Water-controlled ecosystems as complex networks: Evaluation of network-based approaches to quantify patterns of connectivity

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June 14, 2023

Abstract

This study provides a new perspective on understanding the intricacies of water-mediated connectivity in ecosystems, bridging landscape ecology and geomorphology through network science. We highlight dryland and river floodplain ecosystems as distinct examples of contrasting water-controlled systems. We (1) discuss central considerations in developing Structural Connectivity (SC) and Functional Connectivity (FC) networks of water-mediated connectivity; (2) quantify the emergent patterns in these networks; and (3) evaluate the capacity of network science tools for investigating connectivity characteristics. Connectivity is quantified using seven parameters at both network and node levels. We find that Link Density, Betweenness Centrality, and Page Rank Centrality are highly sensitive to directionality; Global Efficiency and Degree Centrality are particularly sensitive to weights; while Relative Node Efficiency remains unaffected by weights and directions. Our study underscores the potential to transform how we quantify and understand water-mediated connectivity, especially in consideration of the role(s) of weights and directionality. This interdisciplinary review has implications for both theoretical insights and practical applications in environmental management and conservation efforts.

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