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Analytical evaluation of 1D cumulative infiltration with regards to soil hydraulic properties

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Modelling and understanding of water flow in the vadose zone are important with regards to water management and require appropriate estimation of water infiltration during rainfall events. Several numerical and analytical models, as well as field experiments, have been proposed to quantify cumulative infiltration under different hydrological initial and boundary conditions. Yet, few studies have focused on the impact of different soil hydraulic parameters on the cumulative infiltration of water. This study quantifies the impact of the saturated and residual water contents, the saturated hydraulic conductivity, the pressure head scale parameter, and the retention curve shape parameter on the cumulative infiltration of water for the case involving zero surface pressure head and uniform initial pressure head of -100 cm. Cumulative infiltrations are calculated using the analytical formulation proposed by Haverkamp et al. (1994). It shape parameter, beta, involved in this formulation is initially considered with a value of 0.6. The results show that parameters can be classified with respect to their impact on the cumulative infiltration, with the saturated hydraulic conductivity having the most significant and the shape parameter having the least significant impact. Impact of various parameters can be adequately explained by considering the physics of water infiltration through soils. In addition, a sensitivity analysis is performed with respect to beta values. This parameter has previously been shown to be soil dependent. The results highlight the impact of this parameter. Our study clearly establishes a link between soil hydraulic properties and surface water infiltration, and the need to properly select the beta parameter as a function of the soil type to ensure a proper modelling of water infiltration and corresponding surface runoff.

Ref: Haverkamp R., Ross P.J., Smetten K.R.J. and Parlange J.Y., 1994. Three dimensional analysis of infiltration from the disk infiltrometer 2. Physically based infiltration equation. Water Resources Research, 30:11, pp. 2931–2935.