MODELLING THE IMPACTS OF CLIMATE CHANGE ON CITIES: HEAT RELATED RESIDENTIAL DISCOMFORT AND ADAPTATION OPTIONS

ARCADIA FACTSHEET 7

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High temperatures and heatwaves are associated with large impacts on society. This factsheet highlights the effect of climate change and an intensification of the UHI on residential discomfort. This risk can be reduced by implementing adaptation strategies to increase the resilience of buildings to high temperatures, and through adaptation strategies to reduce anthropogenic heat emissions. The greatest benefits to residents are seen when both strategies are implemented in parallel.

Context

- Overheating of buildings in summer, and the associated thermal discomfort people face, is likely to become increasingly severe under future climate change.
- Residential buildings can also amplify outside temperatures, dependent on architecture, building type, construction material, ventilation, and external weather characteristics.
- Whilst there are no standard overheating limits to guide residential building design, internal temperature thresholds above which people will feel discomfort have been defined, for example 26 to 28°C for bedrooms and living space.

Method

- Studies have suggested that external temperatures can be amplified by 0.7 to 1.5°C for terraced buildings; 1.7°C for semi-detached buildings; 0.7 to 1.5°C for detached buildings, and by -0.8 to 2.7°C for flats.
- This provides an indication of overheating risk related to the basic thermal properties of different building types (assuming natural ventilation and no air conditioning).
- In this study it is assumed that people will feel discomfort in living spaces when internal temperatures reach and exceed 28°C.
- An equivalent external temperature threshold which relates to this internal temperature threshold is estimated for each building type based on the amplification data outlined (table 1).
- The temperature thresholds are applied to current and future temperature time-series data from the urban spatial weather generator.
- Spatial footprints of heat events, and how such risks could change in the future, are created.
- The event maps are linked to residential population to calculate the potential number of people at risk from thermal discomfort for each building type.

Building type	External to internal temperature amplification range	Lower limit for external maximum temperature threshold	Upper limit for external maximum temperature threshold
Terraced	0.7-1.5	26.5	27.3
Semi-detached	1.7	26.3	26.3
Detached	0.7-1.5	26.5	27.3
Flats	-0.8 – 2.7	25.3	28.8

Table 1: The temperature thresholds used to define residential discomfort for a variety of housing types

Residential thermal discomfort

- Under future scenarios of climate change the average annual number of days when thermal discomfort could occur increase compared to the baseline.
- Correspondingly, the number of residents at risk from thermal discomfort increase under all scenarios.
- For the baseline period 45 to 66% of residents living in flats could be affected by thermal discomfort (median result). This is dependent on the external temperature threshold used (fig.1).
- In contrast 18 to 23% of residents living in detached homes could be at risk.
- By the 2030s 59 to 76% of flat based residents and 24 to 29% of residents in detached homes could be at risk (high emission scenario, median result).
- If anthropogenic heat emissions also increase then 78 to 87% and 47 to 49% of residents in flats and detached properties could be at risk.
- The results reflect the underlying characteristics and thermal properties of the building types; the location, concentration, and number of residents living in each property type; and the localised temperature regimes.

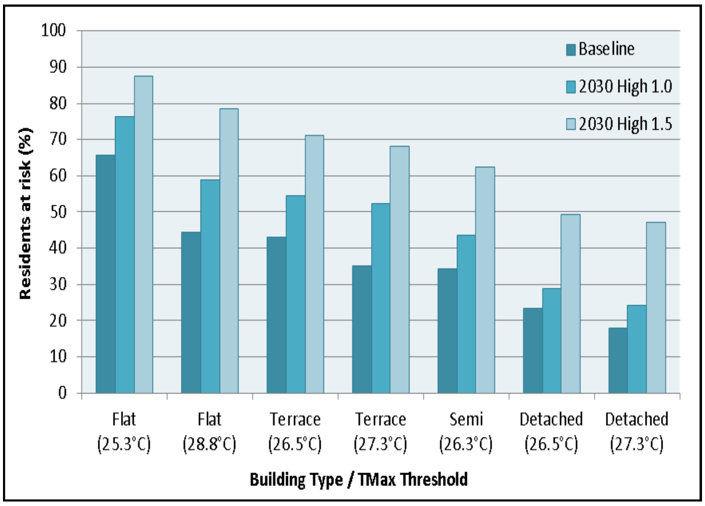

Fig.1: Residents at risk from thermal discomfort per heat event (median results). Results for the 2030s assume that urban anthropogenic heat emissions remain stable (1.0) and that they increase by 50% (1.5).

