

Interactive comment on “Exploring the sensitivity on a soil area-slope-grading relationship to changes in process parameters using a pedogenesis model” by W. D. D. P. Welivitiya et al.

Anonymous Referee #1

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General comments

This is a nicely written and well-conducted model study that fits well in ESurf. The authors present a sensitivity analysis of the pedogenesis model SSSPAM5D. The results are quite interesting and have important implications for understanding the spatial variability of soil properties in the landscape. I only have two minor concerns. The first is that the setup is relatively simple: straight, planar slope and a relatively limited One-At-a-Time sensitivity analysis, but given the computational demands of the model, this is understandable and hard to work around at this point. Another minor concern is that in this model, there is no feedback between evolving soil properties and runoff rate that controls erosion (Equation 4). Basically r is fixed by the authors. It would be very

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interesting for future work to have some kind of feedback between infiltration rate or saturated hydraulic conductivity or soil water holding capacity and r . For this paper, I would be happy if the authors could include a minor discussion point on this matter. In conclusion, the quality of this paper is excellent and I believe that the point made by the authors, that these results confirm the generality of the area-slope- d_{50} relation, is important and holds significant implications for geomorphology and soil science. It is definitely a very interesting study to publish in ESurf. Apart from my two minor concerns, I only have some specific comments for the authors to take into account, see below. I also believe the number of figures and tables is quite high and could be reduced. My recommendation is therefore minor revisions in order to streamline the presentation of the results to the reader, by eliminating a few figures and explaining a few statements in the text better.

Specific comments

- I like the S-A- d_{50} plots and the explanation of how to use them in figure 4. Just as a suggestions to make it more attractive, it would be nice to fill in the contours with colours (using the same scale for all figures makes comparison very fast)

-p.5 line 12-13: The authors can call their model as they will of course, but I am not quite sure if I agree with the 5 dimensions. Because a point-based model simulates 2 (or n) soil properties does not make it a 3D model (or $n+3$ model)? . Also: “depth down the soil profile”, why not just name it z and talk about the 3 spatial dimensions? -p.8 use consistent writing of Shields criterion (if’ve found Shield’s, Shield and Shields in the text) -p.9 line 12: delete “and”: smaller particles, the cumulative. . . -p.9 lines 14-17: repeated from p.8 line 15-17. I suggest to eliminate the former. -p. 10 lines 4-7: Is it important how you define the thickness of the armour layer? -p.10 Eq4. Define r and x . -p.13 The authors suddenly talk about chemical weathering here. Yet in paragraph 1.2 no distinction is made. I think it is important to mention this earlier and what the authors mention on p13, line 5 that “we do not explicitly model chemical weathering”.

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-p.14 paragraph 3. Mention here what a and b stands for (see p 16, lines 14-17) - p14, line 28 gradings -p.18 lines 11-15. I can not see this in the mentioned figure. No mention of 1a and 2b, just 1 vs 2? -p.18 lines 25-26. See one of my main concerns, that grading does not change the discharge/infiltration rate. Can the authors include a short discussion on this? Fine-textured soils will be more prone to crusting, coarse fragments generally promote water infiltration in addition to armouring the surface and reducing erosion. See a good review by Poesen and Lavee (1994, Catena) -p18 paragraph 5.2.2. What about changes in the intensity-frequency of events? Authors now only change the absolute amount of discharge. Would these conclusions hold when a time-varying behavior in the event series (with the same annual mean) is applied? -p.19 line 8: Ranger 1 or 2? -p.19, line 17. This is an important conclusion! -paragraph 5.2.4 suggest to change to "changing the erodibility and selectivity exponent" -p.19, line 27: suggest to change to: "the d50-exponent beta" -p20, line 4: geometry? -Figure 4. Is it not possible to read in the points from Surfer and plot the left figure in matplotlib to streamline all figures? -Figure 5. The authors need to indicate not only the weathering rate, but also the second variable (Ranger 1 or 2 grading) in the figure. -I suggest to eliminate figure 6 in order to reduce the total number of figures -I suggest to eliminate figure 7. The main results are summarized in fig 8 anyways and there are more simulations in fig8 which are also not shown. -Fig 13 is cut off on the left -Table 1. The authors just downgraded their model one dimension here. -Table 2 caption: "to generate" -Table 3 doesn't add much extra over figure 8. Suggest to eliminate.

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