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Nitrate tracing in tile drainage using ^{15}N and ^{18}O data

F. Bůzek (1), V. Bystřický (4), R. Kadlecová (2), T. Kvítek (3), P. Ondr (4), A. Zajíček (3) and P. Žlábek, P.

(1) Czech Geological Survey, Geologická 6, 152 00 Prague 5, Czech Republic, (2) Czech Geological Survey, Klárov 3, 118 21 Prague 1, Czech Republic, (3) Research Institut for Soil and Water Conservation, Žabovřeská 250, 156 27 Praha 5 – Zbraslav, Czech Republic, (4) University of South Bohemia in České Budějovice, Faculty of Agriculture, Studentská 13, 370 05 České Budějovice, Czech Republic (frantisek.buzek@geology.cz)

To overcome the problems associated with the mixing of water from the unsaturated zone with groundwater in tile drainage we constructed a simple two-component model of drainage discharge. One component is the infiltrated precipitation, the other is the local groundwater, reaching the drainage. As a mixing point we considered the drainage itself or a boundary between the riparian and the saturated zone, respectively. The transport of infiltrated water through the unsaturated zone is described as a piston-like flow, the drainage discharge is modelled as a piston flow in combination with a variable groundwater contribution. The ?18O data were used for calculation of the contribution of infiltration to the discharge, for estimation of the catchment recharge and for model fitting. The transit time of infiltrated water to the drainage discharge was approximately one-year, being strongly dependent on the volume of infiltration and on the discharge dynamics. The groundwater contribution formed a significant part of drainage discharge (from 65 to 98 percent of drainage discharge). Nitrate content and ?15N data were used for specification of nitrate flux and of the origin of nitrate in the drainage discharge. The same two-component model was used for nitrate balancing.

In the Dehtáře catchment, we observed three types of groundwater recharging the tile drainage in different parts of the catchment. The nitrate content of groundwater varied between 130 mg and 2 mg NO3-.L-1 for shallow and confined groundwater, respectively. The nitrate in groundwater and in drainage discharge is of inorganic origin only, without any significant input of organic nitrogen. The isotopic fractionation of nitrogen, associated with the denitrification reaction, was observed in a part of the catchment and only at the beginning of monitoring campaign in 2004. The nitrate coming to the drainage from infiltration had a variable concentration from 250 to 520 mg NO3-. L-1. The nitrate content and ?15N showed a seasonal variability, according to the pattern of nitrogen application and uptake. The resulting decrease in nitrate content (and the increase in ?15N value) was delayed because of the necessary transport time from root zone to the drainage level.

In the Jenín catchment, we observed two types of groundwater recharging tile drainage water, differing slightly in the resulting nitrate content (2 and 6 mg NO3-. L-1) and ?18O (-10 and –10.3 %¸) because of the difference in altitude. The nitrate in groundwater and drainage discharge is a mixture of both inorganic and organic nitrogen (?15N value for groundwater being 5.2 and 6 %¸, respectively), whereas the nitrate from infiltration water was of inorganic origin only (?15N value varied from –2 to –1%¸). The nitrate content in infiltration water increased steadily over the period of catchment monitoring (from about 110 up to about 150 mg NO3-. L-1), probably without much variation. The sampling site J3, collecting water from the two drained subcatchments and the undrained rest of the catchment, showed denitrified nitrate in summer 2004 only. For the rest of the campaign, its output was very similar to that from the drained parts of the catchment.