Environmental impact of acid river neutralization system in the Kusatsu hot spring area, Gunma, Japan

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The Kusatsu hot spring area, located at the eastern foot of the Kusatsu-Shirane volcano, is one of the most famous spa resorts in Japan and originates in hydrothermal activities of the Kusatsu-Shirane volcano. The springs are all strongly acidic, and some of them show relatively high arsenic concentration. Rivers in this area are also all acidic due to acidic hot spring water flows. The Gunma prefectural government started a river water neutralization system to improve water quality downstream in 1964. Today, the system is operated by the Ministry of Land, Infrastructure and Transport. Neutralizer prepared by mixing powdered limestone particle with river water is poured directly into the river. Neutralization results in several thousand tons of neutralization products and other suspended materials being accumulated annually in the Shinaki dam reservoir. Sediment of Shinaki Dam is continuously dredged by water pump to prevent water and sediment from overflowing. After dehydration by a filter press, dredged sediment is dumped at local dedicated disposal sites. Disposal processes are comprehensively monitored due to the arsenic and other heavy metals contained in sediment. In this study, facts about environmental impact of the acid river neutralization system were investigated.

Sediments of Shinaki dam partly contain 1000 to 2000 mg/kg of arsenic in wet basis. The results of the modified BCR sequential extraction procedure on sediment core samples in the dam suggest that arsenic in bottom layer coexist with reduced iron minerals like iron sulfides as As(III) under anoxic conditions while that in surface layer coexist with iron(III) oxyhydroxide minerals, which are probably original forms of neutralization products, as As(V). Dumped sediments in the disposal sites contain around 500 mg/kg of arsenic. The results of leaching experiment with sediment core samples of the disposal sites in pure water reveal that the possibility of dissolution of As(V) from the sediments dumped with cement type solidifier. On the other hand, only trace amounts of As(III) were leached from the sediments dumped without the solidifier. Disposal processes thus strongly affect mobility of arsenic in disposal sites.