Making the case for adaptation

- Increasing the resilience of buildings, illustrated by increasing the external temperature threshold of flats from 25.3 to 28.8°C, results in 22 to 43 less event days per year by the 2050s (high emission scenario).
- This demonstrates potential benefit of adaptation strategies aimed at increasing building resilience to high temperatures, such as through improved ventilation or increased shading of buildings.
- Adaptation strategies to stabilise anthropogenic heat emissions, e.g. through urban greening schemes and reduced energy use, will also be beneficial for reducing residential thermal discomfort.
- If anthropogenic heat emissions remain at the present day level, alongside adaptation at a building level, then the number of event days could be reduced by 24 to 52 days per year by the 2050s (high emission scenario) (fig. 2).
- The greatest benefits are seen when both strategies are implemented in parallel.

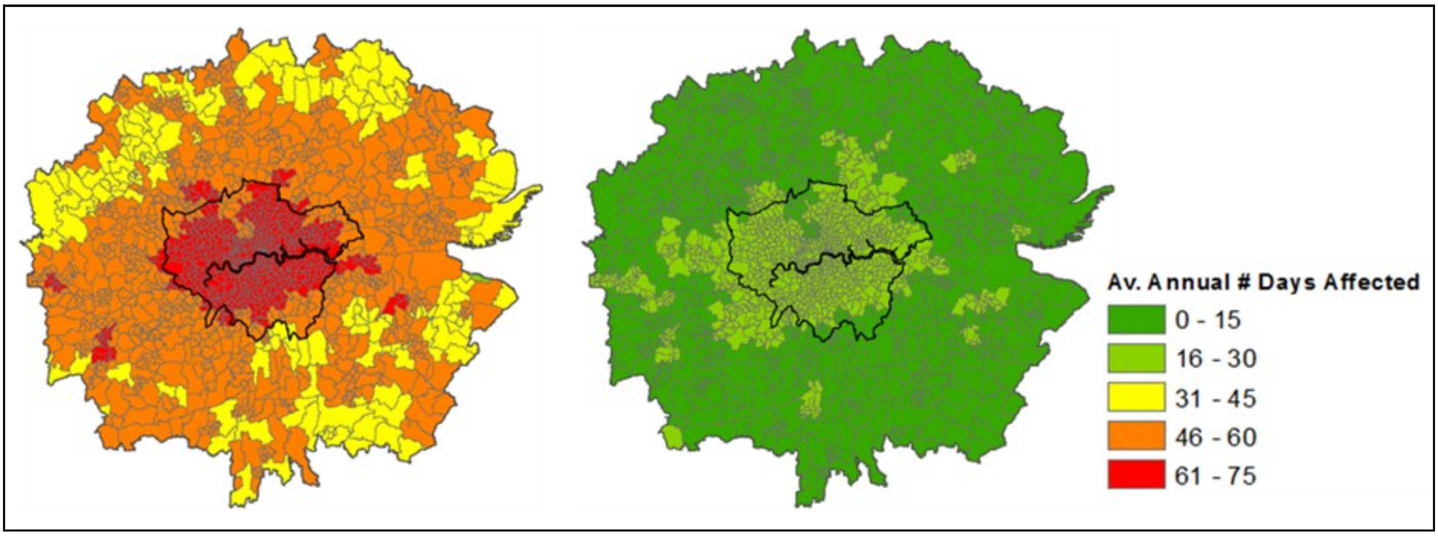

Fig. 2: Average annual number of days residents could be at risk from thermal discomfort for the 2050s (high emissions) assuming no adaptation (left) and adaptation strategies aimed at increasing building resilience and stabilising anthropogenic heat emissions (right)

For additional information see:

- ARCADIA website: www.arcc-cn.org.uk/project-summaries/arcadia/
- ARCADIA Factsheet 2