

Water chemistry and nitrogen isotopic ratio of river water in the Makinohara Plateau, Shizuoka, Japan

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We investigated the effects of fertilizer application to tea plantations on river water quality (major dissolved components and heavy metals) in 24 small rivers that drain the northern part of the Makinohara Plateau (200-250 m above sea level) in Shizuoka Prefecture, one of the most famous tea-growing areas in Japan. River water sampling were conducted on August 28 and 29, 2022, from the 24 catchments covering an area of 0.027-0.70 km², with tea plantations occupying 7-100 % of the catchment area (the rest is mainly forested). The difference in elevation (Δh) between the highest point of the respective catchment and water sampling point is 24-176 m. The plateau is covered by the Makinohara Gravel Bed of about 20-30 m in thick, which is underlain by the about 30 m thick Furuya Mud Bed (silt and sandy silt). The groundwater table is located within the Makinohara Gravel Bed.

The river water in and around the Makinohara Plateau was heavily contaminated by the fertilizers and was of Ca-SO₄·NO₃ type. The lowest pH value was 4.2. The concentrations of NO₃⁻ and SO₄²⁻ in the river water generally follows the relationship of NO₃⁻ : SO₄²⁻ = 1 : 0.77, when ammonium sulfate is dissolved. The NO₃⁻ and SO₄²⁻ concentrations tend to increase as the areal percentage of tea plantations in the catchment increases, whereas HCO₃⁻ concentration tends to decrease. Due to the acidification of groundwater by fertilizer application, heavy metals such as aluminum (0.02-17.4 mg/L) are loaded into the river. The concentrations of NO₃⁻ and SO₄²⁻ in river water are strongly dependent on elevation, i.e., the smaller the Δh (upstream), the higher the concentrations, and the concentrations decrease as the river water flows downstream. The nitrogen and oxygen isotopic ratios of NO₃⁻ are low for the smaller Δh cases, which is characteristic of chemical fertilizers ($\delta^{15}\text{N}$ is generally less than 5-8 ‰), but the isotopic ratios show an increasing tendency as the river water flows downstream. We will be able to clarify the water quality evolution process of river water in more detail by understanding the quality and nitrogen and sulfur isotope ratios of groundwater in the Furuya Mud Bed.

Keywords: Tea cultivation, River water, Water chemistry, Dissolved aluminum, Nitrogen isotope