What urban streamflow can tell us about changes in water storage and streamflow due to development

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The urbanization of a watershed radically impacts how watersheds store, transmit and discharge water. Although urbanization's effects on floods, droughts, and water supply have been explored in recent decades through land-use modeling, hydrological modeling, remote sensing, and empirical approaches, clarification of these effects remains a challenge due to limited availability and accessibility of useful data. Streamflow records for three neighboring watersheds in Baltimore, an urbanized watershed, an urbanizing watershed and a natural watershed, provide a unique opportunity to study the influence of urbanization on watershed function. The 5-minute instantaneous discharge records span an increase in residential development of the urbanizing watershed. Coupling the streamflow and development records allows direct comparison of hydrologic changes with spatial patterns of land use change. Recession analysis was used to evaluate altered hydrologic response, particularly relationships between watershed storage and streamflow that may occur during urbanization. Recession approaches were applied using variable time steps to estimate the time derivative of streamflow (dQ/dt) to avoid known issues in parameter estimation driven by the time derivative of a noisy time series. Several hypotheses are tested, including comparisons to conceptual models of hydrologic change that would be expected in urbanizing watersheds. Preliminary results suggest that hydrologic changes are notable during periods of intense development, with recession plot characteristics markedly variable in urbanizing and urban watersheds as compared to the natural watershed. Analysis of streamflow records during the process of urbanization reveals groundwater-surface water interactions driven by urban development previously only observed over relatively shorter time periods. These findings can inform implementation of sustainable design of storm water management and future development planning.

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