydrology is a science that deals with the waters above and below the land surface of the Earth, their occurrence, circulation and distribution, in both time and space, their biological, chemical and physical properties, and their reaction with the environment, including their relation to human beings."

Origins of Hydrology

It rose out of a practical need to supply water for irrigation, protect against floods, and purify water.



Hydrology is Interdisciplinary

Basic sciences

Engineering Sciences

Economic and social sciences



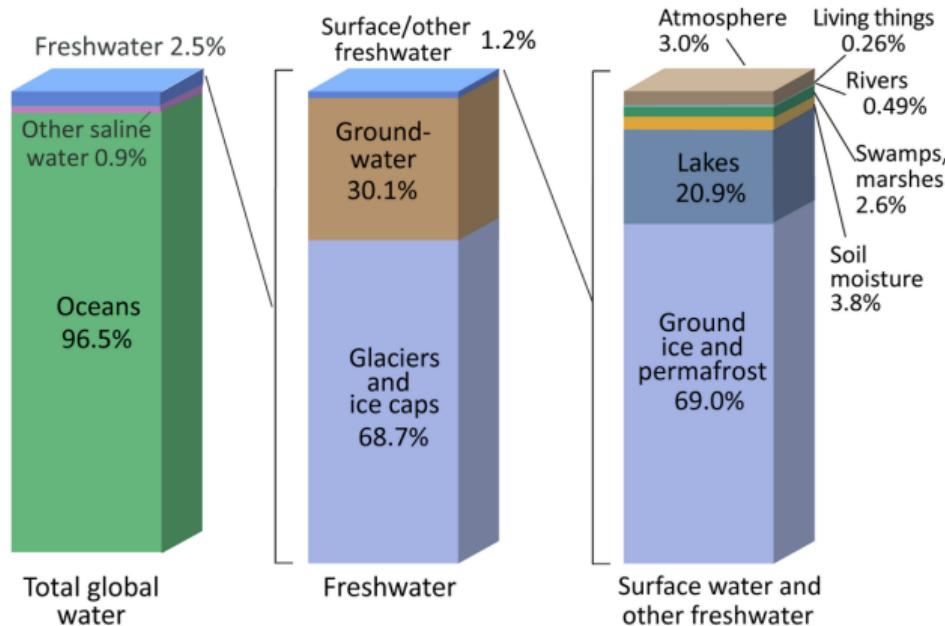
Why "Physical" Hydrology?

Physics is the scientific study of matter, its fundamental constituents, its motion and behavior through space and time, and the related entities of energy and force (sound familiar?)

The foundations of physical hydrology derive from fundamental laws of physics, such as the conservation of mass, energy, and momentum.

