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Peak Streamflow Trends and Their Relation to Changes in Climate in Illinois, Iowa, Michigan, Minnesota, Missouri, Montana, North Dakota, South Dakota, and Wisconsin

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Abstract

Flood-frequency analysis, also called peak-flow frequency or flood-flow frequency analysis, is essential to water resources management applications including critical structure design and floodplain mapping. Federal guidelines for doing flood-frequency analyses are presented in a U.S. Geological Survey Techniques and Methods report known as Bulletin 17C. A basic assumption within Bulletin 17C is that for drainage basins without major hydrologic alterations, statistical properties of the distribution of annual peak streamflows (peak flows) are stationary; that is, the mean, variance, and skew are constant. The stationarity assumption has been widely accepted within the flood-frequency community; however, a better understanding of long-term climatic persistence and concerns about potential climate change and land-use change has caused a reexamination of the stationarity assumption. This work is part of that reexamination.

The stationarity assumption is a concern because flood-frequency analyses that do not incorporate observed trends and abrupt changes may result in a poor representation of the true flood risk. Bulletin 17C does not offer guidance for incorporating nonstationarities when estimating floods, and it describes a need for studies that incorporate changing climate or basin characteristics. In response to this need and a history of concern regarding nonstationarity peak flows in the region, this study was done to assess potential nonstationarity in peak flows in the north-central United States.

This report summarizes the methods used to detect hydroclimatic changes in peak-flow data in the study region. Four periods were selected for analysis of peak flow, daily streamflow, and climate data. The periods are (1) a 100-year period, 1921–2020; (2) a 75-year period, 1946–2020; (3) a 50-year period, 1971–2020; and (4) a 30-year period, 1991–2020. The starting point for these analyses was the initial data analysis of peak flow described in Bulletin 17C, which includes plotting the peak flow and checking for autocorrelation, monotonic trends, and changes points. Analyses were added to examine additional features in the data. Results are provided in a U.S. Geological Survey data release. The study limitations are documented for users of the results.

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