IMPERIAL

Environmental Chemistry and Hydrology: Tracing Hidden Pollution Pathways Using Geochemical Tracers

Supervisors

Lead Supervisor: Tristan McKenzie (t.mckenzie@imperial.ac.uk)

Research Group

Our research combines field and lab-based groundwater geochemical tracers (radon and radium isotopes) with contaminant chemistry to better understand how humans impact natural waters through pollution and climate change-driven hazards. In addition to field and lab-based research, we also combine observational geochemical data with statistical approaches and machine learning. This is an opportunity to join a dynamic, internationally connected research group working on pressing environmental challenges.

Background

The coastal ocean is highly vulnerable to pollution and climate change. 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. For example, submarine groundwater discharge transports substantial quantities of water, nutrients, greenhouse gases, metals, and other pollutants directly to the ocean. Yet, it remains one of the least understood parts of the hydrological cycle. Climate change, urbanisation, and sea-level rise are rapidly transforming these environments, with substantial consequences for coastal ecosystems, water quality, and human health.





The Project

This project involves a combination of field work and laboratory experiments. 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 depending on student interest. The project will involve highly societally relevant research such as:

(1) Quantifying groundwater discharge rates, coastal flushing rates, and surface water - groundwater interactions
(2) Mapping coastal aquifer responses to baseline tidal and extreme event fluctuations
(3) Understanding how hydrological regime shifts influence coastal biogeochemistry and contaminant flows

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. Computational (programming/statistics) skills are a bonus. 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 be encouraged to participate in activities that diversify their skillset and research network. The societal relevance of the project also may provide opportunities for media, stakeholder, and policy engagement.

Want to learn more?

If you are interested in the position, please contact Tristan McKenzie directly (t.mckenzie@imperial.ac.uk) to discuss further.

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.

Adyasari, D., Dimova, N., Dulai, H., Cartwright, I., Gilfedder, B., McKenzie, T., Fuleky, P. (2023). Radon-222 as a groundwater discharge tracer to surface waters. *Earth-Science Reviews, 238,* 104321. doi:10.1016/j.earscirev.2023.104321.

McKenzie, T., Habel, S., Dulai, H. (2021). Sea-level rise drives wastewater leakage to coastal waters and storm drains. *Limnology and Oceanography Letters, 6(3),* 154-163. doi:10.1002/lol2.10186.