Biogeochemical and Ecological Effects of Coastal Groundwater Discharge into Mediterranean Lagoons

Project Summary
Water fluxes from the land to the ocean are important drivers of coastal ecosystems and the critical role of surface water discharge from rivers to coastal ecosystems has been well documented for decades. However, the ‘footprint’ of hidden subsurface flow of groundwater on hydrology, productivity, diversity and functioning of coastal ecosystems along the world’s shorelines is only recently being recognised. Coastal aquifer systems extend underneath the coastline, and groundwater originating from these aquifers is an additional pathway for nutrients, trace elements and contaminants to the coastal zone. Similarly, the tidally, wave- or wind-driven recirculation of seawater through nearshore sediment can be a pathway for solutes, in particular where coastal sediments contain high concentrations of nutrients or contaminants.

In this project, ‘downstream’ ecological effects of coastal groundwater discharge into Mediterranean lagoons will be investigated. Coastal lagoons are of critical ecological and economic importance as transitional (brackish) water bodies. At the same time, these semi-enclosed systems are disproportionally affected by land-derived fluxes of water and solutes through restricted offshore exchange.

This PhD project forms part of the ANR-Chair of Excellence program ‘Rethinking Land-Ocean Connectivity – an Integrated Approach to Understanding the Effects of Groundwater on Coastal Ecosystems’ which investigates the hydrological processes and their ‘downstream’ ecological effects in an interdisciplinary and collaborative approach. The project will be carried out in collaboration with colleagues from the French laboratories MARBEC, LECOB, IFREMER, BRGM, LEGOS & IRD (Tunisia) and colleagues from Germany, Spain, Switzerland and Australia.

This PhD project will focus on biogeochemical and ecological effects of groundwater fluxes into coastal lagoon ecosystems. Two complementary approaches are planned: (a) to investigate the role of groundwater as a nutrient pathway and resulting effects on primary productivity, and (b) to develop the use of molluscs as bio-archives for lagoon hydrology. Each of these two approaches can form the subject of a stand-alone PhD project, or a combination of both can be carried out, depending on the interest and skills of the candidate.
Lagoons with contrasting hydrobiological conditions ranging from near pristine to heavily impacted systems will be investigated, e.g. Etang de La Palme & Etang de Salse-Leucate on the French Mediterranean coastline and the lagoons Ichkeul and Bizerte in Tunisia.

In the first approach, nutrient input associated with groundwater processes will be documented, and the stable isotopes $\delta^{15}$N and $\delta^{13}$C (together with algal stoichiometry) will be evaluated as tracers of groundwater-borne nitrogen in coastal primary producers. The salinity-dependence of hydrogen isotopes in algal lipid biomarkers will be explored as tracer for lagoon hydrological conditions.

In the second, complementary approach, mollusc shell bioarchives for lagoon environmental conditions will be developed. The aim is to reconstruct temporal variations of lagoon salinity throughout the lifetime of the animal by investigating the sclerochemistry of shells of resident oysters and mussels, using tracers such as the oxygen isotope signature $\delta^{18}$O and the element ratio Mg/Ca embedded in the shell during their growth. Growth increments will be analysed by cathodo-luminescence, in order to understand the relationship between shell growth rate and hydrological conditions.

**Tasks & requirements**

Applicants must hold an MSc or equivalent degree in a relevant field in environmental science (biogeochemistry, ecology, ecohydrology, hydrology, oceanography or similar). The PhD student will be in charge of field missions, data collection, geochemical analyses, data analyses, scientific publication etc. Interest in field-work based, interdisciplinary research and good communication and written skills in English are essential. French language skills would be an advantage. A driver’s license is required. Starting date of the three-year position is 1 September 2015. The project is fully funded by ANR & Labex OT-Med; the position is based at the Centre de Recherche et d’Enseignement de Géosciences de l’Environnement (CEREGE) at Aix-Marseille University; salary will be paid at standard PhD rate at Aix-Marseille University.

Applicants should send a complete CV, publication list (if available), a short outline of research interests and experience, and the names and contact details of two referees to Thomas.Stieglitz@jcu.edu.au and patrick.raimbault@mio.osupytheas.fr.

**Supervisor team**

Dr Thomas Stieglitz (HDR); Chair d’excellence ANR @RAAction / CNRS; Centre de Recherche et d’Enseignement de Géosciences de l’Environnement (CEREGE); Aix-Marseille Université. Email: thomas.stieglitz@jcu.edu.au

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In addition, colleagues from the laboratories MARBEC, LECOB, IFREMER, BRGM, LEGOS & IRD will contribute to supervision as appropriate. Further information on the host laboratories: www.cerege.fr; www.mio.univ-amu.fr; www.otmed.fr

**Further reading:** Stieglitz TC, van Beek P, Souhaut M., Cook PG, 2013. Karstic groundwater discharge and seawater recirculation through sediments in shallow coastal Mediterranean lagoons, determined from water, salt and radon budgets. Marine Chemistry 156, 73-84.