Identification of variable P-source areas at the catchment scale with a deterministic model approach

I. Kistner, G. Ollesch and R. Meissner

The identification of phosphorus source areas is of importance for sustainable management of catchments and to reach the main goal of the WFD. Often, nutrient balancing models or modifications of the Phosphorus Index approach are applied to quantify P loads and to identify risk areas. However, most of these approaches have empirical elements or statistical modules and do not take the temporal/spatial dynamic into account. This paper (poster) presents results from a field study in a small research catchment that forms the basis of physically based distributed model system to identify P source areas and critical times.

The 1.44 km² Schaefertal catchment is located in the Harz mountains at an elevation of app. 450 m a.m.s.l., 150 km southwest of Berlin. The Luvisols and Cambisols, which have developed on loess sediments, are used intensively for agriculture. At the catchment outlet, continuous measurement of discharge and automatic event sampling for sediment and P load are carried out. Measurement of meteorological and soil parameters are included in the sampling programme. Since January 2001 fifteen flood events were documented that account for 90 % of the total sediment load and two-thirds of the P loss. Twelve of these fifteen events were associated with snowmelt or frozen soils. The complex catchment response to runoff generation and sediment or P loads is documented in hysteresis curves which are a combination of clockwise and anti-clockwise direction. An event specific sediment/P relationship can be identified as a result of source area characteristics and connectivity aspects. The sediment/P ratio at the catchment outlet is significant higher in case of a long transport distance to the catchment outlet compared to source areas near the measurement point.

The modelling tool WASIM/AGNPS/SMEM/ANIMO was developed to estimate the erosion and nutrient loads of a catchment, with special emphasis on runoff generation and spatial heterogeneity of source areas. The four core models are loosely coupled. Results of the soil water calculation from the hydrological model WASIM, for example, are used as input for the phosphorus cycling in ANIMO, estimation of surface runoff volume triggers the erosion model SMEM as well as sedimentation and channel processes in AGNPS. The calibration and verification of the P-module was conducted with raster based samplings of soil information. Although pasture areas are close to the channel and drained, they were classified as low risk areas. Furthermore, the continuous hydrological modelling allows the event specific localisation of surface runoff and a dynamic estimation of P availability in the topsoil. The model has the ability to simulate the spatial heterogeneity of runoff generation in the Schaefertal catchment and to identify and quantify the dynamic character of source areas of sediment associated nutrients and soluble P.

Irina Kistner, Gregor Ollesch, Ralph Meissner
Helmholtz Centre for Environmental Research – UFZ, Dept. of Soil Physics, Brueckstr. 3A, D-39114 Magdeburg, Germany, gregor.ollesch@ufz.de