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Validating a hydrological classification of European soils with river discharge data

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Water flow through soil is a primary determinant of discharge dynamics in a catchment as well as the transport of pollutants from agricultural fields into surface waters. Assessing the risks for water bodies from agricultural production thus requires knowledge on the distribution and spatial heterogeneity of hydrological soil properties. This information is not available on a European scale, although pedologists started to compile European soil information as early as 1974.

In order to close this gap, we reclassified the Soil Geographical Database of Europe (SGDBE) in a hydrological manner by adopting the Hydrology Of Soil Types (HOST) system developed in the UK. The HOST classification uses pedological information on substrate, permeability, water regime and the presence of aquifers to reflect a number of conceptual models, which describe dominant pathways of water movement through the soil. In a set of over 500 catchments in the UK, the HOST classes explained 79% of the variability in the discharge dynamics as summarized by the base-flow index (BFI). The BFI is the long-term proportion of base flow on total stream flow and a BFI coefficient was estimated for each HOST class in the UK. We validated BFI predictions using these UK coefficients and the reclassified SGDBE with discharge data from 103 catchments spread throughout Europe. We also estimated new coefficients from the European discharge data and investigated the influence of topography and climate on the results.

We found that a hydrological soil classification can be built based on the attributes present in the SGDBE. Limitations were encountered in the classification of peat

soils and the presence of aquifers. Common classes were generally overestimated because of the coarse resolution of the SGDBE. The BFI predicted using the reclassified SGDBE explained around 65% of the variability in measured BFI in catchments in the UK and Northern Europe. The explained variance decreased from Northern to Southern Europe. Comparing BFI coefficients estimated from catchments in the UK and from the whole of Europe showed that the hydrological response of the HOST classes is consistent throughout Europe. However, the influence of soil on the BFI is decreasing towards Southern Europe and other factors such as climate and topography become more important. An additional factor is that in Mediterranean catchments precipitation and associated hydrological response is highly irregular, thus summarizing long-term discharge regime into a single BFI value is meaningless.

The results show that pedological information is useful for characterizing soil hydrology within Europe and the long-term discharge regime of catchments in Northern Europe. In our preliminary study, the development of a hydrological soil classification was limited by the availability of discharge data with correctly delineable catchment boundaries rather than the available soil data. This demonstrates that for the integration of hydrology and pedology, soil information with hydrologically interpretable attributes as well as high-quality discharge data from clearly defined catchments are needed.