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Impact of Fractal Dimension and Scaling Properties on the Ecohydrological Dynamics of Wetlandscapes

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Wetlands are ubiquitous and critical elements of the mosaic of aquatic habitats. The role of wetlands in the global ecohydrological and biogeochemical cycles is intimately tied to their structure. Here, we used the concepts of self-similarity and self-affinity to scrutinize morphology and size distribution of wetlands. We analyzed digital elevation models (DEMs) and implemented topographic depression search algorithms to identify wetlands in six 100 km^2 landscapes across the United States. The comparison between the output of these models and actual wetland data provided by the National Wetland Inventory (NWI) shows good agreement. Differences among wetlandscapes can be explained by the influence of local topography, geological history of the region and hydro-climatic forcing. For all the considered landscapes, the fractal dimension (D) of wetlands' shorelines varies within the theoretical range ($1<D<2$). This variation is of key importance from an ecological perspective since species are strongly associated with wetland edges during breeding and non-breeding seasons. Despite apparent variations, wetland size distribution can be described by the same Pareto power-law distribution. Such distribution constitutes the basic architecture of any wetland network, and, restoration efforts should focus on conserving the size distribution and spatial organization of individual wetland populations, which is the basic unit of metacommunity dynamics responsible for maintaining species diversity.