Assessment of the spatial distribution of submarine groundwater and associated nutrients discharge along the Ikuchi Island coastline, Seto Inland Sea, Japan

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Ikuchi Island located in the central Seto Inland Sea, is an example of a classic oceanic island with no large rivers, high shoreline-to-land area ratio and steep topography. Due to small annual precipitation (1100mm) with large inter-annual variation, the island faces a risk of water shortage, especially in dry seasons. As an alternative water resource, submarine groundwater discharge (SGD) could potentially substitute as a water supply for irrigation. Estimation of SGD along the coastline is therefore crucial to develop a sustainable water management plan for people living in the island. What’s more, Onodera et al. (2007) found that nitrate contamination of groundwater in Ikuchi Island was very serious, thus, the spatial distribution of SGD and associated nutrient fluxes along the shoreline of Ikuchi Island may also be important for reducing the occurrence of eutrophication in Seto Inland Sea.
To analyze the spatial distribution of SGD and associated nutrients, we performed a continuous ^{222}Rn and conductivity (EC) monitoring survey on a boat along the shoreline during December 22th, 2015. The total SGD flux was estimated to be 8.60×10^{6} m^{3} yr^{-1} based on the ^{222}Rn mass balance, which was in reasonable agreement with results obtained from the Darcy’s law ($8.53\times10^{6}$$m^{3}$ yr^{-1}) and water balance calculation (8.55×10^{6} m^{3} yr^{-1}). A strong pattern in the spatial distribution of SGD was observed, with the highest values (>2.5 cm d^{-1}) located along the western part of the island due to the steepest topography and much lower population. The results from a nutrient analysis of the groundwater indicated that the associated nutrient fluxes loading through the SGD pathway were 109.6×10^{6}, 2.980×10^{6}, and 439.8×10^{6} g yr^{-1} for DIN, DIP and DSi, respectively, which were comparable to or even higher than the levels observed in the local streams. Therefore, adequate attention should be paid to the importance of SGD as one source of nutrients during the eutrophication controls process in this area.

Keywords: Submarine groundwater discharge (SGD), Radon, Nutrients , Ikuchi Island

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