Investigation of suspended sediment production by using X-ray fluorescence analysis in the Oromushi River

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1. INTRODUCTION

Nutrients and organic matter play a great role in ecological system in a riverine ecosystem, which are closely related to suspended sediment (SS) supply. In general, SS are transported not only from inside of river network but also from surface soil in sub-river basins. Heavy rainfall enhances resuspension of SS from surface soil, which are transported into river networks, and causes high turbidity at the downstream end. However, it has not been revealed how SS is produced in each sub-river basin and how much SS is transported from each sub-river basin into the down stream end. Therefore, the identification of the areas, in which SS production is greatly increased (i.e. main SS sources), is a determining factor to understand the sediment production and transportation processes.

In the previous studies[1], some techniques have been proposed for estimating transportation rate of SS from sub-river basins to the downstream end by using radioactive, chemical component, redfield stoichiometry, and so on. Among them, chemical component analysis has been revealed to be useful to clarify SS transportation rate from each sub-river basin into the downstream end. This study thus aims to clarify SS transport rate by using the fluorescent X-ray analysis (XRF analysis). Also, we made an attempt to develop a new technique for estimating transportation rate of SS from each sub-river basin into the downstream end.

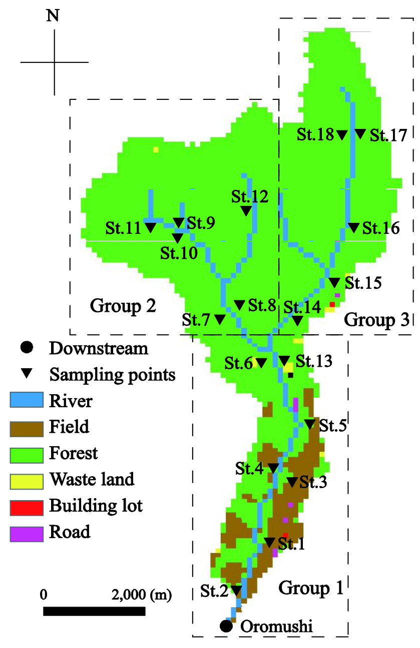

Fig.1 Oromushi river basin land use map, location of the sampling points and three main regions of the catchment.

2. MEHODS

2.1 SITE DESCRIPTION

The Oromushi River is located in Hokkaido area, and the river length, basin area and mean slope are 9.7 km, 29.3 km^2 and 1/43, respectively. Super high turbidity (e.g. more than 10,000 mg l^{-1}) has been observed in Oromushi River basin, which suggests that this river basin is suited to our investigation purposes. The catchment mainly consists of two predominant landuses: forests and agricultural fields, with 80.7 % and 15.8 % of the coverage, respectively.

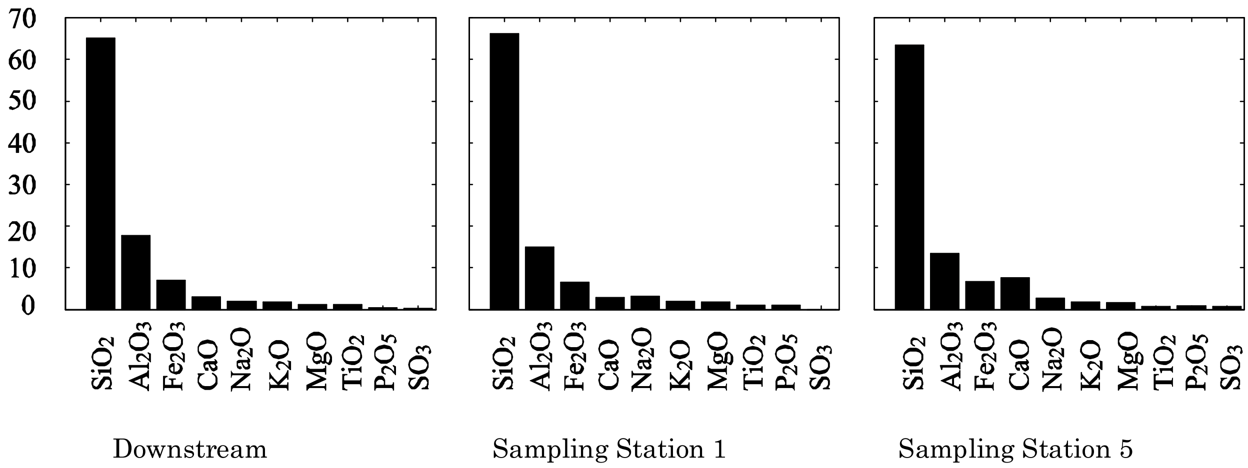

Fig.2 Geochemical composition of representative sampling stations located at the downstream, station 1 and station 5 measured by X-ray fluorescence analysis.

2.2 FIELD OBSERVATIONS AND LABORATORY PROCEDURES

The area of study was divided into 18 sub-domains in terms of the landuse, elevation, surface soil and vegetation type, and a soil sample of approximately 1125 cm^3 was collected from the soil surface layer of each sub-domain. Additionally, a riverbed material, assumed as the accumulation of sediments transported from upstream regions, was sampled at the downstream end of the river basin. In the laboratory procedures, XRF analysis was performed on samples sieved with distilled water through a 63 εm mesh followed by drying for 24 hours at 105 °C. After the sieving, the samples were combusted in a muffle furnace at 750 °C for 1 hour to oxidize compounds and eliminate organic matter. Moreover, laser diffraction analysis was carried to understand the physical properties and identify the predominant particle size of the sediment grains through the particle size distribution.

3. RESULTS

As expected from natural soil samples, XRF analysis revealed a large number of chemical components from all the sediment samples, in which SiO_2, Al_2O_3, Fe_2O_3 and CaO were identified as main chemical components from principal component analysis. In contrast, Na_2O, K_2O and MgO were found to be minor chemical components. Moreover the particle size distribution analysis results showed that there is a difference between the predominant grain sizes from the two types of landuses in the catchment (i.e. forest and agricultural fields). Sediments from agricultural fields and the downstream region include finer particles with a predominant diameter of less than 10 εm more than forests.

4. CONCLUSIONS

XRF analysis showed that the pattern of chemical components from the downstream end is similar to agricultural field compared to forest, which suggests that the production from SS in the agricultural field may be more dominant rather than forest. Ishida et al (2010) proposed a technique for estimating transportation rate of SS from each sub-river basin into the downstream end by using similarity of the pattern of chemical components. However, since the technique cannot consider any uncertainty and errors from sampling, this study proposes a new technique for the estimation of SS transportation rate.

REFERENCES

(1) Ishida T, Nakayama K, Okada T, Maruya Y, Onishi K, Omori M. 2010. Suspended sediment transport in a river basin estimated by chemical composition analysis. Hydrological Reseach Letters 4: 55-59. DOI:10.3178/HRL.4.55.