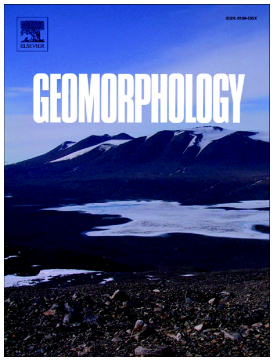

The scaling of urban surface water abundance and impairment with city size

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The scaling of urban surface water abundance and impairment with city size

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Abstract

Urbanization alters surface water compared to nonurban landscapes, yet little is known regarding how basic aquatic ecosystem characteristics, such as the abundance and impairment of surface water, differs with population size or regional context. This study examined the abundance, scaling, and impairment of surface water by quantifying the stream length, water body area, and impaired stream length for 3520 cities in the United States with populations from 2500 to 18 million. Stream length, water body area, and impaired stream length were quantified using the National Hydrography Dataset and the EPA's 303(d) list. These metrics were scaled with population and city area using single and piecewise power-law models and related to biophysical factors (precipitation, topography) and land cover. Results show that abundance of stream length and water body area in cities actually increases with city area; however, the per person abundance decreases with population size. Relative to population, impaired stream length did not increase until city populations were >25,000 people, then scaled linearly with population. Some variation in abundance and impairment was explained by biophysical context and land cover. Development intensity correlated with stream density and impairment; however, those relationships depended on the orientation of the land covers. When high intensity development occupied the local elevation highs (+15 m) and undeveloped land the elevation lows, the percentage of impaired streams was less than the opposite land cover orientation (-15 m) or very flat land. These results show that surface water abundance and impairment across contiguous US cities is influenced by city size and by biophysical setting interacting with land cover intensity.

Keywords: urban streams; urban water bodies; power-law scaling; impaired streams