Impacts of highly concentrated turbid water on the groundwater in the Tedori River alluvial fan, Japan

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The Tedori River alluvial fan in the Ishikawa prefecture is a representative alluvial fan in the Hokuriku region in Japan. The river water is taken by a headworks located at the top of the alluvial fan and is used for irrigation in paddy fields with a total area of about 7,500 ha. Seepages from the riverbed and percolations from the paddy area are the main sources of groundwater in the Tedori River alluvial fan. In 2015, large-scale landslides in the upper reaches of the Tedori River caused a long period of high turbidity in the river. Highly concentrated turbid water with an average concentration of 585 mg/L (a maximum of 4,012 mg/L) has been discharged continuously into the river since May, 2015. This turbidity has caused concerns about the recharge functions of groundwater in the alluvial fan.

In this study, the measurements of paddy percolations and riverbed seepages, before and after the occurrence of high turbidity, were used to examine the influence of these phenomena on groundwater recharge functions in the alluvial fan. We measured water requirement rates in the paddy area in the Tedori River alluvial fan. The measurements were conducted before and after the midsummer-drainage period at >100 paddy fields. We also measured the river discharges in the cross-sections of the river throughout the alluvial fan. The number of cross-sections was 16 and we estimated the riverbed seepages by calculating the discharge differences between the cross-sections.

The results revealed that the amount of paddy percolation decreased significantly due to the turbidity of the river water. The average percolation in the paddy area was found to be 12.4 mm/day in 2014 and 7.9 mm/day in 2016 before the midsummer-drainage period. Moreover, the average percolation in the paddy was found to be 19.6 mm/day in 2014 and 13.7 mm/day in 2016 after the midsummer-drainage period. The volume of the riverbed seepage was observed to have reduced and the seepage section were also observed to have shortened. The observed seepages from the river bed were 4.72 m3/s in 2009 and 3.33 m3/s in 2016 for the irrigation period, whereas for the non-irrigation period, these values were 5.92 m3/s in 2009 and 1.25 m3/s in 2016. Furthermore, the seepage section was found to shorten from 14.2 km to 8.0 km, due to the high turbidity of the water.

Finally, we estimated the amount of groundwater recharge based on these measurements, which revealed that the groundwater recharge from paddy percolation decreased by 270 mm/year (36%), and the recharge from riverbed decreased by 591 mm/year (61%). The total groundwater recharge decreased by 861 mm/year (36%), a value that corresponded to the groundwater level measurements. From these results, we can conclude that the effects of highly concentrated turbid water on the groundwater are quite serious in the Tedori River alluvial fan.

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