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Co-production of water quality map by researchers and societies to establish a traceability system of environment

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Traceability, which can trace the route of a material from its utilization to production area, is a key system based on the precautionary principle of global environmental issues. Stable isotope (SI) ratios of element can be utilized as a traceability index regarding the source and process of the element in the environment. In order to establish a traceability method and its assimilation in the society, Research Institute for Humanity and Nature (RIHN) has been installed elemental and stable isotope (SI) instruments in the laboratory, and started a cooperative study to implement their traceability application. As one application, RIHN started a project of making water quality map, which aims to elucidate the spatial distribution of the concentration and SI ratios of elements in terrestrial water. This is because elements in organisms and agricultural-fishery products are derived ultimately from the ambient water, and the concentrations and SI ratios of elements in the water vary geographically rather than seasonally. This geographical variation of terrestrial water is attributed to the amount and quality of atmospheric precipitation, geology and human activities in the watershed. Accumulating the data of water quality map provides basic information on traceability studies including water-material circulation, biodiversity, and climate change as well as agricultural and fishery products and food. Here I will show one example of this water quality map in Saijo city of Ehime prefecture.

Saijo city in the Setouchi-region is rich in groundwater with good quality. As a water-capital in Shikoku, Saijo aims to develop a water circulation law to the sustainable use of groundwater. To obtain the fundamental information for this law, we collected water samples at 150 sites in two seasons, groundwater samples at 1032 sites, monthly precipitations over 6 years, and rice products, and analyzed their concentrations for 50 elements and four SI ratios. Their result is summarized as follows:

The δD and δ^{18}O ratios of river water decrease with elevation, while the excess-deuterium value (d-value) increases. The d-value of rainwater is high in winter and low in summer, but the seasonal variation is not clear in the δD and δ^{18}O ratios. The slope on δ^{18}O-δD diagram is 8 for precipitation but is 7 for surface and ground waters, indicating latter waters experience evapotranspiration. Rainwater at high elevation has high d-value in spring to summer when plant growth is active, suggesting a contribution of re-evaporated water. The altitudinal increase of d-value of surface water is ascribed to the increasing contribution of winter rainwater and re-evaporated water vapor. The d-excess value of groundwater is high along a river channel, indicating its potential as a water traceability index from surface to underground.

The distribution of Ca in water is similar to that of Sr, while the Sr isotope ratio varies in accordance with the watershed geology. The Sr isotope ratio of rice is correspondent to that of water. This similarity is also extended to the concentration of SO_4 and its sulfur isotope ratio. These isotopes in the water can be utilized as geological traceability indices of agricultural products.

Based on the water-quality map, surface- and ground-water monitoring started at 10 sites This result shows that the flow rate of groundwater in the basin of Kamo river is evaluated to be 10 m per day. Further, the concentration of nitrogen increased gradually, showing the increase of human impacts. Rainwater becomes enriched in Asian dust in spring, and heavy metals in winter. However, the heavy metal concentrations become low with elevation, suggesting their source to be within Saijo city such as refuse incinerator. This is supported from the SI ratio of Pb in the rain and rice. These data are useful for water-circulation law, showing the potential of water quality map for the co-monitoring of environments between researchers and societies.

Keywords: traceability, water quality map, coproduction, environment, Saijo