Geophysical Research Abstracts
Vol. 20, EGU2018-8702, 2018
EGU General Assembly 2018

Understanding N transfer through the critical zone: spatial and temporal variation in a typical karstic agricultural catchment, SW China, determined using high-frequency in-situ nitrate sensor

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The Houzhai catchment in Guizhou province, SW China is a typical karstic agricultural area and has exhibited high nitrate concentrations, since the 1980s. High nitrate concentrations observed in both ground (spring) and surface waters distributed across the catchment have been attributed to intensive land use practices associated with agriculture and the well-developed conduit and fracture network typical of karst terrain, which allows rapid hydrological delivery from land to water. New sensor technologies now enable high frequency measurement of in-situ water quality and reduce uncertainty in characterizing concentration-discharge relationships, thus providing better understanding of variation in retention rates and pathways of nitrate transfer through the catchment. In this study, in-situ nitrate ion-selective electrodes were deployed at five sites in the Houzhai catchment to determine variations in spatial and temporal nitrate concentrations in spring and surface water over a period of 1 year. Discharge and nitrate exhibited seasonal variation, with high discharge and large variation of nitrate concentration observed in the wet season (May to Oct.) for all sites. Nitrate-N at the five sites ranged from 0.65 mg/L to 22.7 mg/L and showed rapid temporal changes that corresponded to the changing hydrologic conditions. Nitrate concentration increased more than 3-fold during one rainfall event, with nitrate concentration higher than the threshold of safe drinking water standards stipulated by the WHO. More frequent and higher nitrate peaks were observed during the wet season relative to the dry season. Nitrate concentration increased significantly over the duration of the first two rainfall events and reached a maximum concentration in the following events. Concentration-discharge dynamics associated with later rainfall events between June and July followed the same pattern as those observed during the first two events, except the peak nitrate concentration was reduced. However, in contrast to the previous smaller recharge events, the increase in nitrate was sustained over a longer time period. Nitrate concentrations were relatively stable during the dry season. Nitrate-N flux calculations identified that more than 85% of the annual loading of nitrate occurred during the wet season at two sub catchment and surface river sites. However, high contributions during the dry season at the middle reaches and outlet of catchment were also observed. Rainfall events appear to be a critical control of nitrate transport in this karstic area. This study suggested the fast response of nitrate variation to rainfall and give the hint to update water quality management in future.

This research was supported by UK-China Critical Zone Observatory (CZO) Programme, 41571130071 and Natural Environment Research Council, NE/N007425/1.