Abstract Book Pedometrics 2017

ΠΕΔΟ
METRICS

WAGENINGEN 2017

Wageningen, 26 June – 1 July 2017

Mapping root depth soil water in sub-Saharan Africa

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Soil root zone plant-available water holding capacity (RZ-PAWHC) is one of the most sensitive soil parameters determining crop growth. This study produced the first map of the rootable depth and the RZ-PAWHC of sub-Saharan Africa (SSA). First, geo-referenced data for 28,000 soil profiles were used as input for digital soil mapping techniques to produce soil property maps of SSA (sand, silt, clay, bulk density, organic carbon, cation exchange capacity, exchangeable aluminium and sodium, pH-H O, electric conductivity, coarse fragments, drainage class and depth to bedrock). The variance explained R2 varied between 52% and 77% for these basic soil properties but was critically low ($<30\%$) for coarse fragments content and drainage class. Next, these maps were used as input data to (pedotransfer) functions, rules and criteria, which we developed and parameterised based on literature review, to produce derived maps of soil water retention at field capacity and wilting point, the soil fine earth fraction from coarse fragments content and, for maize, the soil rootable depth. Mapped versus observed water retention had an R^2 of 72% and a RMSE of 0.10 cm³/cm³. The map of rootable depth could not be adequately validated due to lack of adequate data on rootability. Results were aggregated to a RZ-PAWHC map of SSA with a spatial resolution of 1 km^2. RZ-PAWHC ranges between 0 and 235 mm with an average of 74 mm. In soils with unrestricted rootability to 150 cm (maximal rooting depth of maize), the average effective PAWHC is 113 mm and, excluding coarse fragments, 137 mm. The total soil volume of SSA potentially rootable for maize (approximately 30,000 km³) was reduced by one-third (10,500 km³) due to soil conditions restricting root zone depth, of which 4,800 km³ are due to inadequate aeration and 2,500 km³ due to sodicity. The overall assessment of RZ-PAWHC could not be adequately validated but the accuracy seems most limited by the accuracy of the soil property maps from which the maps of RZ-PAWHC and especially rootable depth were derived.

keywords: *soil depth, root depth, soil water, soil map, Africa*