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Could ‘Sponge Cities’ Help Us Prepare For Our Flooded Future?

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Science

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Extreme weather, a changing climate, and impervious streets and roads have combined to create an urban disaster

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The past month has seen some of the worst flooding news in decades. Headlines like ‘Death toll rises and thousands flee homes as floods hit China, ‘Flagstaff declares state of emergency as devastating floods hit Arizona’, and ‘Scores Die in India as Monsoon Rains Swamp Towns and Send Boulders Tumbling’, all underscore the urgency of our climate emergency. And recent videos from cities in Belgium, Germany and the Philippines, in addition to London, New York, Zhengzhou, and Wellington, play out a worryingly-familiar scene – urban landscapes submerged in flood waters; their critical infrastructure rendered useless.

While many of these news-making events have been driven by extreme weather events, the form and fabric of cities contribute significantly to their impact. The first thing to consider is that the overwhelming majority of cities sit on or near water. The Thames might be the river that most people associate with London, but in reality, it’s just the only one that hasn’t been hidden under centuries of urban development. *“London, before we built over it, was a pretty watery place”,* said Sophie Jackson, from the Museum of London Archaeology. Most urban areas use floodbanks, reservoirs, barriers and dams to

contain their waterways, and to defend against rising water levels, but such efforts are increasingly being seen as a last line of defense. And climate change is pushing many beyond their design scope. The Thames Barrier has been closed 199 times since it became operational in 1982. 160 of those closures have happened since the turn of the millennium. Speaking to *The Developer*, architect Asif Din said, *"The 500-year storm has become a one-in-20-year occurrence or even less. London will flood and when it happens, it will be dramatic."*

And if a river breaks its banks, or a sudden rainstorm dumps huge quantities of water onto a city, where does it go? The standard concrete and tarmac surfaces that dominate modern cityscapes are impervious to water – it flows along these surfaces, rather than being absorbed into them. In many cases, floodwater finds its way into storm drains. These underground networks of pipes redirect it elsewhere, typically to an existing waterway (e.g. canal or ocean) or temporarily to a designated storage well. But such systems can be – and often are – overwhelmed. Take the city of Taipei, which in June, experienced 129 mm of rain in a single day. The capacity of its drains? Just 78.8 mm. Widespread flooding resulted. Stormwater can also mix with wastewater and other pollutants during such events. For those living in low-lying communities, the health implications of flooding can be dire.

All of this has seen cities begin to re-imagine their relationship with water – a growing number are, in particular, investing in new ways to manage stormwater.

Rotterdam is home to a particularly creative approach to water management. Known as Benthemplein, it was the city's first the water square – an outdoor public space that

doubles up as flood-proofing. On dry days, its two shallow basins act as a skate park and a performance space. The deepest pit is a dedicated sports area, marked out for football, volleyball and basketball. The wide steps and pathways that surround and connect the pits are designed for sitting and socializing. But when it rains, the square is transformed. A series of spouts and gutters guide the water into the shallow basins. If they fill up, the water is then discharged into the deeper pit. Altogether, Benthemplein can hold up to 1.7 million liters (~ 449,000 US gallons) of water. Once the wet weather has passed, the water is then allowed to drain into the underlying soil, or is pumped to a nearby canal for treatment. As one of its designers, Dirk van Peijpe, has said, *“The critical point is that none of the water goes into the sewers.”*

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As successful as that project has been, van Peijpe and many others have started to look beyond it. Rather than just designing systems that allow the water to drain away slowly and stably, they want to harvest and reuse it. This approach to urban design – where water is held in place to be called-upon when needed – is known as the ‘sponge city’, and it is rapidly growing in popularity.

