

## Estimation of submarine groundwater discharge and associated nutrient fluxes in Otsuchi Bay, northeast Japan in summer

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Otsuchi Bay is a small semi-enclosed bay along the Sanriku ria coast. Although the watershed of the bay has large amounts of groundwater resources, the rates of groundwater input into the bay and associated nutrient fluxes are still unclear. In this study, we estimated the rates of submarine groundwater discharge (SGD) and associated nutrient fluxes into Otsuchi Bay using the radon-222 (<sup>222</sup>Rn) and salinity mass balance model during the spring and neap tides in summer. As a result, SGD rates ranged from  $0.10$  to  $1.07 \times 10^6 \text{ m}^3 \text{ day}^{-1}$  ( $1.29$  to  $13.16 \text{ cm day}^{-1}$ ) with a mean of  $0.43 \times 10^6 \text{ m}^3 \text{ day}^{-1}$  ( $5.28 \text{ cm day}^{-1}$ ) during the four sampling periods. This value was similar to the annual groundwater recharge rate ( $0.63 \times 10^6 \text{ m}^3 \text{ day}^{-1}$ ) estimated by the water balance method in the whole basin. Estimated fluxes of dissolved inorganic nitrogen (DIN) and phosphorous (DIP) through the SGD were  $50.2$  to  $511.6 \text{ kg day}^{-1}$  and  $0.4$  to  $4.2 \text{ kg day}^{-1}$ , respectively. In contrast, these fluxes through the river water were  $127.9$  to  $336.6 \text{ kg day}^{-1}$ ,  $1.7$  to  $7.8 \text{ kg day}^{-1}$ , respectively. Nutrient fluxes through the SGD were approximately 40 and 33 % of all terrestrial fluxes of DIN and DIP, respectively. In addition, DIN flux of the SGD was approximately 7.7 % of that of the oceanic water even though DIP flux of SGD was only 0.2 %. In Otsuchi Bay, the N/P ratio in bay water during the stratified period was often lower than Redfield ratio. Therefore, DIN supply from the SGD would have a non-negligible contribution on primary production during the stratified period.

Keywords: submarine groundwater discharge , Otsuchi Bay