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Simple method to estimate pollution loads from non-point sources and its applicability

YOSHIKAWA, Seiko[1*] ; MOCHIZUKI, Hidetoshi[2] ; TAKAHASHI, Hidehiro[2]

[1]National Institute for Agro-environmental Sciences, [2]NARO Western Region Agricultural Research Center

Radical nitrogen has been increasing mainly by nitrogen fixation under the manufacturing of chemical fertilizers. This has resulted in increasing water pollution, eutrophication, and greenhouse gas emissions. Nutrient loads to the environment from non-point sources are difficult to quantify, although those from point sources are almost all regulated in Japan. The aim of this study was to propose a simple method to estimate pollution load (especially N load) units of river water and groundwater for each land use, and to verify its applicability.

The study area consisted of 26 watersheds (1,342 km^2) covering 72% of Kagawa Prefecture in Japan. We estimated NO_3-N concentration factors in groundwater for upland fields, paddy fields, forests and urban landuse types by performance of a multiple regression analysis of the watershed-mean groundwater NO_3-N concentrations and the landuse ratios in each of the 26 watersheds. The results showed that the NO_3-N concentration factor, which was gained as the partial regression coefficient for the multiple regression analysis, in groundwater was 15.2 mg L^{-1}, 10.3 mg L^{-1}, 2.3 mg L^{-1}, and 2.5 mg L^{-1} for the upland fields, paddy field, forests, and urban landuse types, respectively. N pollution loads runoff for river water and groundwater were calculated by multiplying total-N concentration factors for river water by river flow rate, and by multiplying NO_3-N concentration factors for groundwater by groundwater flow rate. The total N pollution loads runoff were 26.6 kg ha^{-1} y^{-1}, 12.6 kg ha^{-1} y^{-1}, 2.8 kg ha^{-1} y^{-1}, and 8.8 kg ha^{-1} y^{-1}, for upland fields, paddy fields, forests, and urban areas, respectively.

Applicability was investigated for one river watershed, where spring water quality was measured in the periods 1994-1995 and 2007-2008. NO_3-N concentration increased with stream downward in 1994-1995, however, the tendency diminished in 2007-2008. River T-N concentrations were 2.5 mg L^{-1} and 2.4 mg L^{-1}, and groundwater NO_3-N concentrations near the coast were about 8 mg L^{-1} and 6 mg L^{-1} for the two periods, respectively. On the other hand, cropland ratios were 23.8% and 21.4%, and surplus-N from croplands (applied-N - absorbed-N by crops) was calculated as 31.1 kg ha^{-1} and 27.2 kg ha^{-1} from cropland, and surplus-N from the whole watershed was 43.2 kg ha^{-1} and 39.7 kg ha^{-1} for the 2 periods, respectively. The arrival of N loads to the sea by river and groundwater was calculated to be 51% and 48% of the whole surplus-N in the watershed for the 2 periods, respectively. These results are in line with other reports in which pollution load arrival is about half or below half of the pollution load generated.

Keywords: landuse, non-point source, pollution loads, groundwater, river water