The Nakaohe wetland park in Nanning of south China's Guangxi Zhuang Autonomous Region is an example ... [+] XINHUA NEWS AGENCY/GETTY IMAGES

In Green Square, a locality in the inner-east of Sydney, up to 320 million liters of polluted stormwater can be treated via ultrafiltration (to remove solids and pathogens) and reverse osmosis (to remove salts and other minerals) before being stored in huge underground tanks. From there, it is piped into residential, commercial and community buildings and facilities, for reuse. It fills washing machines, flushes toilets, or irrigates the neighborhood’s parks, sports grounds, and gardens.

Since 2014, China has also been adopting and adapting sponge city design principles. The country’s pace of urbanization is unparalleled – the proportion of China’s population living in cities has more than doubled in just 25 years (from 26.4 % in 1990 to 56.1 % in

2015), which put huge pressure on land use and water supplies. Now, 98 % of its major cities are exposed to frequent flooding and water-logging. As part of a government scheme, 30 cities have constructed (or restored) wetlands, installed green roofs, increased tree cover and incorporated permeable pavements. The goal is for *"70% of rainwater [to]... be soaked into the underground instead of...discharged into the nearest rivers and lakes."*

Permeable (or porous) pavements, which allow rainwater to trickle slowly through them and into the underlying soils, have been around for many years, and are in use in cities across Europe and the US. Designed to look like typical construction materials, they're popular because they provide much of the same functionality as traditional pavers – they're strong and solid, and they look familiar. But many sponge city approaches are decidedly more green than grey.

Natural and constructed wetlands not only give surplus water somewhere to go, the aquatic plants that fill them filter that water, cleaning it in the process. They can also be a haven for biodiversity, but in that regard, natural wetlands greatly outperform anything we can engineer. In some cases, green roofs and living walls can contribute to city's water management plan, as well as planting more native trees, protecting existing forested land, and establishing new green spaces within the concrete jungle. This last approach is sometimes described as 'de-paving' – literally digging up existing pavement and tarmac to create more porous, greener streets. This could be as small-scale as replacing a patch of concrete in front of your home with some wildflowers. But in numerous cities, much larger-scale efforts are underway – e.g. replacing the concrete of a school playground with

soft grass pitches, or, as is happening in Barcelona, closing off entire neighborhood blocks to through-traffic and turning some of their paved streets into planted parks.

Earlier this month, 31 cities signed up to the Urban Nature Declaration – a program led by C40 Cities that aims to *"establish ambitious nature targets to achieve climate resilience and create an agenda for people and nature to support one another."* Signatories, including Seattle, Guadalajara, and Tokyo, have committed to take one of two 'pathways'. By 2030, they'll have transformed 30-40 % of their *"total built-up city surface area"* to green or permeable surfaces, or they'll have ensured that 70 % of the city population *"has access to a fit-for-purpose green or blue space within 15 minutes [on foot]."*

How successful could these approaches be? Well, as with most things, it depends on a whole host of factors. In 2020, researchers looked at a densely-urbanized 15 km^2 area in the center of Melbourne. Using data from a historic flood that hit the area, they modeled the impact that different green infrastructure could have. When rainwater capture, green roofs, permeable paving, tree planting and enhanced water storage were all implemented across the catchment, the mean peak flood depth was reduced by up to 50%. With the exclusion of rainwater capture – which could remove all flooding in small pockets of the city – none of the interventions alone were effective against the floodwater.

Even well-designed systems can be overwhelmed. Speaking to Reuters earlier this month after devastating floods hit Zhengzhou, Faith Chan, associate professor at the University of Nottingham Ningbo, said that its *"sponge city measures are designed to cope with about 180-200 mm of rain in 24 hours."* A staggering 201.9 mm of rain fell in a single

hour on Tuesday 20th July. Zhengzhou’s spongy water management system was powerless against the deluge.

The reality is that green and sponge infrastructure are not a magic bullet against urban flooding. But as part of a much bigger, more systematic effort – one that includes smarter, more sustainable planning decisions, as well as a more equitable approach to urban design – they can help. If we really want to reduce flooding, we have to stop screwing with our climate.

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Laurie Winkless

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