Submarine groundwater discharge and associated nutrient inputs into an urban estuary (Sydney Harbour, Australia)

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The effects of submarine groundwater discharge (SGD) have been widely analysed from different perspectives, however, few studies have considered urbanization. In this study, we used radium isotopes to assess SGD-derived nutrient fluxes (N, P and C) into Sydney Harbour. Sydney is the most populated city of Oceania, with several localised cases of historical groundwater pollution. We sampled top and bottom waters at the harbour scale (~20 km) and at the scale of four small embayments (~2 km). A decreasing gradient in radium isotopes concentrations from upstream to downstream was observed as well as two major groundwater "hotspots". Radium mass balances revealed that total SGD fluxes ranged from 42 to 121 $x10^4$ m^3 d^{-1} which is several times greater than the mean annual river discharge into Sydney Harbour. Radium had a positive correlation to phosphate and dissolved organic carbon, and a negative correlation with dissolved inorganic nitrogen. SGD derived nutrient fluxes exceeded maximum riverine nutrient fluxes by a factor of 3 for DOC, 10 for PO_4^{3-}, 44 for NH_4^+ and 1.3 for NO_X. The estimated SGD rates in Sydney (2.2 cm d^{-1}) were comparable to the global average of radium-derived-SGD in other urban estuaries (~3.1 cm d^{-1}). It has been considered that most of the nutrient inputs from urbanization enter the estuary through rivers or stormwater, but our study suggest that SGD plays a larger role.

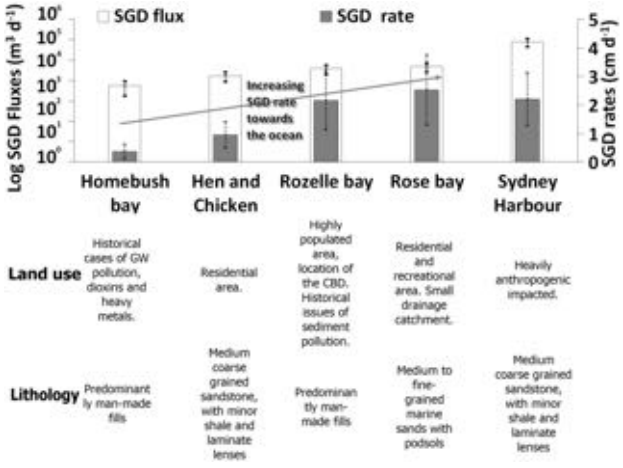

Fig 1. SGD fluxes and rates at the Sydney Harbour and different embayments