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Interactive Comment

Interactive comment on "Explanation of the values of Hack's drainage basin, river length scaling exponent" *by* A. G. Hunt

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The author derives a relationship between the Hack's Law exponent and the chemical length exponent (homogeneous systems) and the optimal path length exponent (heterogeneous systems) at the percolation threshold for two-dimensional systems. A nice agreement is found.

At issue here is not the derived relationship but why it the percolation model is relevant to actual river basin geometries as described in the Theory section I see several problems.

1. It is my understanding that the chemical path and critical path exponents apply to the percolation cluster at (or near) the percolation threshold. Why should any real system,

at the start of the erosion process, be at this threshold? Tightly packed soils could be well below threshold, loose soils well above it. The derivation, as written, seems to depend on the soil being near the threshold.

2.The author appeals to the two-dimensional percolation model. But a real system is three dimensional (the vertical dimension being cut off at the surface). As water starts to flow it is not confined to the very surface, and one could imagine that the vertical structure might be important. If it is, then one should be using the chemical distance exponent in three dimensions (possibly modified by the surface), which is 1.37 instead of 1.13. What is the justification of using a two-dimensional percolation model?

3. When thinking about conductive paths in a percolating system, one imagines the fluid being injected along, say, the upper edge, and depending on the bond density flow paths do or do not appear. But in a real landscape, water is incident from above, striking both percolating and non-percolating regions. (A counter-example would be melt water originating from the face of a wide glacier.) Are we to imagine that water incident from above on a large non-percolating region will not form stream channels? This needs clarification.

4. For the heterogeneous system, the author uses a critical path exponent obtained by assuming a log-normal distribution of resistances. Actual soils have a particle size distribution that is multifractal. I would expect, therefore, that one should be using a multifractal distribution of resistances: this could well change the value of the critical path exponent. Granted, the proper universal multifractal parameters for actual soil channels may not have yet been discovered, but the author should at least make it clear that the log-normal distribution is an assumption open to revision.

In summary, in light of the questions raised, I wonder if the nice agreement of this percolation model and Hack's Law is fortuitous. If the author can satisfactorily address them (or explain why they are mistaken and don't need to be addressed) I would recommend publication.

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