Soil-dependent β and γ shape parameters of the Haverkamp infiltration model for 3D infiltration flow

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January 18, 2023

Abstract

Estimating of soil sorptivity (S) and saturated hydraulic conductivity (K s) parameters by field infiltration tests are widespread due to the ease of the experimental protocol and data treatment. The analytical equation proposed by Haverkamp et al. (1994) allows the modeling of the cumulative infiltration process, from which the hydraulic parameters can be estimated. This model depends on both initial and final values of the soil hydraulic conductivity, initial soil sorptivity, the volumetric water content increase ([?] ϑ), and two infiltration constants, the so-called β and γ parameters. However, to reduce the number of unknown variables when inverting experimental data, constant parameters such as β and γ are usually prefixed to 0.6 and 0.75, respectively. In this study, the values of these constants are investigated using numerical infiltration curves for different soil types and initial soil water contents for the van Genuchten-Mualem (vGM) soil hydraulic model. Our approach considers the long-time expansions of the Haverkamp model, the exact soil properties such as S , K s , and initial soil moisture to derive the value of the β and γ parameters for each specific case. We then generated numerically cumulative infiltration curves using Hydrus 3-D software and fitted the long-time expansions to derive the value of the β and γ parameters. The results show that these parameters are influenced by the initial soil water content and the soil type. However, for initially dry soil conditions, some prefixed values can be proposed instead of the currently used values. If an accurate estimate of S and K s is the case, then for coarse-textured soils such as sand and loamy sand, we propose the use of 0.9 for both constants. For the remaining soils, the value of 0.75 can be retained for γ . For β constant, 0.75 and 1.5 values can be considered for, intermediate permeable soils (sandy loam and loam) and low permeable soils (silty loam and silt), respectively. We clarify that the results are based on using the vGM model to describe the hydraulic functions of the soil and that the results may differ, and the assumptions may change for other models.

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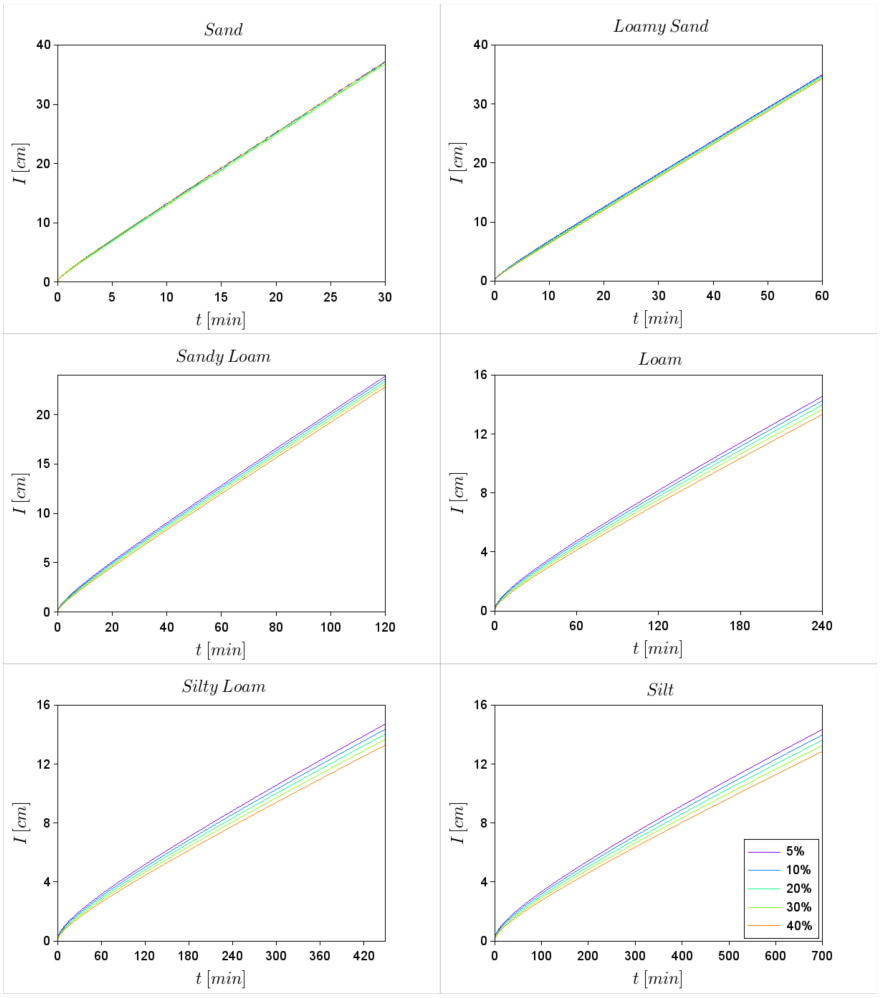

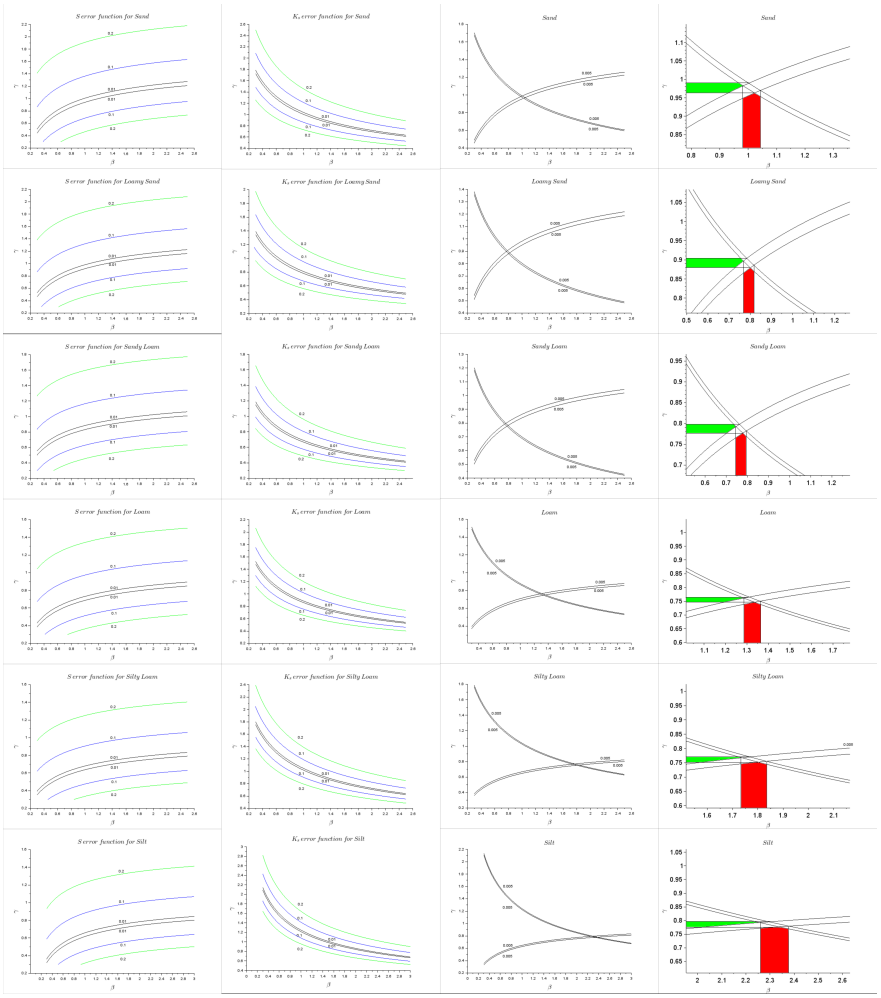

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