

## ***Interactive comment on “How Hack distributions of rill networks contribute to nonlinear slope length–soil loss relationships” by Tyler H. Doane et al.***

### **Anonymous Referee #1**

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In this generally well-written manuscript, the authors present a simple probabilistic argument for explaining the Hack distribution and the relationship between sediment yield and hillslope length. The research is sound and interesting, and the case study lends support to the theory. The limitations of the study, largely arising from the assumption of a Scheidegger network, are clearly explained in the discussion. There are however a few logical and mathematical steps that are needed to substantiate the theory.

First, my main concern is with equation (2), from which many of the main results on  $fA$  follow. It is not clear how the authors obtained it and what assumptions are involved. In principle, the ensemble average of  $A$ , given  $l$ , is  $\langle A \rangle = \int A(f_l(l|A)f_A(A))/(f_l(l))dA$ .

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So, the ensemble average of  $A$  should contain information about the entire joint probability distribution. How does it reduce to equation (2)? Is  $\varphi$  really a constant?

Second, it should be better emphasized what aspects of the theory are new. From the abstract and the introduction, it seems the authors are going to develop a complete and unifying theory for the Hack law and distribution. The work however builds a lot on previous work (e.g., Dodds and Rothman) and there are many assumptions along the way, so it is hard to keep track of what is new and what is merely a review.

Minor comments.

I strongly suggest dividing section 2.1 in subsections. Here the theory is long and very involved. I believe that with subsections, it could be easier to identify and connect the different pieces of the theory as well as recognize the key new aspects. This also applies to section 3.

Line 150. This is the first time  $\alpha$  and  $\lambda$  appears, without being introduced.

Line 153. I think the authors meant (13) rather than (19). Same in line 176.

Line 169. Correct “Larger”.

Line 304. Missing “of” in “last part of our goal”.

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Interactive comment on Earth Surf. Dynam. Discuss., https://doi.org/10.5194/esurf-2020-63, 2020.

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