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Temporal streamflow connections using nonlinear dynamics and complex networks

Nazly Yasmin (1) and Bellie Sivakumar (1,2)

(1) School of Civil and Environmental Engineering, The University of New South Wales, Sydney, Australia (n.yasmin@student.unsw.edu.au, s.bellie@unsw.edu.au), (2) Department of Land, Air and Water Resources, University of California, Davis, USA (sbellie@ucdavis.edu)

Adequate knowledge of temporal connections in streamflow dynamics is important for proper planning and management of our water resources. Time series analysis provides an important means to study the temporal dynamics of streamflow. Despite the development of numerous time series methods and their applications for streamflow, our understanding of its temporal dynamics remains inadequate. The present study offers an approach that combines the concepts of nonlinear dynamics and complex networks to examine the temporal connections in streamflow dynamics. First, a nonlinear embedding procedure is employed to reconstruct the single-variable time series in a multi-dimensional phase space to represent the underlying dynamics. Then, treating this reconstructed phase space as a 'network' (with the reconstructed vectors serving as 'nodes' and the connections between them serving as 'links'); several complex networks-based methods (e.g. strength distribution, clustering coefficient, degree distribution) are employed to identify some key properties. The approach is applied to test the properties of monthly streamflow dynamics at each of 639 streamflow- gaging stations in the contiguous United States. The implications of the outcomes for prediction of streamflow and for the development of a catchment classification framework are also discussed.