Stores of Water

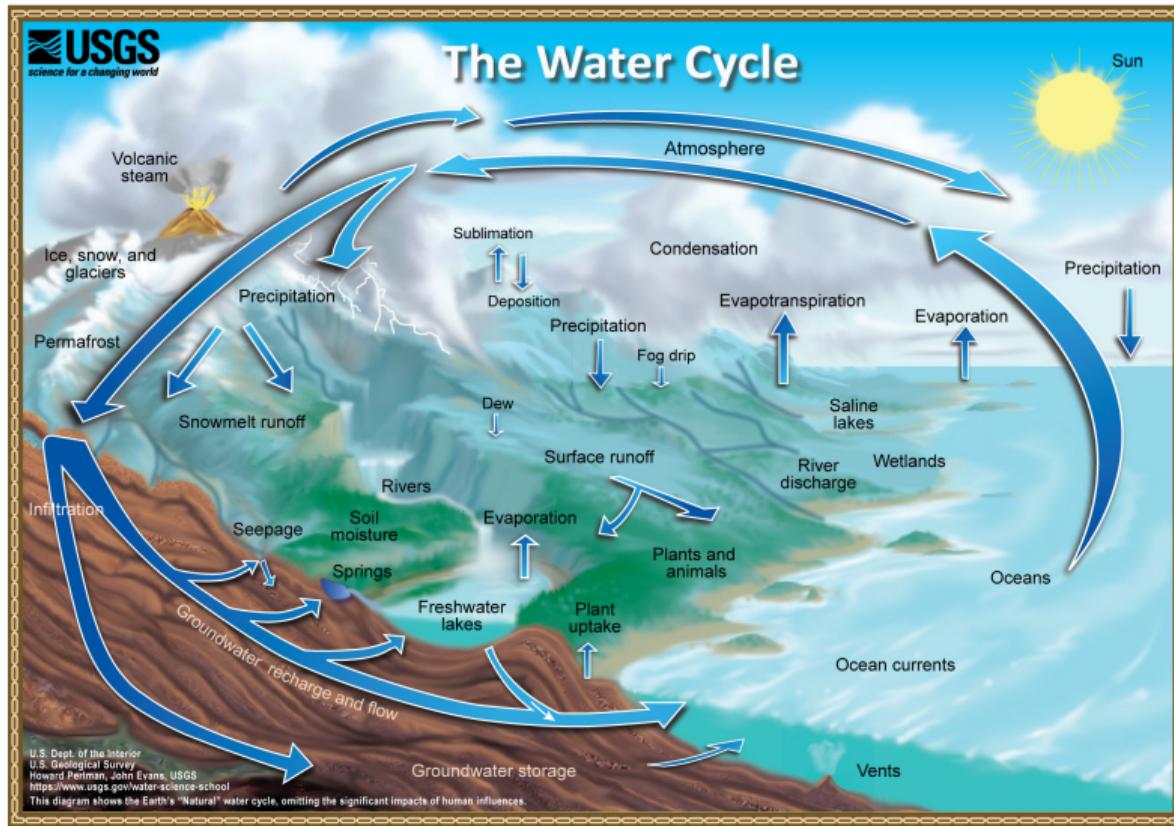
Where is Earth's Water?



