Tracking nitrogen transformations in agricultural soils applying stable isotopic analyses

Nitrogen is one of the crucial nutrients for plants and main component of agricultural fertilizers. This element occurs in numerous chemical forms and undergoes not only chemical transformations but also microbial consumption. Nitrogen cycling across soils, waters and air is therefore very complex and still contains numerous unknowns. Especially, as a results of nitrogen addition to soils in form of fertilizers, its transformations are intensified. Consequently, nitrogen that should serve as plant nutrient, is transformed by soil microorganisms to gases and released to atmosphere or washed out by rains reaches groundwaters. These processes may cause a loss of more than a half of added nitrogen, which results in significant economical losses. Moreover, they cause serious environmental problems. The leached nitrogen causes serious contamination of groundwaters with nitrates, which reduced their usefulness as drinking water resources. Nitrogen released to atmosphere as N_2O is greenhouse gas of 300 times larger warming potential than CO_2.

For tracing and quantifying of nitrogen fluxes stable isotopic techniques will be applied. Each element contains a small admixture of heavy isotope, which amount differs depending on the production and consumption processes of particular substance. Therefore the isotopic analyses constitute a unique tool for getting insight into particular biochemical processes.

Especially unique are the N_2O isotopomer analyses, which allow for determination of, not only the isotope values for nitrogen and oxygen, but also of nitrogen isotope enrichment in different positions of the linear N_2O molecule. These results allow for estimation of the contribution of N_2O already reduced to N_2, hence may help in quantification of the main missing component in the nitrogen budget. N_2O isotopomer analyses will be combined with isotopic analyses of mineral nitrogen compounds in soil and leakage waters, including ammonium, nitrate and nitrite. Nitrite isotope analysis in soils is an absolutely novel idea, which may open new interpretation perspectives. All the results will be combined together in a nitrogen cycling model.

The result of this project will be the construction of complex nitrogen cycling model in two analysed soils, indicating the quantitative contribution of nitrogen transformations in soils. This method can be further used to investigate the processes associated with applying different fertilizing strategies and help in development of climate-smart agriculture.