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Model tool for identifying potential risk areas of in situ colloidal-P transport through soil macropores

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In Denmark an interactive web-based tool for mapping agricultural areas at risk of phosphorus (P) losses is presently being developed based on the P Index concept. Leaching of P to tile drains by colloid-facilitated transport in macropores is an important process of P loss in structured soils and hence ought to be accounted for in the tool. The leaching of colloidal-P in structured soils is a function of the soil's ability to disperse, the colloidal-P content, and colloidal transport. The potential of colloidal transport is controlled by the hydraulic conductivity in the soil matrix, the presence of preferential flow paths in the soil, and an active flow volume of water in the mobilisation layer (the topsoil). The objective of our study was to use information from a newly developed raster-based soil property map of Denmark to identify areas with a potential high risk of colloidal-P transport through soil macropores. The dataset was based on measurements on almost 500 large soil columns (6280 cm3) sampled at 68 different localities in Denmark covering a variety of different soil types. In the laboratory, unsaturated (k(h)) and saturated (Ks) hydraulic conductivity was measured. In addition, soil water characteristics were measured on 100 cm3 soil samples. Three key parameters were considered crucial for the potential transport of available colloidal-P in the macropores: a) the near-saturated hydraulic conductivity (here defined as the conductivity at a soil water potential of -1 kPa, k(-1)), b) the difference between log(Ks) and log(k(-1)) expressing the possible degree of preferential transport through macropores, and c) the amount of soil pores larger than 30 μm representing the active flow volume of the topsoil. We derived PTFs predicting the key parameters based on neu-

ral networks and the Bootstrap method using four classes of soil texture, amount of organic matter, bulk density, and soil horizon as predictors. As a means of identifying areas with a high risk of leaching through macropores, water flow was simulated using a one-dimensional hydrological model (HYDRUS-1D) using the distributed data of the hydraulic properties derived from the PTFs. The distributed data were divided into different classes yielding a combination of 100 profiles with different hydraulic characteristics. Representative weather data for a ten year period were used at hourly time steps. Even though HYDRUS-1D simulates water transport in the soil matrix only, we believe that the model is able to give a qualitative estimate of the risk of macropore flow. When the infiltrability in the soil matrix is exceeded in the B horizon, water is supposed to flow into the macropores. In combination with the information on the possible degree of preferential transport through the macropores in the subsoil and the active flow volume in the topsoil it is possible to identify areas at risk of P loss through soil macropores. This approach will be tested as an additional component of the Danish P Index.