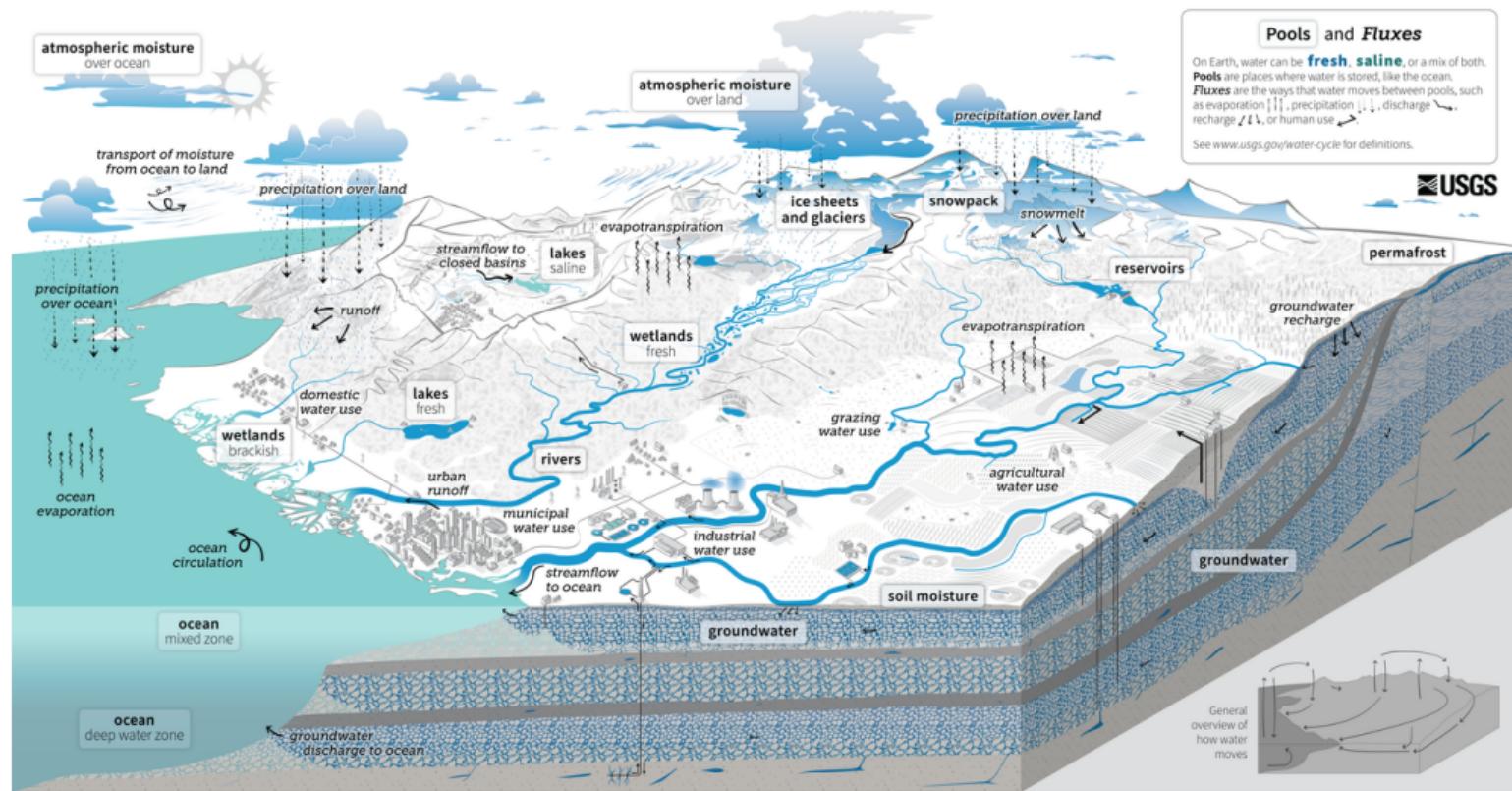
Credit: U.S. Geological Survey, Water Science School. <https://www.usgs.gov/special-topic/water-science-school>

Data source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources. (Numbers are rounded).

