

# Nitrogen emission process with groundwater flow including hyporheic effect in a coastal mountain catchment, Kyusyu region

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Previous many researches had been focused on the nitrate emission in urban or rural catchments, for solving the nitrogen environment problem (Burt et al., 1994). Especially, high nitrate load was reported in agriculture land of rural area (Tsurumaki, 1992; Burt et al., 1994; Saitou et al., 2002). On the other hand, the nitrate elimination had been observed in the some groundwater discharge area (Howerd, 1985; Ishizuka and Onodera, 1997), deeper groundwater (Postma et al., 1991), or the hyporheic zone between the surface water and subsurface water (Hinkle et al., 2001). It is effective that the discharge area tends to be in reduction condition (Freeze and Cherry, 1979). To verify the role of groundwater flow to nitrate emission and to evaluate the nitrate flux to sea, it is important to confirm the nitrate transport through the hyporheic zone.

The objective of this study is to evaluate nitrate discharge of coastal groundwater to the inland sea with considering the effect of rainfall and land use on nitrate emission and hyporheic effect in coastal groundwater on nitrate transport.

The results are summarized as follows,

1) The recharge area has high nitrate content. But the nitrate concentration declines with groundwater flow from the east hill to the river. Especially, it becomes approximately 0 in the area closed to the river. On the other hand, the nitrate concentration in the river was 2mgL<sup>-1</sup> during the low tide, but it was 0mgL<sup>-1</sup>, except at the low tide. This means that the seawater contains little nitrate, as compared with the river water. Based on the natural chloride tracer, this area was determined as mixing zone of groundwater with seawater. This means that here is a hyporheic zone. This suggests the nitrate elimination process occurred in the hyporheic zone. In addition, we confirmed that the nitrate load to the sea was negligible by groundwater.

2) The difference between in Shimo-Kamagari and Shiranui is also detectable. The nitrate concentration is low in the groundwater of recharge area (3.0mg L<sup>-1</sup>) as well as river (1.8mg L<sup>-1</sup>) in Shiranui, as compared with that in the other (13.2mg L<sup>-1</sup>, 8.2mg L<sup>-1</sup>). The annual rainfall is in Shiranui twice of that in the other. The effect of simple dilution by rainfall could not explain these differences between nitrate concentrations in both areas. This suggests that the hyporheic effect expands up to the upper stream in the Shiranui.

3) The effect of rainfall on the nitrate content of groundwater was indicated a little bit in the discharge area as well as in the groundwater of recharge area. In case of Shimo-Kamagari, the nitrate declined quickly and radically in an alluvial fan. However, in Shiranui, the nitrate remained through the groundwater flow from the river to the sea, despite low input nitrate content from the river. The orange plantation area ratio in the Shimo-Kamagari is similar to that in Shiranui. If we assumed that nitrogen input in both catchments is similar, two possible hypotheses are suggested. One is an expansion of the hyporheic zone in an upstream area. The other is the groundwater flow rate exceeded the denitrification rate or the decline of denitrification rate with the oxidation condition in the discharge area.

4) The different of nitrate concentration due to topographic condition is shown. The steeper slope has groundwater of high nitrate content, as compared with that in gentle catchment. This also suggests the different of groundwater rate. It supposes that because the groundwater flow rate exceeded the denitrification rate, the nitrate remained in the hyporheic zone. But we could not verify these mechanisms. It is one of remained problem. In addition, the nitrate concentration is relatively high in the Yatsushiro Inland Sea near the Shiranui. It is also important to confirm the relationship between the nitrate emission by groundwater and seawater chemistry.