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Identification of flow system, sources and behaviors of major anion in a typical soil water-groundwater continuum hillsl

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1 Introduction

In the hydrological system, headwater catchments are source areas for water, nutrients, sediment, and biota for larger steams (Sidle et al., 2000). Unsaturated zone is an important pathway for nutrition leaching in headwater where baseflow dominates (Costa et al., 2002), and the leach pattern is mainly controlled by soil texture and corresponding hydraulic properties. In this study, an intensive study including soil physics investigation, long-term monitoring about the soil water and groundwater hydrochemistry and sources identification of nitrogen by nitrogen isotope are conducted to describe the conceptual soil water-groundwater flow system and discuss the factors controlling the local groundwater hydrochemistry.

2 Study area

The study area is a typical headwater catchment in Ichikawa City (35.76oN, 139.97oE), Chiba Prefecture, Japan (reference). The annual average precipitation is 1,316mm, with the maximum monthly precipitation of 226.5mm/month in study area. The annual average temperature is 15.6 oC while the highest temperature of 31.2 oC occurring in August.

3 Result

From the surface, there are sandy loam (0-1 m), loam (1-2.5 m), clay loam (2.5-3.2 m) and sandy clay (3.2-4.5 m). The porosity shows slight increases from 0.68 at the surface to 0.78 at depth of 4.3m. Due to the occurrence of the Joso clay underlying the loam, the Ks of layer below 3.2 m in depth about two orders lower than the loam and sandy loam. The vertical profile of θr changes little with an average of 0.30.

The average background values for Cl-, NO3- and SO42- were 17.64 mg/L, 0.33 mg/L and 1.52 mg/L, respectively. At the pear orchard, Cl-, NO3- and SO42- concentrations increased dramatically due to anthropogenic inputs of fertilizers. The average concentrations of Cl-, NO3- and SO42- were 32mg/L, 233 mg/L and 85 mg/L, respectively. The concentrations of Cl-, NO3- and SO42- in groundwater of the valley in average are 35.17 mg/L, 129.67 mg/L and 2.39 mg/L, respectively.

4 Discussion

Base on the soil texture of the cross section A-A, there are three flows, interflow along the slope (I), local groundwater flow (LG) and regional groundwater flow (RG), and all of them finally dischage to the valley wetland. In average, the groundwater discharging to the valley at S4 is consisted of waters from LG (43%), RG (56%) and I (less than 1%). Mixing ratios also show seasonal variations. In winter, the ratio of RG with an average of 68% is larger than LG (32% in average), which implies that lateral discharge of groundwater is the dominant factor controlling the groundwater flow in the wetland. While in summer, the contribution of LG becomes higher, and the ratio of LG has exceeded that of RG in May and July, showing the strength of recharge from the upland to LG.

5 Conclusion

An intensive study including both hydrochemical monitoring and numerical simulation are applied to discriminate pollutants sources, evaluate pollutants behaviors and predict long-term effect of soil pollution to local groundwater.

Base on the soil texture and physics investigation, three runoff components interflow (I), local groundwater flow (LG) and regional groundwater flow (RG), are discriminated in the hillslope soil water-groundwater flow system. Two anthropogenic pollutants NO3- and SO42-, which have been approved keep conservation in both soil groundwater according to isotope and redox analysis, are treated as traces to separate these components. And it is found that in average, about 43% of groundwater comes from local groundwater recharge (LG) and 56% comes from regional groundwater recharge (RG). The ratio of interflow (I) only takes up smaller than 1%.

Reference

Sidle, R.C. et al., 2000. Stormflow generation in steep forested headwaters: a linked hydrogeomorphic paradigm. Hydrological Processes, 14(3): 369-385.

Costa, J.L. et al., 2002. Nitrate contamination of a rural aquifer and accumulation in the unsaturated zone. Agricultural water management, 57(1): 33-47.