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Use of multiple pedotransfer functions in modelling a 37-year time series of actual evapotranspiration and drainage

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Design and performance assessment of near surface waste disposal facilities require an estimate of the expected long-term average drainage from soil covers to underlying engineered structures and disposed wastes. However, often the exact composition of the soil covers is not yet defined for the design phase of a waste disposal facility, although some basicproperties, such as the textural class or textural fractions may be available or can be anticipated. These basic soil properties can be used to estimate parameters needed to calculate water fluxes through the soil cover by using pedotransfer functions (PTF). However, applying PTFs introduces a significant uncertainty because their accuracy is often limited. Even more, applying a PTF to predict water fluxes in the geographical region for which the PTF were developed does not necessarily give the best estimate compared to simulations using PTF for soils in different regions (Guber et al., 2006). To deal with these uncertainties, predictions with multiple PTFs (so-called multi-model predictions) are carried out resulting in an ensemble (i.e. statistical) estimate of the variable of interest. In this study, an ensemble estimate of the average annual actual evapotranspiration and drainage is done using 27 PTFs available from the literature relating soil textural information to soil hydraulic parameters for 5 textural classes. A 37-year long record of daily values of meteorological data for the Campine region in Belgium (northern Belgium) is used in this analysis.

The variability among the estimated soil hydraulic properties is large between the different estimates within one textural class. However, it corresponds quite well with uncertainty and spatial variability frequently observed within a single field. For each textural class, 27 values for average yearly drainage and actual evapotranspiration were obtained. Although the difference between the minimum and maximum values within a single textural class was large, the interquantile range was quite small. Therefore, the medium of the 27 simulations was taken as a first estimate of the yearly drainage and actual evapotranspiration. Estimated yearly average drainage values were 37.4, 37.0, 34.6, 33.6 and 32.7 cm / year for respectively a sand (Z), loamy sand (S), light sandy loam (P), sandy loam (L) and a loam (A) soil. Values of actual evapotranspiration were 47.7, 49.1, 51.5, 51.9 and 53.1 for the five textural classes. The median shows a clear trend between the different textural classes: a decreasing sand content resulted in a decrease in average yearly drainage. Texture of the soil material can thus be used as an engineering design parameter because drainage of soil water to the underlying barriers and wastes can be limited by proper selection of soil materials.

References

Guber, A.K., et al., 2006. Vad. Zone J., 5:234-247.