NITRATE TRANSPORT AND REDUCTION MEASURES IN COASTAL AQUIFER OF AN AGRICULTURAL WATERSHED, SOUTHERN JAPAN

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The authors conducted the study to demonstrate the nitrate (NO_3^-) transport and reduction process in the coastal groundwater of Seto Inland Sea, southern Japan. Eutrophication of Seto Inland Sea is regarded as one of the main environmental issue in Japan. Therefore, it is important to assess the nitrate discharge from land to the sea in this region. Firstly, we investigated the horizontal variations of NO_3^--N, HCO_3^--C, Cl^- concentrations and ORP along with groundwater flow at the study catchment. Secondly, we examined NO_3^--N transport and reduction process in the coastal groundwater. We also estimated the NO_3^--N discharge by groundwater from the study catchment to the sea. The results are summarized as follows: 1) NO_3^--N concentrations in the shallow groundwater were about 30mgL^{-1} in the midstream area of the catchment, whereas it decreased less than 2.0mgL^{-1} in the downstream area. The inverse relationship between HCO_3^--C and NO_3^--N concentrations suggests biochemical denitrification process in groundwater of the downstream area. This is also supported by the low ratio of seawater contribution (<1.0%), and relatively low ORP in the groundwater of the downstream area; 2) The NO_3^--N concentrations in the downstream area were relatively higher in High-flow season than that in the Low-flow season. These results suggest to be caused by the variation of groundwater velocity in the downstream area, suggesting that the effect of denitrification is larger in the Low-flow than the High-flow season. These indicate that the NO_3^--N discharge by shallow groundwater in the High-flow is larger than that in the Low-flow season; 3) NO_3^--N concentrations in deep groundwater also decreased in the downstream area, however the concentrations were higher than that of the shallow groundwater. Further filed investigation revealed that the river water level is higher than the groundwater level from the midstream to the downstream area, and as a result the river water recharge the groundwater system. According to the geologic data, the upper layer of the study catchment is characterized by sedimentary soil abounded with organic matters. Furthermore, there are no sewage lines in this catchment, and as a result domestic wastewater is discharged directly to the river. The overall implication is that the leaching of organic matters from the upper sedimentary layer and the recharge of groundwater by the river water leads to supply of DOC to the groundwater, and consequently increase in denitrification process in the shallow groundwater than the deep groundwater; 4) Based on these results, we estimated the NO_3^--N discharge by groundwater to be about 5.0% of the annual nitrogen input to the study catchment from fertilizer application (Table 1).

Table 1. Estimated groundwater discharge and NO_3^--N discharge by groundwater.

	Groundwater discharge (mm)	NO_3^--N discharge (kgN)	NO_3^--N discharge ratio (%)
Low flow season (6 months)	Shallow: 30 Deep: 151	Shallow: 1.33 Deep: 200	2.05
High flow season (6 months)	Shallow: 54 Deep: 201	Shallow: 47.2 Deep: 266	3.19
Total (1 year)	436	515	5.24