Long-term monitoring of nitrate leaching after N addition from the forested watershed composed of Japanese cedar and cypress

Rieko Urakawa[1]; Hiroto Toda[2]

[1] Graduate School of Agriculture, Tokyo Univ. of Agric. and Technol.; [2] Agric. Tokyo Univ. of Agric. and Tech.

Recently, the functions of Japanese forests such as fixation of carbon dioxide, prevention of sediment discharge, and supplying clean water are more important than wood production only. Therefore, it is important to reduce the fluctuation of streamwater quality after several tending practices in the artificial forest. Water budget and streamwater chemistry have been monitored for about 30 years in a small forested watershed in the University forest of TUAT. The objectives of this study were to investigate the effects of Nitrogen addition on soil water NO_3^- concentration and to clarify the relationship between the chemistry of the soil water and streamwater using solute transport model in HYDRUS-1D. The monitoring was carried out in a small forested watershed (1.3 ha) composed of Japanese cedar and cypress in Field Museum Oyasan, Gumma Pref., Japan. The stand age is 34 years in 2009. The annual average air temperature is 11 degrees Celsius, annual precipitation and discharge are 1650 mm and 850 mm, respectively. Depleted water discharge was never observed in this watershed even in 1996 when the annual precipitation was only 900 mm. A flow gauging weir was settled at the bottom of the watershed and the flow measurement was started in 1978. Streamwater has been sampled at the weir once a week generally. Fertilizer was applied in 1979 (100 kgN ha^{-1}), 1983 (100 kgN ha^{-1}), 1985 (100 kgN ha^{-1}), and 1987 (154 kgN ha^{-1}). Soil water was sampled from 3 soil layers; 5, 20, 50 cm depth at nine soil profiles along a contour from 1985 to 1990, before and after the last fertilization in 1987. NO_3^- concentration in water samples was analyzed using colorimetric method or by ion chromatography. NO_3^- transport in subsoil was simulated using HYDRUS-1D. We assumed loading NO_3^- solution to the 2.5 m-long soil column. The observed fluctuation of the NO_3^- concentration in soil water at 50 cm depth was used as NO_3^- input. Considering the evapotranspiration, the input of water flux was decided as 50% of the precipitation. NO_3^- adsorption by the volcanic ash subsoil was considered to be existed. We used the reaction parameters obtained by applying the isotherm from the laboratory experiments to the freundlich curve. Soil water reaction to the N addition varied between profiles. NO_3^- concentration increased to 2.5 $mmol_c$ L^{-1} five months after the application in some soil profiles, while maintained lower than 0.1 $mmol_c$ L^{-1} in the left plots. It suggested that the large spatial variation of NO_3^- concentration was due to the heterogeneous distribution of plant root and water flow paths. On the other hand, NO_3^- concentration in streamwater increased to 0.2 $mmol_c$ L^{-1} about one year after the application. It implied that the concentration fluctuation in streamwater was affected by NO_3^- adsorption in subsoil and the NO_3^- distribution in about 1 m depth subsoil.