Geophysical Research Abstracts
Vol. 18, EGU2016-1191, 2016
EGU General Assembly 2016

Validation of soil hydraulic pedotransfer functions at the local and catchment scale for an Indonesian basin

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In order to accurately model the hydrological processes in a catchment, information on the soil hydraulic properties is of great importance. These data can be obtained by conducting field work, which is costly and time consuming, or by using pedotransfer functions (PTFs). A PTF is an empirical relationship between easily obtainable soil characteristics and a soil hydraulic parameter. In this study, PTFs for the saturated hydraulic conductivity (Ks) and the available water content (AWC) are investigated. PTFs are area-specific, since for instance tropical soils often have a different composition and hydraulic behaviour compared to temperate soils. Application of temperate soil PTFs on tropical soils might result in poor performance, which is a problem as few tropical soil PTFs are available. The objective of this study is to determine whether Ks and AWC can be accurately approximated using PTFs, by analysing their performance at both the local scale and the catchment scale. Four published PTFs for Ks and AWC are validated on a data set of 91 soil samples collected in the Upper Bengawan Solo catchment on Java, Indonesia. The AWC is predicted very poorly, with Nash-Sutcliffe Efficiency (NSE) values below zero for all selected PTFs. For Ks PTFs better results were found. The Wo¨sten and Rosetta-3 PTFs predict the Ks moderately accurate, with NSE values of 0.28 and 0.39, respectively. New PTFs for both AWC and Ks were developed using multiple linear regression and NSE values of 0.37 (AWC) and 0.55 (Ks) were obtained. Although these values are not very high, they are significantly higher than for the published PTFs. The hydrological SWAT model was set up for the Keduang, a sub-catchment of the Upper Bengawan Solo River, to simulate monthly catchment streamflow. Eleven cases were defined to validate the PTFs at the catchment scale. For the Ks-PTF cases NSE values of around 0.84 were obtained for the validation period. The use of AWC PTFs resulted in slightly lower NSE values, although the differences in model accuracy are low. The small differences between the cases are caused by the soil homogeneity in the Keduang catchment. Without model calibration an NSE value of 0.51 was found. At the local scale, the Wösten and Rosetta-3 PTFs can be used to predict Ks. AWC PTFs show insufficient accuracy at the local scale. At the catchment scale, the Wösten and Rosetta-3 Ks PTFs and the developed AWC and Ks PTFs are validated. It is recommended to use the PTFs developed in this study for the Upper Bengawan Solo catchment. More research is needed on the effect of PTF input on simulated hydrological state variables, such as soil moisture content, and the effect of catchment soil heterogeneity on the validation and application of PTFs.