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Evaluation of the nitrate attenuation potential in the aquifer of the Asian megacities

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Nitrate (NO3) is a widespread pollutant derived from human activities. In the developing megacities, groundwater contamination by nitrate is one of the critical environmental problems. For the sustainable use of groundwater resources, it is important to clarify about the natural function of nitrate attenuation such as denitrification process in groundwater. The aim of this study is to examine the nitrate attenuation process and evaluate its potential on the aquifers of the developing Asian megacities.
We examined spatial variations in nitrate-nitrogen (NO3-N) concentration and nitrogen stable isotope ratio (d15N) in groundwater, and tried to evaluate the NO3-N attenuation potential in the study aquifers focusing on 1) the amount of nitrogen input, 2) the content of organic matter as an electron donor and 3) groundwater flow condition, as the controlling factors of denitrification process. The relation between NO3-N concentration and d15N in groundwater suggests that NO3-N attenuation by denitrification occurs in the groundwater of the study sites. However, isotopic enrichment ratio is higher in the Metro Manila (MM) and Jakarta (JK) than that of Bangkok (BK). On the nitrogen input to the aquifer, in case of the BK, the soft clay layer overlies the top of the aquifer and it suggests that nitrogen load by human activity is difficult to reach to the saturated zone. Therefore, nitrogen input should be smaller in the BK aquifer than that in others. On the contrary, it should be largest in the JK aquifer because the surface layer is composed of alluvial and volcanic fan deposit with high permeability, and wide expanse of urban and agricultural area within the basin. The content of organic matter as an electron donor in the aquifer is assumed to be largest in BK and smallest in MM from the basin scale and thickness of alluvial deposit. Groundwater velocity is estimated to be largest in JK and smallest in BK from the hydraulic gradient and hydraulic conductivity in the aquifer. These results and conditions suggest that NO3-N attenuation potential by denitrification should be highest in BK, though the process apparently occurs more significant in MM and JK aquifers because of large nutrient input. However, overall trend shows that NO3-N attenuation potential is relatively high in these study area.