

Traditional infrastructure design often makes extreme flooding events worse, researchers find

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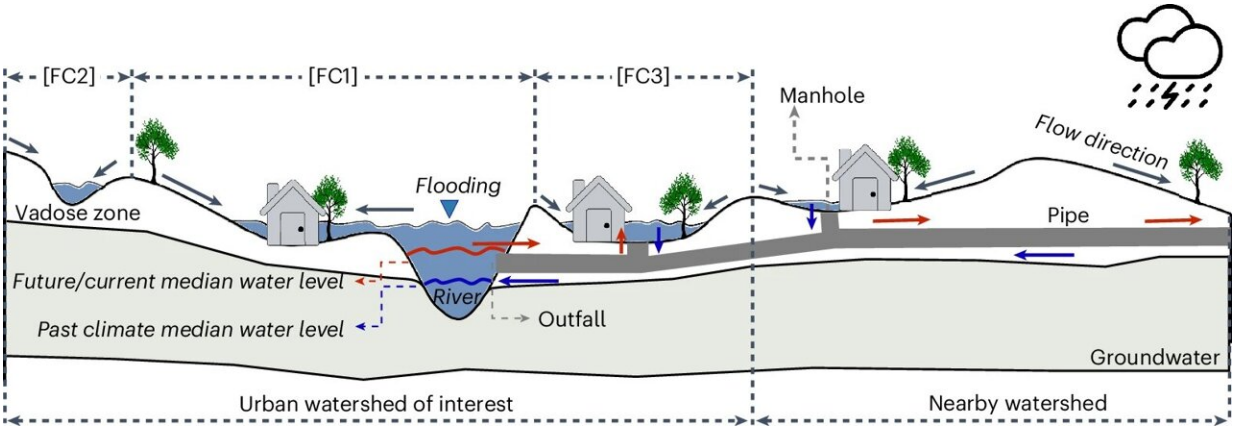


Illustration of key urban flooding concepts. Credit: *Nature Cities* (2024). DOI: 10.1038/s44284-024-00116-7

Much of the nation's stormwater infrastructure, designed decades to a century ago to prevent floods, can exacerbate flooding during the severe weather events that are increasing around the globe, new research led by the University of Michigan demonstrates.

The problem lies in traditional planning's failure to recognize flood connectivity: how [surface runoff](#) from driveways, lawns and streets—and the flows in [river channels](#) and pipes—are all interlinked.

The result is interactions, often unanticipated, between different stormwater systems that can make flooding worse.

"When we [design](#), we typically focus on localized solutions," said Valeriy Ivanov, U-M professor of civil and environmental engineering and co-first author of the study [published](#) in *Nature Cities*. "We have an area of concern, sometimes it's a single plot of land, or a set of parcels that need to be connected by stormwater infrastructure, and we design specifically for those areas.

"But those areas are impacted by flooding that occurs around them, and that means designed stormwater infrastructure may have unintended consequences."

The study is based on record-breaking rainfall that hit Metro Detroit on Aug. 11, 2014, resulting in flooding across the region. The disaster closed highways, stranded drivers, and caused power outages and property damage to over 100,000 homes, with a cost of \$1.8 billion. Researchers analyzed data from that event, particularly from the city of Warren, and placed their findings in the context of current U.S. stormwater design standards and flood warning practices to develop policy recommendations.

Those include:

- Stormwater system designs should take a holistic, systemwide approach to flood mitigation, rather than the conventional approach focused on local solutions.
- Design guidelines for stormwater systems should be revised to consider connectivity in [urban landscapes](#), including flows in subsurface infrastructure such as pipes and sewers, open channel flows such as rivers and streams, and overland flows over natural and built surfaces.

- Advanced computer models that represent the full spectrum of stormwater elements and the behavior of water in them should be mandated.
- Design scenarios should represent the diverse spectrum of factors that control [water flow](#) in urban areas, such as complex rainfall patterns, antecedent soil water conditions, and the operation of existing [stormwater](#) drainage systems.
- Flood hazard mapping approaches should expand their focus beyond river-adjacent floodplains to include risks in urban areas that may be far from permanent bodies of water.

"Current flood mapping practices are indicative of outdated thinking that needs to change," said Vinh Tran, U-M assistant research scientist in civil and [environmental engineering](#) and co-first author. "Whether it's the Federal Emergency Management Agency or someone else producing it, they only provide estimates for floodplains that are near rivers. But here's the problem: In cities, flooding can happen far from any river or stream.

"Take Warren, Michigan, for example. The official flood maps didn't show [flood](#) risks in parts of the city that were miles from any major waterway. And it's not just Warren—this is typical all over the country."

According to FEMA, flooding is "the most common and costly disaster in the U.S." That risk is increasing due to climate change.

Financially, it's a problem. FEMA notes that between 1980 and 2000, FEMA's National Flood Insurance Program paid out \$9.4 billion in insurance claims. Over the following 20-year period, the program paid out \$62.2 billion—an increase of over 660%.

"Without updated designs, the economic impact of flooding will only grow, placing a heavier burden on governments and taxpayers," said Jeff

Bednar, environmental resources manager for Macomb County and a research contributor on the project. "By investing in resilient infrastructure now, we not only protect our environment but also strengthen the foundation for economic growth."

More information: Vinh Ngoc Tran et al, Connectivity in urbanscapes can cause unintended flood impacts from stormwater systems, *Nature Cities* (2024). [DOI: 10.1038/s44284-024-00116-7](https://doi.org/10.1038/s44284-024-00116-7)

Provided by University of Michigan

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