Nonlinear Processes
in Geophysics
Discussions

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

**Anonymous Referee #2**

Received and published: 30 December 2015

## 1   General comments

This paper attempts to derive with the help of percolation models the range of empirical estimates of the scaling exponent of river length, known as the Hack's law exponent. I believe this an original and seductive idea.

However, I would like first to clearly state that the repeated use of the expression 'percolation theory' seems to be rather misleading: what is really shown is a given agreement of a range of numerical values yielded by given percolation models with empirical estimates, not a theoretical explanation provided by an abstract theory.

I would also like to call the attention of the author on a few facts:

- there is presently no attempt to physically explain the observed fluctuations of the Hack's exponent by the multifractal heterogeneity of the driving fields of the river flow, e.g. landscape, topography, soil, rainfall, etc., whereas this exponent should have a unique value in the framework of the Fractal Geometry;

- this would be furthermore in agreement with the fact that the present estimates of the Hack's exponent does not rely on the (fractal) binary percolation model;

- unfortunately, the present manuscript argues that 'Hack's law can be understood using percolation theory . . . because of 1) the fractal structure of the percolation cluster';

- it is also unfortunate that no hint is given on how much non-binary and heterogeneous is the model used by Sheppard et al. (1999);

- there is therefore no obvious justification to take the scaling exponent of the aforementioned model as being the upper bound of the tortuosity exponent;

- there is an interesting attempt to physically explain the relevance of the percolation with the help of considerations based on erosion, but the latter is a $3D$ process -or at least a $(2 + \epsilon)D$ process- and the considered percolation models are only $2D$;

- furthermore percolation exponents are often strongly dimensionality dependent;

- there is no explanation on uncertainties or on the range of fluctuations of the empirical estimates of the Hack's exponent, e.g. is the range obtained with rms estimates?

- conclusions should be accordingly revised..

Overall, I would suggest a revision with further review.

## 2 Detailed comments

- for aforementioned reasons, a more neutral title would be more adequate, e.g. 'Percolation and the estimates of $\cdots$';

- similarly, 'percolation models' would be often more adequate than 'percolation theory', in particular when presenting numerical estimates;

- there is a unique offline equation that is unfortunately not labelled, whereas there is at least an implicit reference to it by an online equation (line 36)$\cdots$ which repeats it but forgets the constant pre-factor 'C' included in the former equation;

- tortuosity is mentioned on line 62, but with no explanation, the exponent $\gamma$ is presented as the scaling exponent of the optimal path length (line 67) then as the tortuosity exponent online 87. This should be done in a more straightforward manner.

- it should be made clearer that $\gamma = 2\beta$ than presently done on lines 85-87;

- furthermore this could be done at line 36, instead of waiting for developments on percolation;

- thestatement of lines 100-101 seems to be in contradiction of what was said before;

- the statement of lines 102-103 seems obscure, in particular 'feasible optimality' was not discussed in the text body, but only mentioned once.

---