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Vertical profile of suspended sediment in a steep mountainous river, Japan

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Quantifying sediment transport from mountainous catchments is essential for watershed management as well as channel morphology. Suspended sediment transport rate in a mountainous river is generally observed by using a single turbidity sensor at a certain height and estimated by simply multiplying turbidity record by stream discharge. Although previous flume experiments have demonstrated obvious vertical profile of suspended sediment concentration (SSC) which is higher at the bottom of flows, vertical profile of SSC has been little investigated in the field. This study attempted to examine vertical profile of SSC at a steep mountainous river based on field observation. The study was conducted in Omukawa River Basin with a drainage area of 72.0 km2 in central Japan. Stream discharge and SSC were observed at a check dam located at the outlet of the basin. Turbid stream water was collected at heights of 0.35, 0.6, 0.85, 1.1 m from the riverbed using a sampling apparatus equipped on a heavy machinery during 10 flood events with an interval of 1 hr. Then, SSC and grain size distribution of the turbid water samples were analyzed. The observed SSC ranged from 2.9 x 10-5 to 4.9 x 10-3 m3/m3 and median diameter of the collected suspended sediment ranged from 0.016 to 0.10 mm. One-third of the observed SSC profiles were almost uniform or showed higher concentrations at the flow surface, whereas the others were consistent with the typical vertical profiles in flume tests (i.e. higher concentration at the bottom). To assess shape of SSC profile, the observed SSC profiles were fitted with the Rouse distribution by varying diameter of the suspension. Because commonly used equations yielded very high near-bed concentrations comparing with observed SSCs, observed SSCs at the height of 0.35 m were employed as near-bed concentrations for calculating Rouse distribution curves. Diameter to obtain the best-fitted curve was defined as representative diameter in this study. Resultant representative diameters were 0.0013 – 0.0072 mm, which were one order of magnitude smaller than the observed median diameters. These results indicate that the observed SSC profiles were rather uniform than those predicted theoretically. At the observation site, fine sediment smaller than median diameter of the collected suspension occupied only < 1% of the riverbed materials, suggesting that the suspended sediment could not be exchanged sufficiently with the riverbed materials. Our results imply that not only finer but coarser suspended particles behave similar with wash-load in gravel bed rivers.