Complex networks for hydrologic modeling: The future

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Hydrologic systems are complex nonlinear dynamically-evolving systems, often made up of a large number of interconnected components that change both in space and in time. Unraveling the nature and extent of connections in hydrologic systems has always been a tremendous challenge. Despite the progress through the proposal and applications of numerous scientific concepts and mathematical methods, our understanding of connections in hydrologic systems remains inadequate. In this regard, modern developments in the field of complex systems science provide new avenues. One particular development is the science of complex networks. Applications of the concepts of complex networks are an emerging area of research in hydrology, with some early studies to examine the spatial and temporal connections in hydrologic systems and also to classify catchments. The outcomes of these preliminary applications are certainly encouraging.

The purpose of the present study is to highlight the future of the science of complex networks in hydrology. This is done through: (1) reviewing some key concepts of complex networks and their relevance to study both general and specific problems associated with hydrologic systems; (2) presenting new applications of such key concepts in hydrology, including for studying the spatio-temporal connections in hydrologic systems, identifying optimal hydrologic monitoring networks, downscaling global climate model outputs, and developing a catchment classification framework; and (3) providing specific directions to address future grand challenges in hydrology, especially those associated with the global scale.