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Hydrologic versus geomorphic drivers of trends in flood hazard

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Flooding is a major threat to lives and infrastructure, yet trends in flood hazard are poorly understood. The capacity of river channels to convey flood flows is typically assumed to be stationary, so changes in flood frequency are thought to be driven primarily by trends in streamflow. However, changes in channel capacity will also modify flood hazard, even if the flow frequency distribution does not change.

We developed new methods for separately quantifying how trends in both streamflow and channel capacity have affected flood frequency at gauging sites across the United States. Using daily discharge records and manual field measurements of channel cross-sectional geometry for USGS gauging stations that have defined flood stages (water levels), we present novel methods for measuring long-term trends in channel capacity of gauged rivers, and for quantifying how they affect overbank flood frequency. We apply these methods to 401 U.S. rivers and detect measurable trends in flood hazard linked to changes in channel capacity and/or the frequency of high flows.

Flood frequency is generally nonstationary across these 401 U.S. rivers, with increasing flood hazard at a statistically significant majority of sites. Changes in flood hazard driven by channel capacity are smaller, but more numerous, than those driven by streamflow, with a slight tendency to compensate for streamflow changes. Our results demonstrate that accurately quantifying changes in flood hazard requires accounting separately for trends in both streamflow and channel capacity, or using water levels directly. They also show that channel capacity trends may have unforeseen consequences for flood management and for estimating flood insurance costs.

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