Evaluation for temporal variation in groundwater inflow to the lagoons connected to Lake Biwa by radon (^{222}Rn) tracer analysis

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Primary production in freshwater lakes and reservoirs are usually controlled by phosphorus (P). Lacustrine groundwater discharge (LGD), direct discharge of subsurface water to lake, is regarded as a potential nutrient paths, including phosphorus from a catchment to lake water environment. There are more than 20 lagoons around Lake Biwa which were originally a part of the lake. These lagoons are regarded to have important functions as settling ponds of inflowing loads from the catchments to Lake Biwa, refuges for shallow water ecosystems and so on. Because these lagoons are connected to Lake Biwa, evaluation of nutrient budget is important for the nutrient cycle in the lake. Some researchers have pointed out the presence of LGD in littoral area of Lake Biwa. However, it has not been evaluated for the lagoons around the lake. In the present research, we aimed to evaluate the temporal variation in groundwater inflow to a lagoon connected to Lake Biwa by radon (^{222}Rn) tracer analysis.

The field campaigns were conducted in December 2017, August and October 2018 for the lagoons (Noda-Numa and Hasu-Ike) located on northeastern shore of Lake Biwa. The volume of inflow and outflow, water temperature, electric conductivity, chlorophyll-a and radon (^{222}Rn) concentration were measured in the lagoon. ^{222}Rn is a radioactive element of uranium (^{238}U) series with 3.8 day of half-life. ^{222}Rn is a useful tracer of groundwater discharge because it generally enriched in groundwater than surface water. To examine the temporal variation in groundwater inflow, the time-series ^{222}Rn concentration in water was obtained. Water samples were collected at the inlet, outlet and near the center of the lagoons and natural springs and groundwater wells around the lagoons. Water and ^{222}Rn balance suggest that groundwater inflow is larger in Noda-Numa than Hasu-Ike. The catchment topography may influence on this difference. ^{222}Rn balance-based residence time of lagoon water was estimated 10-20 days in Noda-Numa, and 4-5 days in Hasu-Ike, were similar with that based on water balance. These results suggest the groundwater inflow is a potential phosphorus path to Noda-Numa.

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