HYD 298 (4 units, S/U)	**Global Groundwater-Agriculture Nexus**
CRN: 29198	Instructor: Thomas Harter UC Davis, Winter Quarter 2023

Format – 3 Week Intensive, 6am-10am live online, joint with 24 students at University of Freiburg, Germany.

This graduate course will be co-taught at UC Davis and University of Freiburg Germany. The course will be held within the University of Freiburg's block course format (3 weeks full-time, M-F, Jan 9-27). S/U grade will be based on participation, on a 20 minute project presentation during the third week, and a project synthesis report due by early March. The class will consist of lectures, guest-lectures, some small group discussions, and student presentations.

Content

About one third of the earth's land surface is used for agricultural production including pastures for livestock. About 15 million square kilometers (10% of the earth's surface) is cropped land in annual or permanent crops. Agriculture, and especially irrigated agriculture, which generates about 40% of global agricultural products on about 20% of cropped land, is highly dependent on adequate water supplies. With its large global land use footprint, agriculture also has major impacts on water resources, which in turn affect ecosystems and human uses of water. Many of the most productive groundwater basins around the globe are closely linked with agricultural activities. Groundwater is an essential resource to manage droughts. Dependency of global food, feed, fiber, and (bio)fuel production on groundwater will increase with a warming climate and more extreme weather conditions. Groundwater is also a major source of drinking water, in many rural areas often the only source of drinking water. Understanding and sustainably managing groundwater resources in agricultural regions is therefore critical to global food security and human health. Assessment, monitoring, regulation, and management of groundwater resources is implemented locally and regionally, sometimes nationally. For graduate students, groundwater issues at the interface with agriculture provide ample work and research opportunities and challenges while collaborating and networking across disciplines (hydrology, environmental sciences, ecology, geography, social sciences, policy, engineering).

Course Content (eleven daily topics for lecture and discussion, readings):

1. Global geography of agriculture and groundwater: groundwater regions of the world, agricultural regions of the world, challenges to global food security, role of irrigation in agriculture, role of groundwater in irrigation
2. Groundwater dynamics in agricultural regions: groundwater systems and water budgets, regional groundwater flow in various aquifer systems, green water vs. blue water, rainfed agriculture, irrigation, groundwater recharge in agricultural regions, modeling
3. Agricultural groundwater management: Quantity/Extraction: US law, EU law, challenges, Integrated Regional Water Management Planning in CA
4. Groundwater quality issues in agricultural regions: sources, occurrence, fate and transport of contaminants: nitrate, pesticide, nitrogen assessment, salinization
5. Groundwater quality focus: Animal farming, manure management, and groundwater: animal farming systems, pathogens, antibiotics / pharmaceuticals, hormones
6. Assessment of nonpoint source pollution of groundwater: vulnerability assessments: overview, soil / unsaturated zone models, groundwater models, high resolution NPS modeling
7. Agricultural groundwater quality: regulation, compliance, monitoring: Pesticides and Nutrients: BMPs, Regulations: US, EU Nitrate Directive, EU Groundwater Directive, EU Water Framework Directive, Enforcement and Monitoring
8. Monitoring groundwater for assessment, enforcement, and trends: Classification, monitoring well construction, monitoring well network design, groundwater age-dating, isotopes for fingerprinting (forensics), trend analysis
9. Groundwater-surface water nexus in agriculture: conjunctive use management, ASR, optimization of conjunctive use, groundwater dependent ecosystems, classification, hyporheic zone dynamics, Scott Valley example, EU examples

Learning Outcomes

- deepen understanding of groundwater hydrology by investigating issues specifically related to agriculture
- understand and learn to apply key principles of physical groundwater hydrology
- understand and learn key policy and regulatory approaches to managing groundwater, and apply appropriate technical-scientific tools to support groundwater management
- gain familiarity with and apply a variety of modeling and field observation tools
- refresh and apply fundamental knowledge from other courses taken during graduate studies to date
- learn basic principles of being a science advisor to policy processes
- gain professional practice: implementing a mock consulting research project
- explore / prepare for potential thesis topic

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Grading

NOTE: The mode of grading for HYD 298 will be S/U based on presentation, synthesis paper, and active participation. Contact the instructor for questions and if a grade variance (letter grading) is needed: thharter@ucdavis.edu.

Schedule

Due to the format of the German program, the course will meet daily from 6am – 10am PST live online (3pm – 7pm in Germany), for three weeks, Monday to Friday. Students will engage in groups of two for their project research. Depending on interest, I am open to hold a weekly one-hour discussion group with the Davis students, in-person on campus, at least in January. The last day of class is January 27.