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Revisiting Horton's laws with considerations of the directly drained VS source area

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River networks have been regarded as excellent examples of self-similar patterns in nature. Fractal characteristics of river networks have been quantified through scaling relations between several morphologic variables (e.g., *Hack*, 1957; *Flint*, 1974). In particular, Horton's legendary study on scaling properties between numbers and lengths of streams in different orders (*Horton*, 1945) has significantly influenced research studies in this subject.

Today, Horton's laws are referred to the log-linear relationships of three variables across stream orders, i.e., number, length, and area which is later added by *Schumm* (1956). In a closer look, there is a conceptual inconsistency between their definitions though. While length is defined as the length of stream of a specific order only, area by its definition includes drainage area of lower order streams. To deal with this inconsistency, there was an attempt to distinguish the average area drained directly by the stream of a particular order in the Hortonian formulation (*Marani et al.*, 1991; *Beer and Borgas*, 1993).

Nevertheless, there remains an interesting problem in the definition of directly drained area for 1st order and for the rest orders in these studies. While the whole area of 1st order stream is regarded as the directly drained area in these studies, for a channel to form it needs the minimum drainage area named source area. In this study, we evaluate how significant considering this zero order area separately is in understanding overall river network organization. To this end, we define new expression for the directly drained area and revisit Horton's laws with a generalized formulation. To test the proposed ideas, several river networks extracted from digital elevation models (DEMs) are analyzed.

References

Beer, T., & Borgas, M. (1993). Horton's laws and the fractal nature of streams. *Water Resources Research*, 29(5), 1475-1487.

Flint, J. J. (1974). Stream gradient as a function of order, magnitude, and discharge. *Water Resources Research*, 10(5), 969-973.

Hack, J. T. (1957). Studies of longitudinal river profiles in Virginia and Maryland. *US, Geological Survey Professional Paper*, 294.

Horton, R. E. (1945). Erosional development of streams and their drainage basins; hydrophysical approach to quantitative morphology. *Geological Society of America Bulletin*, 56(3), 275-370.

Marani, A., Rigon, R., & Rinaldo, A. (1991). A note on fractal channel networks. *Water Resources Research*, 27(12), 3041-3049.

Schumm, S. A. (1956). Evolution of drainage systems and slopes in badlands at Perth Amboy, New Jersey. *Geological Society of America Bulletin*, 67(5), 597-646.