Distribution of stable nitrogen isotope along the hillside and its dynamics

Kayo Matsushita[1]; Sayaka Fukushima[1]; Muneoki Yoh[2]

[1] Environ.Sci.,Tokyo Univ.Agri.Tech.; [2] Tokyo Univ. Agri. Tech.

Introduction

From stable nitrogen isotope, we can get information about its source and the mechanisms of its production or consumption. Biogeochemical studies have used stable nitrogen isotope as a tool to identify the source of pollutant in groundwater and rivers. However, few studies discuss the processes between nitrogen input to the ecosystem (e.g. precipitation) and output (e.g. stream). Consequently, physicochemical or biogeochemical reactions by which nitrogen species are converted within ecosystems are not adequately explained. It is important to determine transportation and reaction of nitrogen within the ecosystem.

In this study, we discuss the source of soluble matters, its transportation, and its reaction. And the aim of this study is to know the mechanisms which cause the change in stable nitrogen isotope ratio of groundwater.

Materials and Methods

The study was carried out in a deciduous forest, in Hachioji, western Tokyo. Groundwater samples were collected from 18 observation wells (piezometer) at 7 sites along the hillside. These altitudes vary from 181m at ridge to 158.5m at bottom.

Stable nitrogen isotope ratio of ammonium and nitrate (d15N-NH4+, d15N-NO3-) was measured by a Mass Spectrometer (Delta plus XP, Thermo Finnigan) connected to Elemental Analyzer (FlashEA1112) after a pretreatment by ammonium tetraphenylborate precipitation method (Sakata, 2001). Nitrate concentration was measured using ion chromatography. Ammonium concentration was analyzed by indophenol-blue colorimetry.

Results and Discussions

High NO3–N concentration, more than 100micromole/L, was observed at shallower observation wells (altitudes of the inlets of groundwater vary higher than 165m) and shallower wells (about 2m depth from the surface) at the bottom. Such wells with high nitrate concentration correspond to lie in channery and loam. While, low NO3–N concentrations (less than 50micromole/L) were observed in some wells. At the ridge, one of such a well of low nitrate concentration has a depth as deep as about 21m. Another one was found at the bottom of steep slope which has a depth of 4.5m. Both of them commonly have water inlets at height of about 160m above the sea level and lie in the mud layer. Elevated d15N-NO3- value were observed in these wells. If denitrification occurs under anaerobic conditions, not only the decrease in NO3–N concentration but the increase in d15N-NO3- value is expected because of large isotopic fractionation during denitrification. Therefore, it is suggested that NO3–N in deep underground of hills was affected by denitrification.

At the bottom of steep slope (2.7m depth), behavior of NO3–N concentration in shallower observation well showed a characteristic change on heavy rain events. Its NO3–N concentration was 33micromole/L in dry period but reached 293micromole/L after heavy rainfall. It was thought that increasing NO3–N concentration after heavy rainfall was caused by NO3–N transportation accompanied with rapid water movement. Thus, a shallower well at the bottom of steep slope may have a feature that responds to heavy rainfall quickly.