

Preventing urban flooding in the face of climate change

April 4 2023, by Michael Miller



University of Cincinnati doctoral student Man Qi is studying ways to prevent flooding in cities. Credit: Andrew Higley

Planners have come up with many innovative ways to prevent flooding caused by heavy downpours—from planting rain gardens to installing

green roofs.

But in many cases, nothing works quite as well as a simple hole in the ground—a detention basin.

That's the finding of an analysis by University of Cincinnati geography students in a research collaboration with the Hamilton County Conservation District.

Lead author and UC College of Arts and Sciences doctoral student Man Qi said cities are developing new ways to trap rainwater and direct it where it's most wanted, especially during droughts. They call these low-impact development practices, which include innovations such as permeable pavement that allows rainwater to seep into the ground instead of diverting it elsewhere.

Another innovation is a bioretention cell composed of ornamental or landscaping plants atop soil specially designed to drain quickly spread over a thick bed of gravel that does likewise. This soaks up large volumes of rain without creating standing pools of open water.

New commercial or housing developments typically must prevent [rainwater](#) from spilling out to other neighboring properties or roads. Hard surfaces like buildings and [parking lots](#) can't absorb [heavy rains](#) so planners must collect or divert the water to prevent property damage.

"A detention pond is a common practice," Qi said. "It temporarily stores the water and releases it into the air or the groundwater or nearby streams at a low rate to reduce the risk of flooding. It also provides some ecological benefits."



The Civic Garden Center of Greater Cincinnati features a green roof that helps collect rainwater. Credit: Andrew Higley

Qi worked with the Hamilton County conservation district to measure the effectiveness of flood-prevention techniques such as detention basins and bioretention cells under five scenarios.

Qi presented their results at the annual American Association of Geographers' conference in Denver.

"In residential areas where the impervious area is less than 40%, low-impact development practices are better. But if 70% or more of the [ground surface](#) is impervious, it's best to put in detention basins," Qi said. "The [flood risk](#) can be greatly reduced."

Climate change is expected to increase both the frequency and severity of rainstorms, which means making deliberate plans for drainage will become even more important in cities, said Professor Lin Liu, a study co-author and co-director of UC's Joint Center of GIS and Spatial Analysis.

With their hard reflective surfaces, cities tend to trap heat, raising the ambient temperature by as much as 7 degrees during the day. This urban heat island effect can provide more energy for damaging storms, Liu said.

"Global warming and [urban sprawl](#) have contributed to [extreme weather](#)," he said. "Coupled with the [urban heat island effect](#) many metropolitan cities have experienced more extreme precipitation events. As a result, urban flooding has become an increasing threat to the loss of human life and property damage in many cities around the globe."

"You can see the extreme rainfalls happen more frequently," Qi added. "Intense, heavy rains could inundate networks designed to prevent flooding and the capacity of drainage networks could fail because they simply can't hold that much stormwater."



The Civic Garden Center of Greater Cincinnati features a green roof that helps collect rainwater. Credit: Andrew Higley

The issue of urban flooding became real for Qi in 2021 when her sister's home was inundated by floodwaters in China's Zhengzhou City. More than 10 million people were affected by the disaster, which was one of the most severe floods in the city's history. As much rain fell in a single day as the city sometimes sees in an entire year.

"My sister's family was badly affected by the flooding. The water flooded their garage. Their cars were underwater," she said. "It was very scary."

The flood killed nearly 400 people and caused \$10 billion in property

damage.

Qi said flooding disproportionately affects lower-income residents who don't have the resources to recover as quickly from a disaster.

Flood insurers create maps around these once-in-a-century disasters. But because of [climate change](#), they are happening more frequently, Qi said.

"Floods affect roads and infrastructure and interrupt society," Qi said. "Schools are closed. Businesses are closed. The impacts are widespread."

Provided by University of Cincinnati

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