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Comment on hess-2021-79

Anonymous Referee #2

Referee comment on "Hortonian Overland Flow, Hillslope Morphology and Stream Power I: Spatial Energy Distributions and Steady-state Power Maxima" by Samuel Schroers et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-79-RC2, 2021

General

The paper is a contribution to a growing program concerning possible maximum entropy production phenomena in the Earth system. It shows what happens with potential and kinetic energy in accumulating flow over slopes of different shapes and forms.

One could, as Rev 1 did, argue that such an approach does not really add much to our insight into hillslope processes beyond some trivial findings, such as that the accumulative flow over a hillslope shows different energy distributions than run-on systems such as rivers. Although I do think some clearer argumentation of the advantages or possible new insights is warranted, I would give the authors the advantage of the doubt at this point after a serious re-write.

It would, however, be a good idea to have some empirical support beyond the very general geomorphological observations presented here. One starts with some classical work (Horton, etc) and then neglects three decades with hundreds of hillslope runoff studies to come to a new approach. How does this work compare to that body of scientific literature?

Major remarks

The paper is very long and often one is lost in technical detail that would better be placed

in an appendix. Perhaps a matter of taste but the writing is expansive, which further reduces clarity of argument. It reads more like a chapter in a PhD thesis than an article. If this is indeed also to be a chapter in a PhD thesis, I would recommend keeping this version (after some adjustments) as it is more complete, but in an article one would prefer a more succinct narrative that is clear and to the point.

There is a page+ list of variable names, which is good to have, but one is forced to jump back to that list to keep track of the arguments. It is good to show derivations from, more or less, first principles, but not in the main text. One could more or less start with Eq. 16 and show the relation with Horton & Bangold.

A slope that is in steady-state with Peff=50mm/h will soon cease to exist. It is ok to use it as a calculation example but one cannot then conclude (L 510) that only certain configurations are feasible because they have power maxima. The assumption that slopes regularly come into steady-state with even a Peff=5mm/h is more of the problem. This points back a bit at the lack of connection with empirical work.

Finally, a new approach or theoretical ansatz would be much stronger if testable hypotheses are generated. If not, the whole theory becomes untestable and thereby puts itself outside mainstream science. In L520 and further, one comes very close to such a hypothesis (rill initiation) that should be clearly formulated. All the cushioning words in this paragraph make this not a very clear hypothesis and thereby the theory extracts itself from falsifying experiments. Perhaps this is then the main weakness as a grand theory is presented that cannot be tested without the nitty-gritty details that are common in (empirical) hillslope studies.

Minor remarks

As this seems to be part of the larger program started by Kleidon, it is not at all clear how this in the end all fits in that framework. Perhaps this is snowed under the many side remarks made but a clear statement on this, and a much shorter introduction, would improve readability and impact.

If one uses so many variables, it is good to use them consistently. The list suggests there is a difference between Peff and I but it seems from the figures in results and the text that they are the same (l 235).

L 51: Good (but not only) example of why the write-up is not helping towards

understanding the core findings. This remark does not contribute to the general findings and arguments. There are important and relevant differences between biological and river networks, as the generalization of West et al., 1997 in Banavar et al., 1999 (Nature 399:130–132) shows. Yes, they are both efficient networks with power-law properties but that is where the similarity ends.

L 194: Why would precipitation be decreasing along a 100 m slope?

L 207 Sheet flow is generally not a fully developed turbulent flow. The exponents in eqs 18&19 are usually not valid for sheet flow. In the conclusion, the authors already hint at the fact that hydraulic details need to be taken into consideration when it comes to rill initiation and the change from laminar-like to full turbulence is likely to have a lot to do with that.

L 299: What is the value of having cases 3 & 4 in Table 2?

L 454: Deduct should probably be deduce.

L 456: Punctuation.