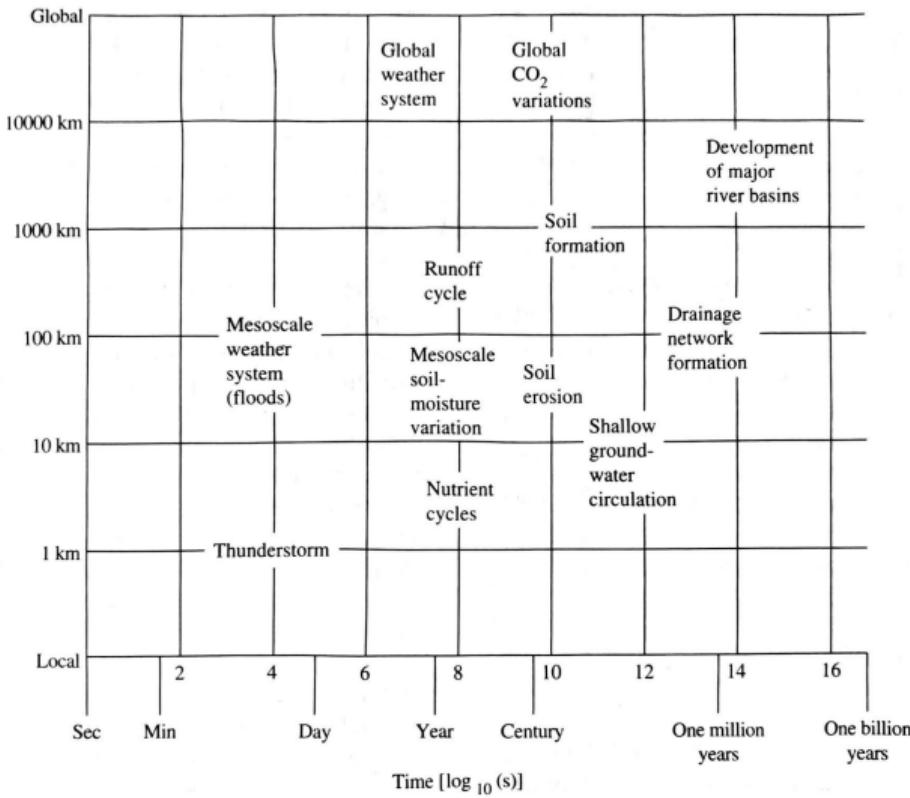
Pathways of Water



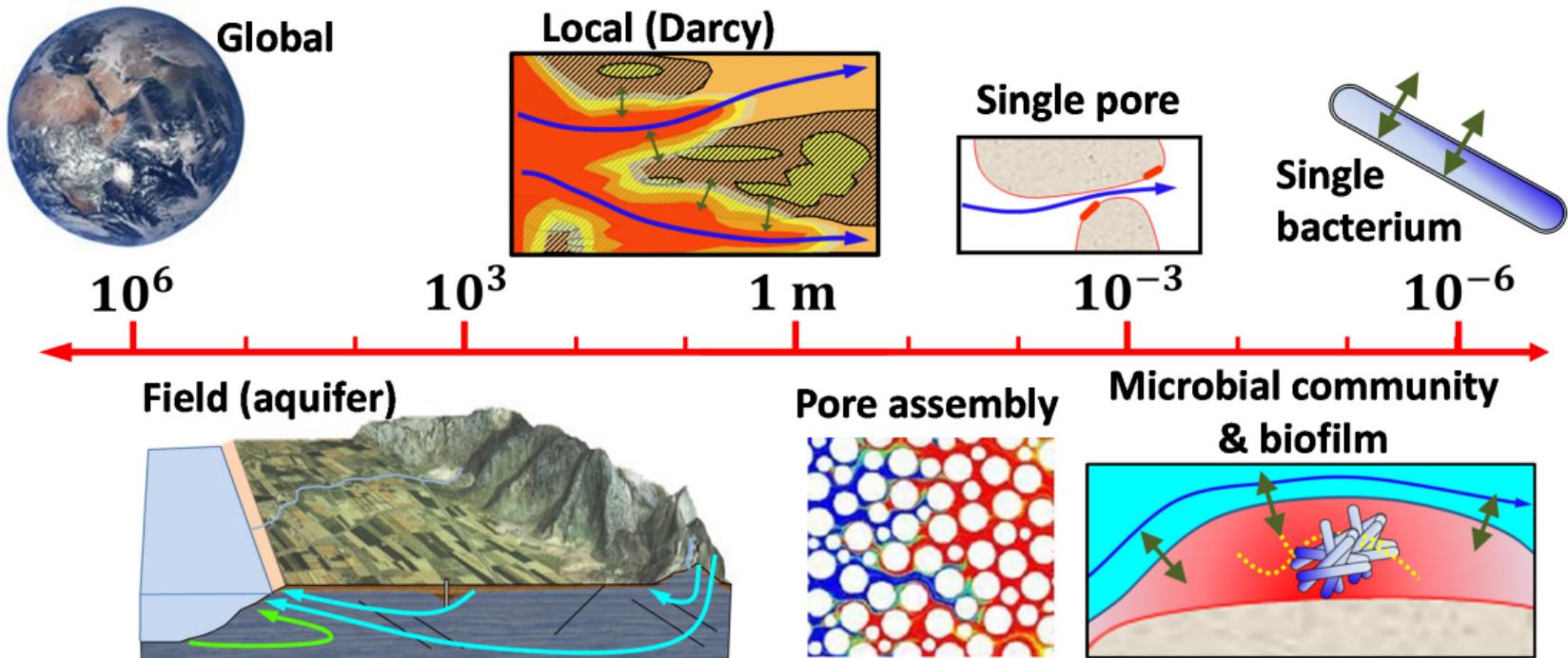
