

Effects of insufficiently managed forests and agricultural lands on river nutrient concentrations in the Hii River basin

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In recent years, the migration of many young individuals from rural to urban areas has resulted in depopulation and increased proportions of elderly individuals in rural areas, which has led to poorly managed forests and agricultural lands in such areas. Such abandoned land uses are considered to be one of the main factors that cause large amounts of nutrient transportation from upland areas to downstream areas in the basins. It is predicted that the increased frequency of heavy rainfalls as a result of climate change increases the nutrient loadings from forests and agricultural lands under current management practices, leading to a general degradation in the water quality of downstream rivers. However, little information is available regarding how those forests and agricultural lands affect nutrient concentrations in river water in response to changes in hydrological conditions. This study aimed to clarify effects of changes in precipitation and river discharge on the relationship between river nutrient concentrations and land uses in a river basin where many of the forests and agricultural lands have been insufficiently managed.

The study site was Hii River basin (area: ca 920km²) located in the eastern part of Shimane Prefecture, which has the highest rate of population aging in Japan. The Hii River is the largest river flowing into Lake Shinji and Lake Nakaumi, which are representative brackish water lakes in Japan. Approximately 80% of the Hii River basin is occupied by forest, while 10% is composed of agricultural land. 63% of conifer plantations in the basin required thinning. The area of abandoned agricultural lands in the basin increased by 12% from 1990 to 2005. The basin was subdivided into nine subbasins. River water for chemical analyses (total nitrogen: TN, total phosphorus: TP, nitrate, phosphate) was sampled at the end of each subbasin. Precipitation and Daily discharge data from the Hii River basin were obtained from the Japan Meteorological Agency and from the Izumo River Office (MLIT), respectively.

The nutrient (TN, TP, nitrate and phosphate) concentrations were negatively correlated with the percentage of forest land use, but positively correlated with the percentage of agricultural land use in the subbasins. The absolute values of the correlation coefficients tended to increase with increasing daily discharge. This indicates that nutrient concentrations in the river more clearly reflect land uses in higher flow conditions and imply that forests control increases in nutrient concentrations during storm events, while agricultural lands contribute to increased concentrations. The regression coefficient of the relationship between the nutrient concentration and the percentage of forest land use was negatively correlated with daily precipitation. The correlation was strong for TP. These results suggest that the effectiveness of forest controls on the increased concentration of TP in rivers becomes high as precipitation increases. The results of this study imply that forest cover prevents soil surfaces from being eroded by raindrop impacts and subsequently overland flow, and thus prevents phosphorus attached to the soil from being supplied from the forest into river water.

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