Long-term effects of urbanization on the flow rates and durations of small streams in southern California

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Abstract. Fifty-two U.S. Geological Survey gauges with records greater than ~20 yrs. and watersheds less than ~250 km^2 were used to empirically model the effects of urbanization on small free-flowing streams in southern California. The gauged watersheds span a gradient of urban development and ranged from 0 - 23% imperviousness in 2001. Urbanization emerged from an expansive array of geographic information system-derived hydrologic variables as a statistically significant ($p < 0.05$) predictor of instantaneous peak flow rates at the 1, 1.5, and 2-year recurrence intervals. Urbanization proved less significant for higher flows (e.g., $p < 0.20$ for 5-year flows). Most importantly with respect to geomorphic response, urbanization extent was a significant predictor of the magnitude (coefficient) and shape (exponent) of the duration density functions (DDFs) of the gauge records. DDFs are conceptually similar to probability density functions and were fit as power functions ($r^2 > 0.9$) to days of occurrence versus logarithmically binned discrete discharges to represent the entire record of daily mean flows greater than some nominal value (e.g. 0.03-0.3 m^3/s depending on watershed size). For a particular drainage area and climatic setting, urbanization results in proportionally longer durations of geomorphically effective flows. Increased duration of sediment transporting flows is a primary driver of accelerated changes in channel form that are often concurrent with urbanization throughout southern California.

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