Water Cycle



Scale



Scale



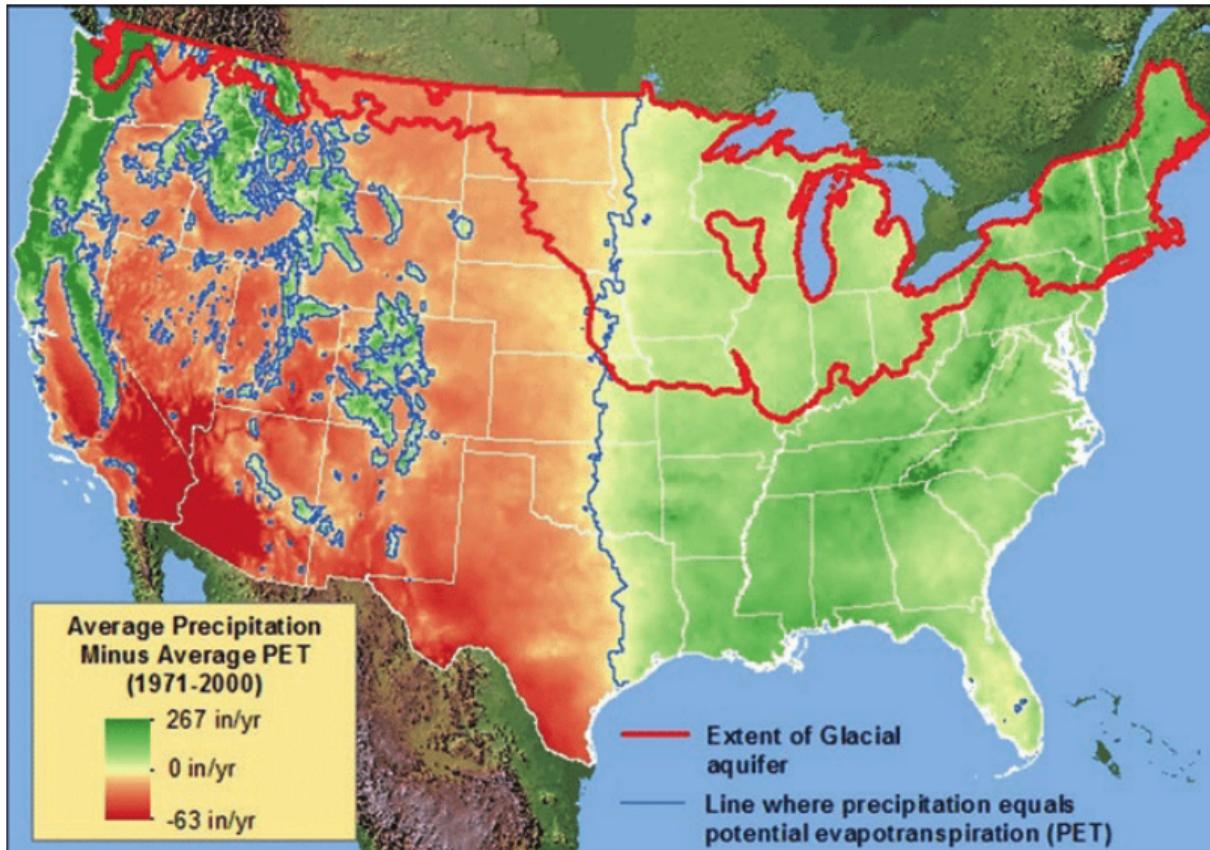
Carrera et al., 2022

Why study hydrology?

