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Modeling the relationship between soil bulk density and hydraulic properties

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Increases in the soil bulk density during compaction may influence many aspects of the soil-water-plant-atmosphere system. Approaches are suggested that could model the effect of an increase in soil bulk density on the water retention curve (WRC) and on the hydraulic conductivity function (HCF). Two expressions of the WRC are considered. Relationships between their parameters and the bulk density of a compacted soil were calibrated and validated against experimental WRC data of soils at various levels of compaction. These relationships enable a relatively good prediction of the effect of bulk density on the WRC. Two expressions are formulated to predict the saturated hydraulic conductivity of compacted soils. The first model is a general expression based on the Kozeny equation that requires only information on the soil bulk density. The second model exploits information contained in the water retention curve (WRC). This approach, which relies on Assouline's model for soil HCFs, also provides a basis for a proposed expression to predict the unsaturated HCF of compacted soils. The model was verified against measured HCFs for soils at different bulk density values. Both the saturated and unsaturated hydraulic conductivities were well reproduced by the suggested expressions.