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Temporal Dynamics of Streamflow Using Complex Networks

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Modeling the dynamics of streamflow continues to be highly challenging. The present study proposes a new approach to study the temporal dynamics of streamflow. The approach couples the concepts of complex networks and chaos theory. Applications of the concepts of complex networks for studying streamflow dynamics have been gaining momentum in recent years. A key step in such applications is the construction of the network – a network is a set of points (nodes) connected by lines (links). The present study uses the concept of phase-space reconstruction, an essential first step in chaos theory-based methods, for network construction to study the temporal dynamics of streamflow. The phase-space reconstruction involves representation of a single-variable time series in a multi-dimensional phase space using delay embedding. The reconstructed phase space is treated as a network, with the reconstructed vectors (rather than the original time series) serving as the nodes and the connections between them serving as the links. With this network construction, the clustering coefficient of the individual nodes and the entire network is calculated to assess the node and network strengths. The approach is employed to a large number of streamflow time series observed in the United States. The results indicate the usefulness and effectiveness of the phase-space reconstruction-based approach for network construction. The implications of the outcomes for identification of the appropriate type and complexity of model as well as for classification of catchments are discussed.