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Interactive comment on "Improved calibration of Green-Ampt infiltration in the EROSION-2D/3D model using a rainfall-runoff experiment database" *by* Hana Beitlerová et al.

Anonymous Referee #2

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This paper uses a large set of rainfall-runoff experiments to derive relations between a parameter of the Green-Ampt infiltration model and other soil properties, states and soil management parameters. A linear mixed effects model is used to setup these relations. The estimated parameters with this mixed model are subsequently validated against a validation set of run-off experiments. In a second step, the propagation of errors in predictions of run-off and sediment load are evaluated.

The paper addresses a relevant topic and makes an important contribution to bringing together datasets that can be used to develop pedotransfer functions for the saturated hydraulic conductivity for which reliable pedotransfer functions are still missing. The

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reason is that this parameter is spatially but also temporally very variable and depending on soil structural properties that cannot be quantified easily.

The authors did not determine the saturated hydraulic conductivity but a scaling factor, the skinfactor, that scales the saturated hydraulic conductivity, is estimated. This is an interesting approach since it allows to evaluate the impact of certain soil properties on the correction of an a-priori estimate of the saturated hydraulic conductivity. But, the authors should pay more attention to the background and knowledge of the readers. The skinfactor is a specific parameter of a certain model. Neither this model nor the meaning of this parameter are known to most of the readers. As it scales the saturated conductivity, it is also crucial to explain how the saturated hydraulic conductivity was derived. The authors refer to the 'Campbell estimation' but do not give a reference and do not explain how this model estimates the saturated hydraulic conductivity and based on which parameters.

The authors should best give the equations that are solved in the infiltration model and explain the different parameters that are used. It is for instance not clear to me how they determined the matrix potential at the wetting front, which is an important parameter in the Green-Ampt equation. Since they write about estimating the soil water potential of the dry soil using pedotransfer functions, I suspect that they used the dry soil water potential as the water potential at the wetting front. This is in fact an incorrect interpretation of the Green-Ampt model parameters since the water potential at the wetting front is only a very week function of the water potential of the dry soil. See Dingman S.L, Physical Hydrology, 1993. Using the water potential of the dry soil as a proxy for the water potential at the wetting front would lead to an overestimation of the infiltration rate and this overestimation could explain why the authors found skin factors < 1 for dry soils. If the authors did not estimate the water potential at the wetting front from the water potential in the dry soil, they should mention how they estimated this parameter and based on which soil properties. Finally, the saturated water content is also a parameter of the Green-Ampt model. The authors do not provide information

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about how this parameter was estimated.

In general, I think that the authors should describe more clearly the methods they used and give more information to the readers. At several places, the authors are implicitly referring to background information that is not available to the readers (examples are given below). Also in the results and discussion section, the authors are referring to results that have not been presented yet. So I think that the structure of the paper requires some improvement as well as the language, which is at some places confusing or contradictory.

Detailed comments Title: You cannot 'calibrate' infiltration. You calibrate a model or parameters of a model. I think you should make clear that you estimated a scaling factor of the saturated hydraulic conductivity, which was estimated with the Campbell equations.

P3 ln 9: I do not understand the role of the matrix potential in this context and how the matrix potential can be estimated since it is not a static soil property. It is tempting to interpret the soil matrix potential in the dry soil as the matric potential at the wetting front. But this is an incorrect interpretation of the matrix potential at the wetting front. The matric potential at the wetting front is in fact independent of the antecedent soil moisture.

P3 ln 16: These are very strange units of the saturated conductivity. Normally saturated conductivity is expressed in m s-1.

P3 ln 24: I am wondering how the skinfactor is derived from the infiltration rate at the end of the experiment. If the infiltration experiment lasts long enough, then the infiltration rate converges to the saturated hydraulic conductivity and the skinfactor can be derived directly from the infiltration. In fact, no Green Ampt infiltration model is needed then to derive the parameter. The authors should be more explicit on how they derived the skin factor from the infiltration rate at the end of the experiment. Did they use the Green Ampt infiltration model or not? How did they decide that the infiltration

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rate did not change over time anymore? Another question is how were the initial and saturated soil moisture content defined and what was the pressure at the wetting front?

