VIEWpoint 新观点

City heatwaves: climate change & human heat stress

Briefing Note

A briefing on research from the Climate Science for Service Partnership (CSSP) China for decision-makers in China No. 05

More than half the world's population live in cities and 80% of global GDP is generated in cities (World Bank, 2020) so supporting city lives, livelihoods and living conditions has a comprehensive benefit.

The increase in near-surface air temperature in China has been faster than the global rate (Wang et al., 2019). Analysis has shown that on average the frequency, duration and intensity of heatwaves in Central Asia have increased significantly from 1917-2016, with enhanced rates during the last 50 years (Yu et al., 2020). At the same time, urban residents face higher health risks because urban heat islands exacerbate heatwave conditions (Sun et al., 2016).

Heatwave Impacts

In the 2017 heatwave affecting Central Eastern China, Shanghai reached a new high of 40.9°C in a 145-year record and the number of heat-related hospitalisations broke the historic record in Shenyang (Chen et al., 2019). In 2018 over Northeast China there were 33 days of consecutive high temperature warnings >35°C issued (Ren et al., 2020). Both research papers found anthropogenic warming has significantly increased the frequency of these extreme events.

An important impact of city heatwaves is human heat stress. Annual heat-related mortality in China between 1986-2005 was 32.1 people per million inhabitants. Under climate change, this figure can be expected to approximately double for a global average of 2°C warming and could increase further without targeted intervention (Wang et al., 2019). Furthermore, a global study of heat-related work productivity loss has been shown to reduce GDP per person (Yu et al., 2019); for an average global surface temperature increase of 2°C the corresponding work productivity loss was 12 days for developed countries and 31 for developing countries.

Cities themselves contribute to the heat problem. Increasing urban extent increases maximum temperatures within the city and can even impact downwind cities (Huang et al., 2019). Air conditioning to cool the inside of buildings makes the outside hotter through waste heat. This feedback increases human heat stress, especially at night, and may counteract heat mitigation measures (Takane et al., 2020).

Key findings

- The frequency, duration and intensity of heatwaves have significantly increased from 1917 to 2016, with enhanced rates during the last 50 years (Yu et al., 2020)
- Whilst the increase in the magnitude of extremes is close to linear under climate change, the increase in the frequency of extremes is much faster (Sun et al., 2018)
- Increases in the frequency and intensity of heatwaves has serious impacts on human health (Sun et al., 2018) and work productivity decreases due to heat stress (Yu et al., 2019)
- Without improved adaptation capacity for urban populations in heatwaves, heat-related mortality is expected to increase (Wang et al., 2019)

Air conditioning emits waste heat out to the city environment Image, Pixabay

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Produced by VIEWpoint, a CSSP China project from the Institute for Environmental Analytics, highlighting research and improving the uptake of climate services developed in the partnership, through accessible resources.

Institute for Environmental Analytics

SUSTAINABLE DEVELOPMENT GOALS

Implications

The body of knowledge of CSSP China points to some answers. For example, Liu et al., (2020) carried out a systematic evaluation of modelling climate, social, economic, health and governance measures to strengthen urban heatwave resilience and found direct implications and key benefits from:

- Increasing the accuracy of heatwave forecasting
- Given ongoing forecasting improvements, the health sector should have a prompt and effective response, including reserving hospital beds in response to heatwave warnings
- Cooling equipment should be made affordable to low-income households

Formalising information into an index-based assessment can help a multi-stakeholder approach to collect consistent inputs and consolidate diverse expert opinions of the climate change risks (Sun et al, 2019). This index, trialled for six cities, considers transport, water, energy, communications and buildings, assisting to measure and monitor the multiple factors of city resilience to climate change. From an urban planning perspective, a study by Sun et al., (2016) modelled the greater Beijing region in a heatwave scenario and showed that green roofs would decrease the near-surface air temperature by 2.5°C, and that temperature reduction can be increased as a fraction of the surface covered.

Further to these research findings, VIEWpoint and the Met Office have created the Surface Urban Heat Island demonstrator. This freely accessible visualisation is a set of maps of satellite-derived land surface temperature at kilometre resolution that allow users, such as urban planners, to directly explore how surface temperatures vary considerably within districts and change over time. Use the demonstrator at **www.viewpoint-cssp.org/demonstrators**

Green roofs have the potential to mitigate heatwaves in cities. Image, Chuttersnap, Unsplash

"Global warming is associated with more severe heatwaves, including more heatwave days, a longer heatwave season and higher hottest day temperature, and expansion of regions impacted by heatwaves"

– Sun et al., 2018

Further reading:

All research papers are outputs of CSSP China

World Bank, 2020 worldbank.org/en/topic/urbandevelopment/overview (accessed 8/3/21)
Wang et al., 2019 DOI:10.1038/s41467-019-11283-w
Yu et al., 2020 DOI:10.1002/joc.6197
Sun et al., 2016 DOI:10.1002/2016JD024873
Chen et al., 2019 DOI:10.1175/BAMS-D-18-0087.1
Ren et al., 2020 DOI:10.1175/BAMS-D-19-0152.1
Yu et al., 2019 DOI:10.1016/j.jclepro.2018.10.067
Huang et al., 2019 DOI:10.3390/atmos10070364
Takane et al., 2020 DOI:10.1088/2515-7620/ab6933
Sun et al., 2018 DOI:10.1029/2018EF000963
Liu et al., 2020 DOI:10.1007/s10653-020-00556-9
Sun et al., 2019 DOI:10.3390/su11072099

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