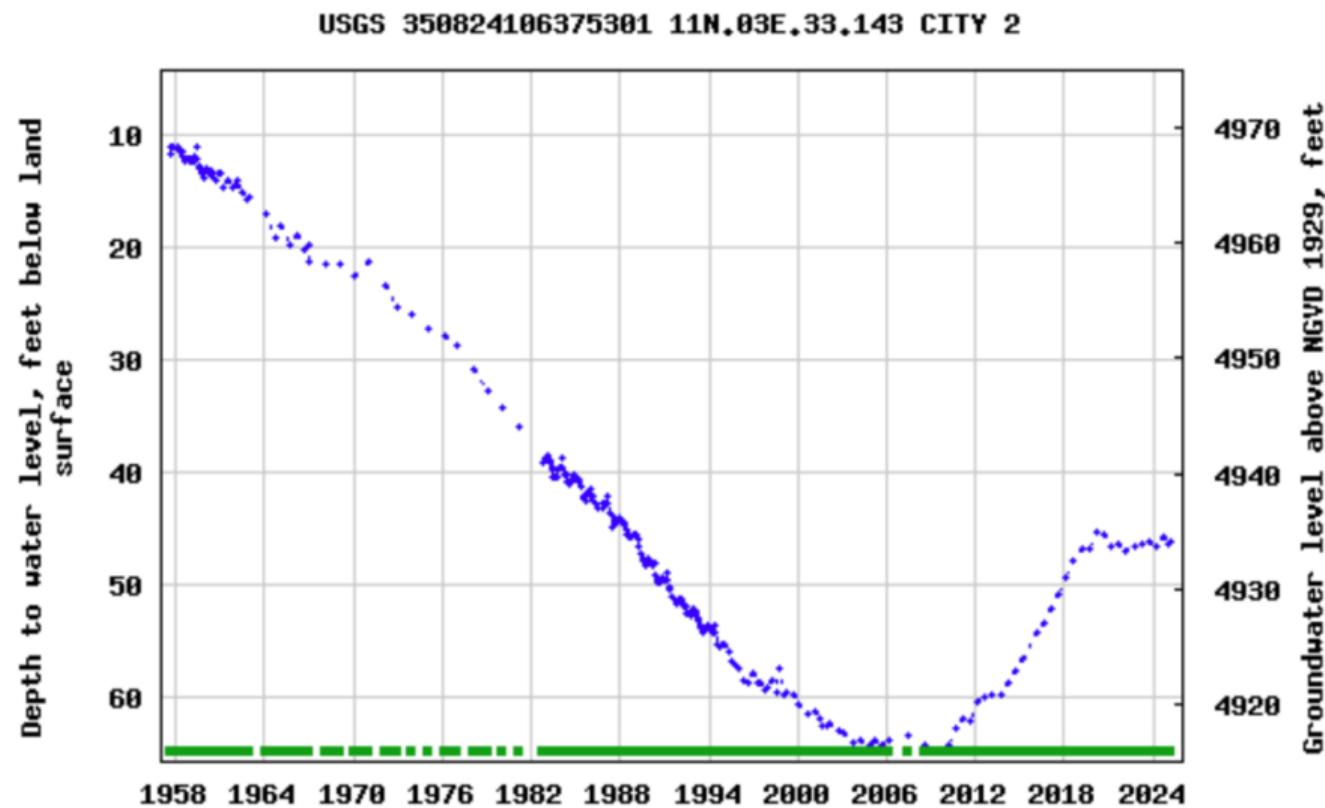
- Every living thing needs water
- Water is not distributed evenly spatially or temporally
- Even if water is available, it may be of poor quality
- Water hazards affect human safety and property
- Climate and land use change are exacerbating all of the above

TL;DR JOB SECURITY

New Mexico Water



New Mexico Water, cont'd.



Next up...

The next class is going to be a hands on overview of the tools we will be using for the homeworks. Please bring your laptop and do the following before class:

- 1 Set up a GitHub username if you do not already have one.
- 2 Send me an email with your GitHub username so I can grant you access to the course repository.
- 3 Install git on your laptop
- 4 Install miniconda on your laptop