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Validation of the Phosphorus leaching model PLEASE at the regional scale

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High soil phosphorus contents in agricultural soils in the Netherlands cause excessive losses of phosphorous to surface waters. Current national phosphorous reduction policies are insufficient to reach the water quality standards set by the European Water Framework Directive in all catchments by 2015. Accordingly, additional measures have to be considered at the regional scale to further reduce phosphorous loadings to surface waters. For a cost effective implementation of these measures an instrument to identify critical source areas for phosphorus leaching is indispensable. In the Netherlands phosphorus leaching at the national scale is simulated with a comprehensive mechanistic simulation model (STONE, Wolf et al., 2005) focusing on changes in phosphorous leaching with time. The identification of critical source areas requires simulations at a high spatial resolution (field scale or smaller). STONE is less suitable for this purpose, because of the large number of input parameters required by this complex model. For this reason, a simple model (PLEASE: Phosphorus LEAching from Soils to the Environment; Schoumans et al., in prep.) has been developed based on the same mechanistic process description for inorganic P as the complex model STONE and a simplified description of the lateral flow of water from soil to surface waters. With this model phosphorous leaching to surface waters can be calculated using readily available information of field characteristics like depth of the groundwater table, precipitation surplus, phosphorous status and phosphorus adsorption capacity of the soil. A comparison of the simplified model with the original STONE model showed a good correspondence of the calculated concentrations in both the topsoil and the subsoil (60-75 cm) by the two models. The average leaching fluxes for soil-wetness classes as calculated by PLEASE were comparable to fluxes simulated by STONE but larger deviation occurred for individual sites due different approaches to calculate runoff fluxes in the two models.

To validate the predicted phosphorous fluxes, the model was applied to four Dutch catchments with contrasting hydrology, soil types and degree of phosphorus saturation of the soils. A soil sampling program was carried out to obtain input data on P binding capacity and P status of the soils. In each catchment 70 sites have been sampled. The sites were selected based on spatial coverage sampling. To calculate the P discharge from the catchments two approaches were followed: (i) PLEASE was applied to each of the 70 sites and the results were interpolated to obtain an estimated of the P leaching of the catchment and (ii) the soil input data were interpolated to 25*25 m grids, followed by modeling the P leaching for each grid. The results of both methods were compared with the measured discharge.

Wolf, J. et al. (2005), The integrated modeling system STONE for calculating nutrient emissions from agriculture in the Netherlands. Environmental Modeling and Software 18, 597-617.

Schoumans, O.F., P. Groenendijk and C. van der Salm (in prep.). PLEASE: A simple procedure to determine P losses by leaching