Urban floods intensifying, countryside drying up

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Professor Ashish Sharma and Dr. Conrad Wasko at UNSW. Credit: Quentin Jones/UNSW

An exhaustive global analysis of rainfall and rivers shows signs of a radical shift in streamflow patterns, with more intense flooding in cities

and smaller catchments coupled with a drier countryside.

Drier soils and reduced water flow in rural areas - but more intense rainfall that overwhelms infrastructure and causes flooding and stormwater overflow in urban centres. That's the finding of an exhaustive study of the world's river systems, based on data collected from more than 43,000 rainfall stations and 5,300 river monitoring sites across 160 countries.

The study, by engineers at University of New South Wales in Sydney and which appears in the latest issue of the journal *Scientific Reports*, explored how rising local temperatures due to climate change might be affecting river flows.

As expected, it found warmer temperatures lead to more intense storms, which makes sense: a warming atmosphere means warmer air, and warmer air can store more moisture. So when the rains do come, there is a lot more water in the air to fall, and hence, rainfall is more intense.

But there's been a growing puzzle: why is flooding not increasing at the same rate as the higher rainfall?

The answer turned out to be the other facet of rising temperatures: more evaporation from moist soils is causing them to become drier before any new rain occurs - moist soils that are needed in rural areas to sustain vegetation and livestock. Meanwhile, small catchments and urban areas, where there are limited expanses of soil to capture and retain moisture, the same intense downpours become equally intense floods, overwhelming stormwater infrastructure and disrupting life.

"Once we sorted through the masses of data, this pattern was very clear," said Ashish Sharma, a professor of hydrology at UNSW's School of Civil and Environmental Engineering. "The fact that we relied on

observed flow and rainfall data from across the world, instead of uncertain model simulations, means we are seeing a real-world effect - one that was not at all apparent before."

"It's a double whammy," said Conrad Wasko, lead author of the paper and postdoctoral fellow at UNSW's Water Research Centre. "People are increasingly migrating to cities, where flooding is getting worse. At the same time, we need adequate flows in rural areas to sustain the agriculture to supply these burgeoning urban populations".

Global flood damage cost more than US$50 billion in 2013; this is expected to more than double in the next 20 years as extreme storms and rainfall intensify and growing numbers of people move into urban centres. Meanwhile, global population over the next 20 years is forecast to rise another 23% from today's 7.3 billion to 9 billion - requiring added productivity and hence greater water security. The reduction in flows noted by this study makes this an even bigger challenge than before.

"We need to adapt to this emerging reality," said Sharma. "We may need to do what was done to make previously uninhabitable places liveable: engineer catchments to ensure stable and controlled access to water. Places such as California, or much of the Netherlands, thrive due to extensive civil engineering. Perhaps a similar effort is needed to deal with the consequences of a changing climate as we enter an era where water availability is not as reliable as before."

"Climate change keeps delivering us unpleasant surprises," said Mark Hoffman, UNSW's Dean of Engineering. "Nevertheless, as engineers, our role is to identify the problem and develop solutions. Knowing the problem is often half the battle, and this study has definitely identified a major one."

Rainfall data used in the study was collected from the Global Historical

Climatology Network, which contains records from over 100,000 weather stations in 180 countries and is managed by the U.S. National Oceanic and Atmospheric Administration. River flow data came from the Global Runoff Database, run by Germany's Federal Institute of Hydrology, which relies on river discharge information collected daily or monthly from more than 9,300 stations in 160 countries.

More information: Conrad Wasko et al, Global assessment of flood and storm extremes with increased temperatures, *Scientific Reports* (2017). DOI: 10.1038/s41598-017-08481-1

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