Geophysical Research Abstracts
Vol. 19, EGU2017-13230-4, 2017
EGU General Assembly 2017

Test of a simplified modeling approach for nitrogen transfer in agricultural subsurface-drained catchments

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In agricultural areas, nitrogen (N) pollution load to surface waters depends on land use, agricultural practices, harvested N output, as well as the hydrology and climate of the catchment. Most of N transfer models need to use large complex data sets, which are generally difficult to collect at larger scale ($>km^2$). The main objective of this study is to carry out a hydrological and a geochemistry modeling by using a simplified data set (land use/crop, fertilizer input, N losses from plots).

The modelling approach was tested in the subsurface-drained Orgeval catchment (Paris Basin, France) based on following assumptions:

1. Subsurface tile drains are considered as a giant lysimeter system. N concentration in drain outlets is representative for agricultural practices upstream.
2. Analysis of observed N load (90% of total N) shows 62% of export during the winter.
3. We considered prewinter nitrate (NO_3) pool (PWNP) in soils at the beginning of hydrological drainage season as a driving factor for N losses. PWNP results from the part of NO_3 not used by crops or the mineralization part of organic matter during the preceding summer and autumn.

Considering these assumptions, we used PWNP as simplified input data for the modelling of N transport. Thus, NO_3 losses are mainly influenced by the denitrification capacity of soils and stream water. The well-known HYPE model was used to perform water and N losses modelling. The hydrological simulation was calibrated with the observation data at different sub-catchments. We performed a hydrograph separation validated on the thermal and isotopic tracer studies and the general knowledge of the behavior of Orgeval catchment. Our results show a good correlation between the model and the observations (a Nash–Sutcliffe coefficient of 0.75 for water discharge and 0.7 for N flux). Likewise, comparison of calibrated PWNP values with the results from a field survey (annual PWNP campaign) showed significant positive correlation. One can conclude that the simplified modeling approach using PWNP as a driving factor for the evaluation of N losses from drained agricultural catchments gave satisfactory results and we can propose this approach for a wider use.