Assessment of Regional Variation in Streamflow Responses to Urbanization and the Persistence of Physiography

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Abstract

Aquatic ecosystems are sensitive to the modification of hydrologic regimes, experiencing declines in stream health as the streamflow regime is altered during urbanization. This study uses streamflow records to quantify the type and magnitude of hydrologic changes across urbanization gradients in nine U.S. cities (Atlanta, GA, Baltimore, MD, Boston, MA, Detroit, MI, Raleigh, NC, St. Paul, MN, Pittsburgh, PA, Phoenix, AZ, and Portland, OR) in two physiographic settings. Results indicate similar development trajectories among urbanization gradients, but heterogeneity in the type and magnitude of hydrologic responses to this apparently uniform urban pattern. Similar urban patterns did not confer similar hydrologic function. Study watersheds in landscapes with level slopes and high soil permeability had less frequent high-flow events, longer high-flow durations, lower flashiness response, and lower flow maxima compared to similarly developed watersheds in landscape with steep slopes and low soil permeability. Our results suggest that physical characteristics associated with level topography and high water-storage capacity buffer the severity of hydrologic changes associated with urbanization. Urbanization overlain upon a diverse set of physical templates creates multiple pathways toward hydrologic impairment; therefore, we caution against the use of the urban homogenization framework in examining geophysically dominated processes.

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