Modelling the saturated hydraulic conductivity of soils amended with different biochars

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Soil organic carbon accumulation is central to the improvement of many soil properties and functions. Biochar use and management could be particularly beneficial for soils with low organic carbon content. It's known that many of soils in the world intrinsically exhibit little ability to retain water and nutrients due to their texture and mineralogy. Also, acquiring biomass for other than agricultural purposes can reduce the organic carbon accumulation and worsens the soil quality. Adding biochar to the soil can affect saturated hydraulic conductivity, water holding capacity and reduce soil erosion and mineral fertilization. It has been shown that saturated hydraulic conductivity depends on type of feedstock and pyrolysis temperatures used for biochar production and application dose but the results are inconsistent. Therefore, in order to explain the different biochar impacts, we propose in this study the use the physical-statistical model of B. Usowicz for predicting the saturated hydraulic conductivity using literature data for various soils amended with biochars (from woodchip, rice straw and dairy manure), pyrolyzed at 300, 500 and 700 °C.

Soil with biochar and pores between them can be represented by a pattern (net) of more or less cylindrically interconnected channels with different capillary radius. When we view a porous medium as a net of interconnected capillaries, we can apply a statistical approach for the description of the liquid or gas flow. The soil and biochar phases and their configuration is decisive for pore distribution and the course of the water retention curve in this medium. The physical-statistical model considers the pore space as the capillary net that is represented by parallel and serial connections of hydraulic resistors in the layer and between the layers, respectively. The polynomial distribution was used in this model to determine probability of the occurrence of a given capillary configuration. Capillary size radii and the probability of occurrence of a given capillary configuration were calculated based on the measured water retention curve and saturated water content. It was found a good agreement between measured and the model-predicted hydraulic conductivity data for the biochar amended soils. It indicates that the used variables and model parameters to predict the saturated hydraulic conductivities of the soils were chosen correctly. The different types and pyrolysis temperatures of biochars affected the soil water retention and the equivalent length of the capillaries that characterize the pore tortuosity in the soil.
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