Effects of additional nitrogen input and different river slope on the outflow from upstream nitrogen-saturated forests

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Non-point source nutrients, such as excess fertilizers from agriculture and human sewage water, are main cause of eutrophication of lakes, streams, and coastal areas. The upstream areas of suburbs of Fukuoka are covered with nitrogen-saturated forests, and supplied high concentration NO_3^- river water to the downstream. Such nitrogen-saturated forests have large impact on the downstream water quality (Chiwa et al., 2012), but less information was available of the mechanism of the changes in NO_3^- concentration from upstream to the downstream.
The objectives of this study were to clarify (1) whether the nitrogen dynamics (the concentration of NO_3^-, $\delta^{15}N_{NO3}$ and $\delta^{18}O_{NO3}$) in the downstream were affected by the nitrogen-saturated forests in the upstream, (2) the influence of nitrogen runoff from agriculture and urban area in the downstream, and (3) the influence of the river gradient on denitrification.
NO_3^- concentration and the stable isotopes, $\delta^{15}N_{NO3}$ and $\delta^{18}O_{NO3}$ were measured in the Tatara River Basin, located in northern Kyushu, western Japan. Water samples were mainly collected from branch rivers; Ino River, Sue River and Umi River. Deciduous mature forest dominates the ridges in the upstream, with paddy, farmland and urban dominating in the middle and downstream. Topographic Index (TI) was calculated by using Digital Elevation Model (DEM) with ArcGIS software.
Our results showed that the NO_3^- concentration in the upstream of three rivers (33.9-82.8 μmol/L) were higher than the other non-saturated forests. Lower $\delta^{18}O_{NO3}$, higher NO_3^- and $\delta^{15}N_{NO3}$ in the downstream were be found in Sue River and Umi River. On the other hand, Ino River showed different trend that lower NO_3^- concentration, higher $\delta^{15}N_{NO3}$ and $\delta^{18}O_{NO3}$ concentration in the downstream. The higher NO_3^- concentration in the downstream in Sue River and Umi River was affected by the increasing agriculture and urban areas in the downstream. However, the NO_3^- concentration in the downstream of Ino River decreased with the increasing agriculture and urban areas.
The average TI value showed no difference between rivers. However, the distribution of TI values in Ino River was different from other rivers. Ino River has smaller changes in gradient from upstream to downstream and fewer agriculture and urban areas in the downstream than the other two rivers. These differences could result in the higher probability of denitrification occurring and the lower NO_3^- loading in the downstream in Ino river.
The nitrogen-saturated upstream forests in this watershed has large impact on the nitrogen sources to the downstream. In the areas with steeper gradient, the high concentration of nitrogen runoff was supplied to the agriculture and urban areas. On the other hand, in those areas with gentle gradient, the nitrogen loading in the downstream also decreased due to the gentle gradient of the watershed and it was suggested that the rate of denitrification and decrease NO_3^- concentration in the downstream was also high.

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