A reinterpretation of Horton's Law of Stream Numbers in terms of distributional rescaling

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Abstract. The Law of Stream Numbers, introduced in 1945 by Robert Horton, is one of the most extensively tested relationships in river basin hydrology. The law states that in the limit of large order, the ratio of the number of Strahler streams for consecutive orders converges to a constant, called the bifurcation ratio. The notion of Strahler order as a discrete indexing set is inherent in the definition of a stream.

Recent investigations provide evidence that distributions of topologic and geometric properties of river networks exhibit statistical simple scaling, with Strahler order as the appropriate scale parameter. Simple scaling of distributions implies that Horton laws are obeyed, and the rescaling factor is the appropriate Horton ratio.

For a large class of self-similar networks, the number of streams in a basin is fundamentally related to magnitude as indexed by Strahler order. While basin magnitude distributions can be estimated empirically, the number of streams in a given basin represents a single realization of a random sequence. For self-similar networks, the identity between number of streams and basin magnitude is used to understand Horton's law of stream numbers in terms of the distributional rescaling of basin magnitude with Strahler order playing the role of scale parameter. Empirically this prediction is tested through comparison of the bifurcation ratio to the Horton ratio for magnitude.