EGU23-15799, updated on 25 Sep 2023
https://doi.org/10.5194/egusphere-egu23-15799
EGU General Assembly 2023

Extreme Climate Change Impacts on Urban Infrastructure and Support Systems

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The global human population is projected to grow to between 8.9 billion and 12.4 billion by the end of the 21st century, with the proportion of the population living in cities projected to increase to 85% (OECD, 2015; UN, 2022). More than 80% of current global gross domestic product (GDP) is generated in cities (World Bank, 2020), demonstrating the importance of urban environments to the global economy and human flourishing. Urban infrastructure systems, such as energy networks, water supply and wastewater treatment, transport, communications, waste disposal and other utilities, are vulnerable to climate change impacts. It is therefore vital that the full range of potential climate change impacts on urban areas are understood.

Low-risk, high-consequence (LRHC) extreme climate change (ECC) events represent a severe threat to many aspects of human society. Existing literature tends to focus on average climate responses projected by climate models and emphasises the most likely scenarios based on a probabilistic approach. The impact of LRHC extreme and worst case scenarios has not received as much attention (Kemp et al., 2022). This includes impacts on urban and peri-urban infrastructure systems, regional and global supply chains, population displacement and migration, food, water and energy security and associated consequences such as increased conflict. While the likelihood of worst-case ECC effects by current assessment is low (IPCC, 2021), there remains significant uncertainty regarding potential climate tipping points that may cascade, trigger feedbacks and lead to runaway climate change (Lenton et al., 2019), even if global temperature increase is restricted to 1.5°C - 2°C (Armstrong McKay et al., 2022) which is growing more unlikely (Liu and Raftery, 2021). The potentially existential impacts of such scenarios necessitates that we exercise the precautionary principle (Sutton, 2019) and “explore the boundaries of plausibility” (Shepherd et al, 2018).

In this study we present synthesised evidence from the most extreme estimates of climate change effects such as extreme temperatures, precipitation, flooding, drought, wildfire, storms and sea-level rise from ECC scenarios, assessing the potential worst-case impacts on urban systems with a focus on heterogeneous regional impacts and the potential need for significant pre-emptive adaptation efforts. Global cities are ranked according to their potential vulnerability to ECC impacts with the aim of identifying cities where critical infrastructure is at risk of failure and what ECC effects they are likely to experience. We highlight gaps in current understanding and the need to focus research in this area while outlining a research agenda to explore ECC effects on urban

infrastructure, including case studies of infrastructure systems in cities identified as vulnerable, with the aim of generating evidence for use in policy development.

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