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Isotopic investigation of the discharge driven nitrogen dynamics in a mesoscale river catchment

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Nitrate in surface and groundwater has increased in the last decades due to landuse change, the application of different fertilizer for agricultural landuse and industrial dust in the atmospheric deposition. Increasing nitrate concentrations have a major impact on eutrophication, especially for coastal ecosystems. Therefore it is important to quantify potential nitrate sources and determine nitrate process dynamics with its drivers. The Bode River catchment (total size of 3200 m^2) in the Harz Mountains in Germany was intensively investigated by a monitoring approach with 133 sampling points representing the same number of sub-catchments for a period of two years. The area is characterized by a strong anthropogenic gradient, with forest conservation areas in the mountain region, grassland, and intensively mixed farming in the lowlands. Consecutive discharge simulations by a mesoscale hydrological model (mhM) allow a quantitative analysis of nitrate fluxes for all observed tributaries. The investigation of nitrate isotopic signatures for characteristic landscape types allows the delineation of dominant NO_3^- sources: coniferous forests are characterized by recycled nitrified soil nitrogen; grassland is mainly impacted by organic fertilizer (manure) and nitrified soil-N; in agricultural land use areas nitrate predominantly derives from synthetic fertilizer application. Besides source delineation, the relationship between runoff and nitrate dynamics was analyzed for the entire Bode river catchment and, more detailed, for one major tributary with minor artificial reservoirs (Selke River). Thereby, it becomes apparent that nitrate isotopic variations increase with decreasing discharge. This effect might be due to a local, more intense impact of bacterial denitrification under low discharge conditions (higher residence time) in the anoxic soil zone, in the groundwater that discharges into the river and in the hyporheic zone. Generally, δ^{15}N and δ^{18}Oof nitrate decrease with increasing runoff, which can be caused by a preferential wash-out of more easily mobilizable, isotopically lighter fractions of the soil nitrate pool.