

Heatwave resilience



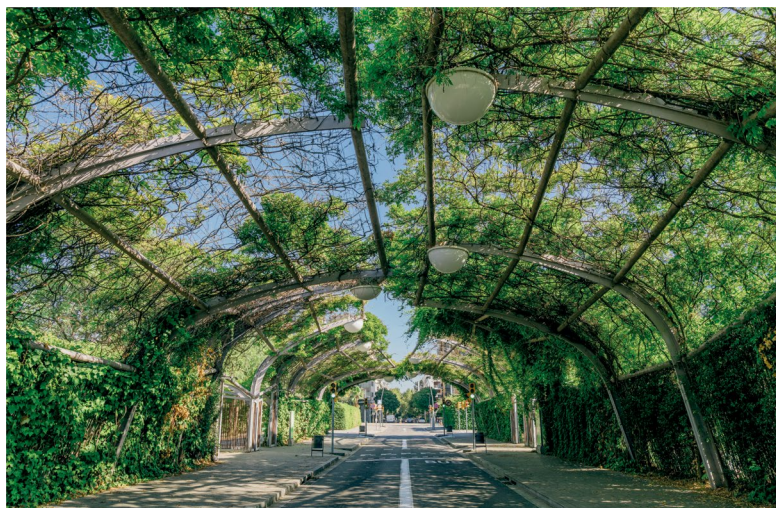
Climate change together with the recent onset of El Niño this year has led to widespread heatwaves. As these events become increasingly commonplace, cities around the world urgently need to build resilience to heat.

July 2023 was the hottest month ever recorded, and by a substantial margin, with the global average hitting around 1.5 °C above pre-industrial temperatures¹. As global temperatures have soared, regional heatwaves have been severe. China set a new national record when the temperature hit 52.2 °C in Xinjiang's Turpan Depression². Meanwhile, large portions of the USA have been experiencing extreme heat, with water off the coast of Florida reaching the temperature of a hot tub, raising concerns for marine ecosystems. Heat-related hospitalizations also spiked in southern Europe as high temperatures lingered for weeks.

The recent surge in temperature is likely due to a combination of ongoing anthropogenic climate change and the transition to El Niño conditions in the Pacific Ocean³. El Niño events arise through a natural cycle of climate variability during which warm water periodically builds up in the central and eastern Pacific approximately every 2–7 years. El Niño conditions are associated with higher global surface temperature and can have substantial impacts on regional weather systems. While El Niño events are a normal part of climate variability, the heat experienced in recent months is unprecedented.

Attribution analysis performed on the 2023 heatwaves suggests that the heat experienced in China would have been a 1-in-250-year event in the absence of human-induced climate change, and the extremes seen in the USA virtually impossible⁴. Instead, in today's modified climate, we can expect similar events in China approximately every 5 years, and in the USA every 15 years⁴. The heatwaves of the past few months are no longer rare and should be considered the new normal.

The impacts of heatwaves can be particularly severe in cities where extreme temperatures are exacerbated by urban heat island effects. The abundance of heat-absorbing surfaces,



A green tunnel helps to cool the streets of Barcelona.

such as asphalt, can greatly enhance surface temperature, particularly at night. Exposure to heatwaves in cities is expected to rise substantially during the rest of the century, even with widespread mitigation of greenhouse gas emissions⁵. This poses a major threat to human health. Many cities around the world are poorly equipped to deal with such heat, and as a result, heatwave events can lead to considerable excess mortality⁶. It's vital that measures to enhance extreme heat resilience are incorporated into city design across the globe.

A variety of strategies are being explored to cool cities, such as painting roofs white to reflect more solar radiation or switching to building materials that absorb less radiation. One of the most promising approaches is increasing green spaces. Urban trees, in particular, can lead to cooling through a combination of shading, transpiration and changes to surface albedo. The effect can be striking, with a study of European cities showing that urban trees can lower surface temperature by up to 12 °C (ref. 7). However, the magnitude of the cooling is highly variable across different locations and temperature regimes⁷. Understanding the regional dependencies and effectiveness of strategies to mitigate extreme urban heat is crucial for implementing the most beneficial policies in a given city.

The importance of green spaces in mitigating extreme urban heat further exposes the

inequalities evident in many cities, with many parks and spacious gardens concentrated in more affluent areas. For example, the legacy of discriminatory housing practices in some US cities may be responsible for differences in urban heat of up to 7 °C between neighbourhoods⁸. Future adaptation strategies need to be implemented equitably if they are to serve the whole community. Adaptation plans for cities are improving in some regions, but they remain inadequate⁹. In particular, small and medium sized cities, and areas that lack sufficient resources, are likely to fall behind. The recent surge in extreme heat events highlights the challenges that cities will need to face to ensure the welfare of their inhabitants.

Published online: 7 September 2023

References

1. July 2023 confirmed as hottest month on record. *World Meteorological Organization* <https://go.nature.com/3KSZPUF> (2023).
2. China logs 52.2 Celsius as extreme weather rewrites records. *Reuters* <https://go.nature.com/3qQGwnQ> (2023).
3. Tollefson, J. *Nature* **620**, 703–704 (2023).
4. Zachariah, M. et al. *Extreme Heat in North America, Europe and China in July 2023 Made Much More Likely by Climate Change* (Imperial College London, 2023).
5. Chen, M. et al. *npj Urban Sustain.* **3**, 38 (2023).
6. Ballester, J. et al. *Nat. Med.* **29**, 1857–1866 (2023).
7. Schwaab, J. et al. *Nat. Commun.* **12**, 6763 (2021).
8. Hoffman, J. S., Shandas, V. & Pendleton, N. *Climate* **8**, 12 (2020).
9. Reckien, D. et al. *npj Urban Sustain.* **3**, 13 (2023).