Examination of Recovery of Salinization of Agricultural Area in Nagapattinam, India due to Tsunami by Strontium Isotope Analysis

Takashi Kume[1]; Chieko Umetsu[1]; Takanori Nakano[1]

[1] RIHN

A huge earthquake of magnitude between 9.1 and 9.3 outbroke in the island of Sumatera on 26 December, 2004. Tsunami triggered by this earthquake hit in wide areas around the Bay of Bengal. Nagapattinam district, a coastal area of Tamil Nadu state in India, is one of the worst areas damaged by this tsunami. After the tsunami, soil and groundwater in the agricultural field in Nagapattinam were immersed by sea water, and then salt minerals were deposited on the soil surface. However, agricultural production in 2006 was recovered to that of the normal year. This rapid recovery is ascribed to the removal of salty sediments by farmers, regional government, and NGOs. According to several studies, the salt-minerals were leached out from the root zone in the soil, and saline groundwater was effectively drained from the soil with high permeability by the heavy monsoon rains Nevertheless, soil and groundwater with high salt concentrations still remain in the district. The main objective of this study is to examine whether salts originated from seawater by the tsunami remain in the agricultural area or not. In order to examine the contribution of seawater-derived salt into the water and soil in the Nagapattinam district, we used stable isotope of Sr. This is because (1) terrestrial water has a wide variation of 87Sr/86Sr ratios (c.a. 0.704-0.924) dependent on the watershed geology, whereas the 87Sr/86Sr ratio of seawater is extremely uniform (0.70918+-0.00001), and (2) mineral has the same 87Sr/86Sr ratio as the ambient water. Accordingly, it is likely that the salt minerals formed by the tsunami have a strong signature of seawater Sr.

We sampled river water (n=20), groundwater at monitoring bore holes (n=10) and deep wells (n=5), and seawater (n=2) in the Nagapattinam district on January 2007 and March 2008. Soil samples were also collected at two soil depths (n=10$*$2) from points of the groundwater monitoring bore holes on March 2008. The Sr isotope ratios were determined by using a thermal ionization mass spectrometer (Triton, Thermo Fisher Sci.) installed at the Research Institute for Humanity and Nature. The 87Sr/86Sr ratio of nine standard samples of NBS987 during this study was 0.710254 (2 sigma mean: +-0.000004, n=12)), and all measurements were normalized to the recommended 87Sr/86Sr ratio of 0.710250.

The average and standard deviation of 87Sr/86Sr ratio in each type of water tended to increase from deep groundwater (0.71038+-0.00132), through groundwater from monitoring bore holes (0.71220+-0.00012), to river water (0.71272+-0.00152). The 87Sr/86Sr ratio of seawater was 0.70919, the value being identical to that of ocean water. The 87Sr/86Sr ratio of groundwater increased from marine 87Sr/86Sr ratio, whereas the concentrations of Na and Cl decreased, with distances from seashore to the inner part of the district, indicating the decrease of seawater contribution toward inland. Groundwater within areas of 1 km from the coast is enriched in marine Sr, suggesting the contribution of the tsunami-derived Sr. An alternative view is that this geochemical feature in the groundwater reflects the natural variation of sea-salt component, which is generally decrease exponentially with distances from seashore. The annual amount of precipitation in this district is over 1,300 mm and the permeability of water in the coastal sand is high. Further, there was no meaningful difference in the 87Sr/86Sr ratio and the chemical composition of dissolved solutes in the groundwater between January 2007 and March 2008. These data enable us to prefer to the latter view. We suggest that the effect of tsunami-derived seawater in the Nagapattinam groundwater was flushed within a relatively short period less than one year.