Abstract

[Research Title]

Impact assessment of climate change on water and nutrient transport with adaptation options for Toyama

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[Abstract]

The objective of this project is to quantify the water and nutrient cycles in Toyama Prefecture using stable and radioactive isotopes and combine the data with numerical models to elucidate the temporally and spatially complex water cycle mechanisms from terrestrial to marine areas, and to propose management measures to maintain a sustainable water and nutrient cycle system adapted to climate change.

Based on the results of chemical analyses of approximately 80 sites, we generalized the mechanisms of groundwater formation in three areas. We evaluated the factors influencing nutrient supply and transport in each area. We focused on groundwater recharge using fallow rice fields as a sustainable water cycle management method to adapt to climate change. We expected it to conserve groundwater volume and supply nutrients to the groundwater and therefore quantitatively evaluated its effectiveness. In addition, we developed the GIS data system of environmental and social information in Toyama Prefecture from the 1980s to 2020 and used it to elucidate the impact of climate change on agriculture and forestry in Toyama Prefecture and to identify suitable areas for groundwater recharge.

The Toyama Hydrological Model, which reproduces the hydrological cycle on land, and the Toyama Bay Lower Trophic Level Ecosystem Model, which reproduces the nutrient cycle in the sea, were developed individually and combined into an integrated land-sea model for Toyama Prefecture. The integrated model was used to predict future changes in nutrient loads from the land area, and its results showed a large impact of changes in the social environment, in which the proliferation of wastewater treatment plants and declining population will result in a decrease of 12,000 kg/day in 2100 as compared with in 1985. To maintain the same level of nitrogen loading, additional nutrients must be added at wastewater treatment plants by a factor of 2.3 in 2100. Results also showed that global warming will increase river discharge, whose impact will be manifested mainly as an increase in nutrient concentrations and primary production in the surface layer (0-20 m depth) near the estuary. On the other hand, the nutrient supply from groundwater as submarine springs will decrease, whose impact on the primary production in the nearshore area cannot be ignored.

It should be noted that some of these results have been reflected in the carbon-neutral strategy and policies related to agriculture, forestry, and fisheries in Toyama Prefecture.

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