Study finds timing of rainfall crucial for flood prediction

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Credit: University of Colorado at Boulder

With record rainfall projected to continue into the future, many worry extreme flooding will follow suit. But a new CIRES-led study published today in *Science of the Total Environment* found an increase in precipitation alone won't necessarily increase disastrous flooding—instead, flood risk depends on how many days have passed between storms.

In the study, CIRES Fellow and Western Water Assessment director Ben Livneh and his colleagues, including CIRES Fellow Kris Karnauskas, looked for a new way to understand soil moisture and how it impacts

flooding. The research team knew soil moisture is important when understanding floods, but measuring soils effectively is challenging.

So they found a proxy for soil moisture: precipitation intermittency, the length of a dry spell between precipitation events. Simply put: after a prolonged time since the last rain, it takes a larger storm to generate flooding; with fewer days between storms, a wider range of conditions can lead to flooding.

"We can actually understand changes in flood risk based on the number of days since the last rain event," Livneh said. "We wanted to make it straightforward because soil water is hard to predict."

The research focused on semi-arid and arid regions and looked at rain as a form of precipitation rather than snow. To create a value for precipitation intermittency, researchers looked at historical observations of 108 watersheds around the U.S. from 1950–2022. Through analysis of these observations, the goal was to understand whether wet or dry soils preceded heavy rain events—and how that influenced floods.

Soil moisture is notoriously difficult to estimate or simulate, results can vary from one person's backyard to their front yard, and understanding how soil moisture influences flood events is even harder. Nels Bjarke, a Western Water Assessment postdoctoral researcher, ran the analysis for the study.

"We don't have comprehensive observations of soil moisture that are continuous over space or continuous through time," said Bjarke. "Therefore, it can be difficult to apply some sort of predictive framework for flooding using just soil moisture because the data are sparse."

Yet, precipitation is widely measured, so the team tested precipitation as

a proxy for soil moisture by looking at the timing of rain, rather than the amount.

Through analysis, the team created a timescale as a meaningful value for precipitation intermittency. They categorized intermittency into segments of five days. Ten days or less indicated low intermittency, when a high range of storms could produce floods.

Drier periods with 20 days or more between storms defined high intermittency, and only serious storms could produce floods. Overall, flood probabilities are 30% lower following long periods of dry spells.

The 2013 floods in Boulder are a real-life example of how precipitation intermittency is applied to flood projections. Seven days of heavy rain nearly doubled the previous record for rainfall. The event displaced hundreds and caused $2 billion in property damage, according to NOAA.

Forecasters and emergency managers could use the paper's findings to anticipate very real flooding risks. Since wide-ranging observations of precipitation exist, forecasters can take the findings of this paper and use intermittency to help predict the likelihood of a flood.

"As we enter the era of big data, we can benefit from simple proxies like the dry-spell length as a way to more intuitively understand extreme events," said Livneh.

More information: Ben Livneh et al, Can precipitation intermittency predict flooding?, *Science of The Total Environment* (2024). DOI: 10.1016/j.scitotenv.2024.173824

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