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Network analysis applications in hydrology

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Applied network theory has seen pronounced expansion in recent years, in fields such as epidemiology, computer science, and sociology. Concurrent development of analytical methods and frameworks has increased possibilities and tools available to researchers seeking to apply network theory to a variety of problems. While water and nutrient fluxes through stream systems clearly demonstrate a directional network structure, the hydrological applications of network theory remain underexplored. This presentation covers a review of network applications in hydrology, followed by an overview of promising network analytical tools that potentially offer new insights into conceptual modeling of hydrologic systems, identifying behavioral transition zones in stream networks and thresholds of dynamical system response.
Network applications were tested along an urbanization gradient in Atlanta, Georgia, USA. Peachtree Creek and Proctor Creek. Peachtree Creek contains a nest of five longterm USGS streamflow and water quality gages, allowing network application of longterm flow statistics. The watershed spans a range of suburban and heavily urbanized conditions. Summary flow statistics and water quality metrics were analyzed using a suite of network analysis techniques, to test the conceptual modeling and predictive potential of the methodologies. Storm events and low flow dynamics during Summer 2016 were analyzed using multiple network approaches, with an emphasis on tomogravity methods. Results indicate that network theory approaches offer novel perspectives for understanding long term and eventbased hydrological data. Key future directions for network applications include 1) optimizing data collection, 2) identifying “hotspots” of contaminant and overland flow influx to stream systems, 3) defining process domains, and 4) analyzing dynamic connectivity of various system components, including groundwatersurface water interactions.