Spatial-temporal dynamics of dissolved nitrate and its source identification in the upper Han River basin, China

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Nitrate (NO_3^-) contamination, as a major form of nitrogen (N) pollution, is a severe environmental problem in river ecosystems with intensive human activities. Source identification of NO_3^- contamination in rivers is pivotal for better management of water quality. Here, we investigated the spatial-temporal dynamics of dissolved NO_3^- in the upper Han River (including the mainstream and major tributaries) with intensive industrial and agricultural disturbance in central China using data from 32 sample sites at four dates, and identified the NO_3^- sources using data of stable nitrogen ($\delta^{15}N\text{-}NO_3^-$), oxygen and hydrogen ($\delta^{18}O\text{-}H_2O$ and $\delta D\text{-}H_2O$) isotopes. A great deal of spatial-temporal variation in NO_3^- concentration was observed with the highest values in summer (22.75±17.75mg/L) compared with other seasons. The $\delta D\text{-}H_2O$ and $\delta^{18}O\text{-}H_2O$ data indicated that modern precipitation was the major water source for the river. A large range of $\delta^{15}N\text{-}NO_3^-$ isotope values (from -20.25‰ to 31.46‰) were discovered, implying that the NO_3^- could originate from diverse sources but can be mainly derived from urban or domestic sewage and atmospheric deposition. Moreover, cluster analysis provides a classification of pollution levels in the mainstream and major tributaries of the river during different seasons based on the sample locations and hydrochemical variables. Overall, our results demonstrated the degraded water quality and poor control of N runoff into river. This study provides useful

information for mitigating nitrogen pollution and eutrophication as well as formulating watershed management in river ecosystems.