

PhD Project Description

Understanding the role of submarine groundwater discharge using geochemical tracers

Supervisors

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Research Group

This is an exciting opportunity to join a new and growing research group.

Project Summary

The coastal ocean is highly vulnerable to climate change due to superimposed terrestrial, climatic, and oceanic forcings. Coastal groundwater systems, which include the coastal aquifer and flow of groundwater to the coastal ocean (submarine groundwater discharge) are particularly vulnerable yet relatively underexplored. This project aims to understand the role of coastal groundwater systems in terms of water and contaminant transport. Key objectives include quantifying how climatic and oceanic events influence submarine groundwater discharge and the coastal aquifer.

This project involves a combination of field work, laboratory experiments, and data science. Analysis of highly specialized geochemical tracers for groundwater (radon and radium isotopes) will be a core aspect of the project, with opportunities to include contaminant tracers dependent on student interest. Data science approaches may include time-series analysis, extreme event detection, and/or machine learning. Specific research questions are somewhat flexible within the broader topic of coastal groundwater systems, the project.



Research Context and Objectives

Intensification of the hydrological cycle drives increasing uncertainties in water quality and resources. This is especially true in the coastal zone, where climate change is expected to have disproportionately strong impact. Within the coastal zone, coastal groundwater systems are under pressure from not only climatic hazards but also increasing human pressure on land.

Coastal groundwater systems span across the land-ocean interface and cover a large biogeochemical (e.g., salinity, oxygen, pH) gradient. Contaminant concentrations are often higher in groundwater and submarine groundwater discharge-driven contaminant flows can match those sourced from rivers. The biogeochemical gradient within the coastal aquifer also can act as a critical pollutant filter, often “trapping” certain metals and nutrients. However, there are significant gaps in our understanding about specific processes, pollutants, and more broadly how climatic hazards impact coastal groundwater systems.

Further reading:

McKenzie, T., Moody, A., Barreira, J., Guo, X., Cohen, A., Wilson, S.J., Ramasamy, M. (2024). Metals in coastal groundwater systems under anthropogenic pressure: A synthesis of behavior, drivers, and emerging threats. *Limnology & Oceanography Letters*, 9(4), 388-410. doi:10.1002/lol2.10413

Richardson, C.M., Davis, K.L., Ruiz-González, C., Guimond, J.A., Michael, H.A., Paldor, A., Moosdorf, N., Paytan, A. (2024). The impacts of climate change on coastal groundwater. *Nature Reviews Earth and Environment*, 5, 100–119. doi:10.1038/s43017-023-00500-2.

McKenzie, T., Dulai, H., Fuleky, P. (2021). Traditional and Novel Time-Series Approaches Reveal Submarine Groundwater Discharge Dynamics Under Baseline and Extreme Event Conditions. *Scientific Reports*, 11, 22570. doi:10.1038/s41598-021-01920-0

Santos, I.R., Chen, X., Lecher, A.L., Sawyer, A.H., Moosdorf, N., Rodellas, V., Tamborski, J., Cho, H.M., Dimova, N., Sugimoto, R., Bonaglia, S., Li, H., Hajati, M.C., Li, L. (2021). Submarine groundwater discharge impacts on coastal nutrient biogeochemistry. *Nature Reviews Earth and Environment*, 2, 307–323. doi:10.1038/s43017-021-00152-0.

Who are we looking for?

Suitable applicants will have a background in earth/ocean/environmental science, chemistry, physics, engineering, or similar and is excited by coastal hydrology. The ideal candidate will have previous fieldwork and/or chemical analysis experience in addition to computational (programming/data analysis) skills. Specific analytical and computational methods will be part of the PhD training as required. Desirable soft-skills include the ability to work both independently and as part of a collaborative team, critical thinking, and an inquisitive mindset.

The candidate will have opportunities for international collaboration and encouraged to participate in activities that diversify their skillset and research network. The societal relevance of the project also may provide opportunities for media and stakeholder engagement.