Geophysical Research Abstracts
Vol. 17, EGU2015-10762, 2015
EGU General Assembly 2015

Modeling diffuse sources of surface water contamination with plant protection products

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Entries of chemical pollutants in surface waters are a serious environmental problem. Among water pollutants plant protection products (ppp) from farming practice are of major concern not only for water suppliers and environmental agencies, but also for farmers and industrial manufacturers. Lost chemicals no longer fulfill their original purpose on the field, but lead to severe damage of the environment and surface waters.
Besides point-source inputs of chemical pollutants, the diffuse-source inputs from agricultural procedures play an important and not yet sufficiently studied role concerning water quality. The two most important factors for diffuse inputs are erosion and runoff. The latter usually occurs before erosion begins, and is thus often not visible in hindsight. Only if it has come to erosion, it is obvious to expect runoff in foresight at this area, too.
In addition to numerous erosion models, there are also few applications to model runoff processes available. However, these conventional models utilize approximations of catchment parameters based on long-term average values or theoretically calculated concentration peaks which can only provide indications to relative amounts. Our study aims to develop and validate a simplified spatially-explicit dynamic model with high spatiotemporal resolution that enables to measure current and forecast runoff potential not only at catchment scale but field-differentiated. This method allows very precise estimations of runoff risks and supports risk reduction measures to be targeted before fields are treated. By focusing on water pathways occurring on arable land, targeted risk reduction measures like buffer strips at certain points and adapted ppp use can be taken early and pollution of rivers and other surface waters through transported pesticides, fertilizers and their products could be nearly avoided or largely minimized. Using a SAGA-based physical-parametric modeling approach, major factors influencing runoff (relief, soil properties, weather conditions and crop coverage) are represented. Water balance parameters are modeled in daily steps, taking into account relief determined discharge pathways, runoff velocity and number of field boundaries passed until receiving streams are reached.
Model development is based on a comprehensive monitoring campaign at 3 smaller catchments in North Rhine-Westphalia (Germany), equipped with two gauges each, upstream and downstream, an optical Trios probe and four Isco-Samplers. The temporal high resolution monitoring of discharge, ppp, orthophosphate and nitrate-nitrogen enables an evaluation of runoff simulations in relation with rain events.
First model results suggest that the simulation of surface runoff pathways enables a spatial-explicit identification of fields contributing to pollutant inputs. We assume that targeted actions on few fields will help solving the problem of diffuse inputs of ppp in our surface water to a considerable extent.