Geophysical Research Abstracts
Vol. 21, EGU2019-18402, 2019
EGU General Assembly 2019

Large-scale redox controlled transport of nitrate from agriculturally dominated catchment areas into surface water bodies

Christoph Merz (1), Jörg Steidl (1), and Nils Moosdorf (2)

(1) Leibniz Centre for Agricultural Landscape Research (ZALF), Müncheberg, Germany (cmerz@zalf.de), (2) Leibniz Centre for Tropical Marine Research (ZMT), Fahrenheitstraße 6, D-28359 Bremen, Germany

Groundwater resources play a crucial role in the whole water cycle. Therefore, its quality must be of high standard and the directives defining water quality must be complied. Groundwater primary discharges into rivers and lakes and a certain amount of groundwater flows into the sea along the shorelines as submarine groundwater discharge (SGD). However, there are still many water bodies in agricultural regions worldwide which do not show a good chemical status or are endangered to lose their good chemical status. The transported nutrients and pollutants are a serious risk for sensitive wetland and marine coastal ecosystems. In many cases, nitrate from land use is the reason for this issue and unclear cause effects still complicate a constructive problem analysis.

Although nitrate is denitrificated as soon as nitrate enriched water encounters an anoxic environment which is accommodated by bacteria, it is high risk to the ecosystem health. The degradation process is not infinite and depends on the chemical reduction capacity of the aquifer system – controlled by the availability of organic material - and the flow dynamics of the underground. Due to the high system complexity, involved hydraulic-geochemical processes do not allow a simple, linear interpolation of the future development. There is a substantial uncertainty in the future magnitudes and rates. Standard approaches of hydrogeochemical analysis often fail describing the needed spatial and reactive correlations between local land use management (source) and contaminated aquatic environments (effects). Therefore the principle item of our approach is an innovative GIS based tool for the spatial and temporal analysis and evaluation of nitrate dynamics in large scale aquifer systems to assess the nitrate flux from agricultural sources via groundwater into surface water bodies and into the ocean by SGD.

The model-based study presented here uses globally available data to identify sensitive global areas where nutrient input from groundwater discharge is potentially expected. The data used represent 1) nutrient input into groundwater based on land use classes, 2) regional groundwater transit times, 3) nitrate degradation by biogeochemical processes, 4) global submarine groundwater runoff distribution connected sensitive coastal ecosystems. Global geo data sets (land use, lithology, groundwater elevation, hydraulic conductivity, global distribution of groundwater runoff, spread of sensitive coastal ecosystems) are coupled with literature data of regional, redox based denitrification rates and reaction dynamics in aquifer systems. The presented approach of redox based catchment-scale nitrate modeling focuses on a clear cause and effect analysis including balancing of subsurface flow and substance dynamics. This system approach will help getting a realistic imaging of the nitrate contamination path together with an assessment of the buffer capacity of the redox system as an ecosystem service under pressure of climate change and land use influence.