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# *Interactive comment on* "Horton laws for Hydraulic-Geometric variables and their scaling exponents in self-similar river networks" *by* V. K. Gupta and O. J. Mesa

**Anonymous Referee #2**

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The paper establishes Horton laws (geometric dependence of a branch variable on the Horton-Strahler order of the branch) for five Hydraulic-Geomeric variables in a Tokunaga self-similar tree under assumption of steady homogeneous flow. The relations among the respective Horton indices are also derived. The predicted values of the exponents are shown to coincide, under some further assumptions, with those of the OCN model for a space-filling tree. The study continues with introducing anomalous scaling exponents (to account for the zero-limit of the channel slope at increasing orders) that allows the authors to consistently establish Horton laws for all the examined variables. The results are tested against observations using the data from three filed studies.



The study results in an important set of analytic constraints that are ready to be tested in observations. The dimensional analysis, used here to obtain the results, has never been systematically applied to examine Horton laws. Hence, the study leads to both methodological and theoretical advances. The reported results will be of interest to the broad NPG readership and will facilitate further research.

At the same time, the paper suffers from clumsy organization, which should be improved prior to publication. In short, it is crucial to (i) clearly formulate the problem, assumptions and methods in the beginning of the paper, (ii) state the necessary definitions prior to their use, and (iii) focus on the results actually used in this study, leaving the related and more advanced concepts to discussion. This also might help shortening the paper length.

I list my specific comments below:

1) The separation of material between "Introduction" and "Background" is currently unclear. Both sections discuss existing studies that form the background for the present research. The sections should be combined, or their difference should be clarified.

2) It would be great to have a dedicated section that will introduce and discuss all the critical definitions (e.g., Horton-Strahler order, Tokunaga self-similarity), assumptions (that of SSHN, SSSON, self-similarity of HG variables), models (OCN, RSN), and methods (Buckingham–Pi theorem, dimension analysis, SS-1, SS-2, anomalous exponent) used in the paper. This will significantly improve reading and comprehension of the paper. In particular, it is worth to summarize the two pillars of the proposed approach: the results of Gupta and McConnell (2008) and the assumption of self-similarity of H-G variables. Those are currently appear hidden in the text.

3) p. 707, Eq(1). It would be helpful to notice that this "traditional" form of Horton laws is not satisfied in a Tokunaga tree (which only obeys limit Horton laws).

4) p. 712, Section 3.1. The sections must include (or appear after) a formal definition

of Tokunaga self-similarity. Also, I'm not sure that RSN should appear in this focused section and not in the general intro.

5) p. 714, Section 3.3. Please mention that the Buckingham–Pi theorem does not specify the precise form of the 6 dimensionless parameters.

6) p. 717. The results of Gupta and McConnell form the core of the presented analytical approach. They should be formulated explicitly (with equations), and probably much earlier in the paper.

7) p. 718, Eq. (11). This equation that requires about a dozen lines of definitions at p. 716 is not used for the results of the paper. I strongly suggest to start with equation (13), which is actually used in the work, and relegate derivations of never-used general cases (11) and (12) to discussion.

8) p. 719, Eqs. (14)-(15). It could be discussed in the beginning of the paper that under the current assumptions the quantities Q, A, and magnitude M are proportional to each other; hence they have the same limit behavior given by Gupta and McConnell (2008).

If comments (7) and (8) are taken into account, the 4-page derivation of the final equation (16) would take a couple of paragraphs.

(9) p. 720, Eq. (16). The limits of A and Q are achieved for large values of order w; unlike the limit for N that is achieved for small values of w. Accordingly, it seems that the statement on l. 7 that the results hold for small values of w should be reconsidered.

(10) p. 721. The self-similarity assumption of the H-G variables is another (together the results of Gupta and McConnell) pillar of the proposed approach. It is worth including some discussion in support of this assumption.

(11) Finally, the title of the paper could specifically mention "Tokunaga self-similar" rather than vague "self-similar"

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