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Landscape dissection and network hydrology: Advancing the hydrologic implications of geomorphologic multiscaling

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The scaling structure of two distinctly different geomorphological attributes of landscapes (collectively characterizing the planform dissection and the vertical roughness of topography) is analyzed and interpreted in terms of hydrologic significance. First, the well-known width and area functions (characterizing the topology of channelized and unchannelized drainage paths) have been shown to exhibit significant deviation from simple scaling. The implication of this non-simple scaling for hydrology is a scale-dependent frequency of in-phase hillslope hydrographs contributing to the basin outlet through river network routing, suggesting the need for extending the IUH convolution framework to a scale-dependent framework for predicting hydrologic response. Second, a new quantity called river corridor width (RCW) function is introduced, defined as the lateral distance from the centerline of the river to the left and right valley walls at several heights above the water surface as one travels down the river. It depicts the roughness of the valley walls and contains more information about the pulse delivery to the channel than simply the frequency of occurrence of tributaries (and their sizes). RWC has been shown to exhibit multifractality which depends on the underlying valley forming processes. The high degree of intermittency in some valleys suggests a scale-dependent pdf of the lateral travel times to the river with consequences for the pdfs of the hillslope generated sediment.