P5, table 2: You used time of consolidation as a predictor variable. But, also relevant for consolidation is the cumulative precipitation after the last topsoil disturbance.

P6 ln 6: 'Dry soil leads to lower skinfactors than saturated soils' This comes a bit unexpected since no results have been shown yet.

P6 ln 8: 'While dry experiments represent the natural conditions of the soil cover, wet experiments represent the soil cover after rainfall and impacts from the destruction of soil aggregates and soil crust, loss of trapped air, or water repellence.' How is this related to the difference between the skin factors for dry and wet experiments?

P6 ln 10: 'The crop type and soil texture group also have an impact on the skinfactor, but only on the inter-level stage.' What is inter-level stage?

P6 ln 25: You must explain which variables are used in the 'Parameter Catalogue'. This catalogue is probably not known to many readers.

P6 ln 33: Explain what you mean with 'environmental sensitivity'.

P6 ln 34: You must give more information about how STEP1 was simplified and what the difference is between STEP2 and STEP3.

P6 ln 14: Is there actually a difference between RSR and the square root of the coefficient of determination?

P7 ln 16: Give information about the location of the site.

P12 Figure 3 and 4: It is not clear to me whether the runoff volumes and sediment 'volumes' were measured or were predicted using the experimentally derived skin factors. I think the latter is the case. What are 'sediment volumes' and why are they expressed in tons? That is not a volume unit.

P12: ‘skinfactor corrected by -MAPE to increase the infiltration rate, produced no runoff’ I did not understand this. If you add a negative number, then the skinfactor decreases and shouldn’t the infiltration rate then decrease and more runoff be produced?

P13 ln 10: How did you decide that the dataset provided sufficient data?

P15: ‘An alternative explanation is the misfit of the empirical estimation functions for the saturated hydraulic conductivity and matrix potential. The experimental basis behind Campbell’s model is unknown (Campbell, 1985). The equations for the matrix potential estimation are based on the measurements of 40 important Belgian soil series.’ I suppose that the matrix potential was calculated from the initial soil moisture content using the water retention curve and that the parameters of the water retention curve were derived from other soil information using pedotransfer functions. But it is not clear to me how this matrix potential was afterwards used in the Green-Ampt infiltration model. It is incorrect to assume that this is the water potential at the wetting front, hf. hf is related to the sorptivity of the soil, Ks, and the difference between the saturated and initial water content. The sorptivity of the soil depends on the water potential of the dry soil but only very weak. The sorptivity is the integral of the weighted unsaturated conductivity between the water potential of the dry soil and the pressure head at the soil surface (which is 0 in case of saturation). Since the unsaturated hydraulic conductivity decreases so strongly with more negative matrix heads, this integral is not very sensitive to the lower boundary of this integral (the matrix potential in the dry soil). As a consequence, the sorptivity and hf are not very sensitive to the matrix potential of the dry soil. Furthermore, hf varies from a few cm to about -30 cm in clayey soils. This is of course much less negative then the matrix potentials in dry soils. As a consequence, using the matrix potential of the dry soil as hf will lead to a strong underestimation of the pressure head at the wetting front and a strong overestimation of the infiltration that is driven by capillarity. In order to compensate for this overestimation of infiltration, the saturated conductivity must be reduced to match the measured infiltration rates. This may be the reason why the skin factors are reduced when the initial soil moisture

content is lower.

P15 ln 37: ‘This method reduces the number of experiments’ Do you mean: the number of parameters?

P 15 ln 38: ‘Previous studies determined different dependencies for the prediction parameters (e.g., the intercept of soil moisture) on each single subset, whereas this study assumed an equal dependency on each parameter for the entire dataset.’ But in the STEP1 model, you considered interactions between the categorical and continuous predictors.

P 16 ln 17: ‘Other significant predictors of soil texture’ You do not predict soil texture but you use soil texture as a predictor. ‘Other significant predictors such as soil texture’

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