

ESM 226: Groundwater Management

Scott Jasechko

“Examines the principles and tools for groundwater management and stewardship of groundwater resources in the US and includes examples drawn from global groundwater management challenges.”

Email: jasechko@ucsb.edu

Office Hours: By appointment

Office: Bren Hall 4404

Course Text and Relevant Readings: Readings posted online

Grading:

Item	Percent of course grade
Quiz	30
Participation	10
Term project oral presentation	20
Term project final report	40

Course Objectives:

1. Develop proficiencies in core qualitative and quantitative principles of groundwater storage, flow, recharge, discharge, quality, management and legal frameworks [Classes entitled ‘Groundwater hydrology 1’, ‘Groundwater hydrology 2’, ‘Groundwater hydrology 3’, ‘Recharge, discharge’, ‘Groundwater quality’, ‘Pumping and management’, and ‘Quiz’]
2. Develop ability to quantify and evaluate groundwater management challenges arising from groundwater overuse and pollution including those identified by California’s Sustainable Groundwater Management Act (SGMA):
 - (2a) Develop abilities to quantify spatiotemporal trends in groundwater levels and identify key processes driving groundwater level fluctuations and trends over time [Classes entitled ‘Groundwater hydrology 3’, and ‘Groundwater levels’]
 - (2b) Learn to quantify groundwater storage and its relevance to stakeholders in a groundwater basin [Classes entitled ‘Groundwater hydrology 1’, ‘Groundwater hydrology 2’, and ‘Groundwater storage’]
 - (2c) Develop knowledge of common groundwater pollutants and techniques available to evaluate contaminant sources and processes governing their abundance [Class entitled ‘Groundwater quality’]

- (2d) Understand factors impacting aquifer storage and evaluate techniques applied to identify land subsidence induced by groundwater pumping [Class entitled 'Pumping and Management']
- (2e) Understand theory and principles governing seawater intrusion and engineering and management interventions available to ameliorate seawater intrusion vulnerability [Class entitled 'Seawater intrusion']
- (2f) Develop skills to evaluate where rivers gain and lose water, and understand how pumping from wells can impact streamflow [Class entitled 'Streamflow depletion']
3. Review, synthesize and present groundwater quality and quantity research and couple results to potential management strategies [Oral Presentations during 'Final presentations' and evaluation item 'Term project final report']

Course Overview and Connections to Course Objectives:

- Classes in blue highlighting (see table below) introduce core principles of groundwater science, including introductions to groundwater storage, flow, replenishment, discharge, quality, management and legal frameworks [*Direct link to course objective 1*]
- Classes in yellow highlighting couple lectures on the six key aspects of California's Sustainable Groundwater Management Act (the six "undesirable results" [*Direct link to course objective 2*]
- Term project presentations—where each student provides a synthesis of results from for their unique groundwater basin—take place during final class meetings [*Direct link to course objective 3 – objective outcome evaluated via Oral presentation and Final report*]

Tentative schedule (subject to changes)

https://docs.google.com/spreadsheets/d/1ycsxe3vXR3iJEPlsYvg_w8IdBv2kroNH7woFXvwwTxI/edit?usp=sharing

Week	Date	Meeting #	Topic	Concepts
1	Monday, September 30, 2024	1	Groundwater hydrology 1	Topics: relevance of groundwater to provision of drinking water, industry and irrigation, and streamflow generation; global (and US-wide) overview of groundwater withdrawals; overview of role of groundwater in global change processes; definitions of key terms (e.g., groundwater, wells, groundwater management, recharge, gaining/losing streams); porosity (primary and secondary)
1	Wednesday, October 2, 2024	2	Groundwater hydrology 1	Topics: relevance of groundwater to provision of drinking water, industry and irrigation, and streamflow generation; global (and US-wide) overview of groundwater withdrawals; overview of role of groundwater in global change processes; definitions of key terms (e.g., groundwater, wells, groundwater management, recharge, gaining/losing streams); porosity (primary and secondary)
2	Monday, October 7, 2024	3	Groundwater hydrology 2	Topics: permeability; hydraulic conductivity; definitions of aquifer, aquitard, aquiclude; heterogeneity and anisotropy; confined conditions; water tables; types of aquifer systems; sources of water to wells;
2	Wednesday, October 9, 2024	4	Groundwater hydrology 2	Topics: permeability; hydraulic conductivity; definitions of aquifer, aquitard, aquiclude; heterogeneity and anisotropy; confined conditions; water tables; types of aquifer systems; sources of water to wells;
3	Monday, October 14, 2024	5	Groundwater hydrology 3	Topics: storativity; specific yield; residence times; estimating groundwater flow rates; (ground)watersheds; hydraulic heads and gradients (horizontal and vertical); flow nets; discharge
3	Wednesday, October 16, 2024	6	Groundwater hydrology 3	Topics: storativity; specific yield; residence times; estimating groundwater flow rates; (ground)watersheds; hydraulic heads and gradients (horizontal and vertical); flow nets; discharge
4	Monday, October 21, 2024	7	Recharge, Discharge	Topics: quantifying 'groundwater' contributions to streamflow; diffuse recharge, focused recharge, water table fluctuation method, tracer hydrology methods; detecting groundwater discharges, managed aquifer recharge
4	Wednesday, October 23, 2024	8	Recharge, Discharge	Topics: quantifying 'groundwater' contributions to streamflow; diffuse recharge, focused recharge, water table fluctuation method, tracer hydrology methods; detecting groundwater discharges, managed aquifer recharge
5	Monday, October 28, 2024	9	Groundwater quality	Topics: Conservative versus non-conservative solutes, Solubility, Major and minor ions, Solute sources, Advection, Dispersion, Common groundwater contaminants (hydrocarbons, arsenic, salinity, nitrate, fluoride) and controls on their mobility, retardation, reaction, point and non-point sources, geogenic sources
5	Wednesday, October 30, 2024	10	Groundwater quality	Topics: Conservative versus non-conservative solutes, Solubility, Major and minor ions, Solute sources, Advection, Dispersion, Common groundwater contaminants (hydrocarbons, arsenic, salinity, nitrate, fluoride) and controls on their mobility, retardation, reaction, point and non-point sources, geogenic sources
6	Monday, November 4, 2024	11	Pumping and Management	Topics: Well hydraulics, Cone of depression, Radius of influence, Spatial scales, Legal principles, SGMA, GSPs, GSAs,
6	Wednesday, November 6, 2024	12	Quiz	
7	Monday, November 11, 2024	no class	no class	no class
7	Wednesday, November 13, 2024	12	Groundwater levels	Topics: Groundwater depletion, techniques to evaluate groundwater levels (e.g., GRACE, piezometric records)
8	Monday, November 18, 2024	13	Groundwater storage	Topics: SGMA's "minimum threshold" value, managed aquifer recharge
8	Wednesday, November 20, 2024	14	Seawater intrusion	Topics: Prevalence, Theory, Treatment and engineering 'solutions'
9	Monday, November 25, 2024	15	Land subsidence	Topics: land subsidence
9	Wednesday, November 27, 2024	16	Streamflow depletion	Topics: Capture, groundwater dependent ecosystems, losing and gaining reaches
10	Monday, December 2, 2024	17	Final presentations	
10	Wednesday, December 4, 2024	18	Final presentations	
Legend				
				Fundamental concepts
				SGMA undesirable results
				Final presentations