High-resolution Monitoring of Extreme Heat within Homes, Work and Public Spaces of Low-Income Communities in Ghana

Executive summary

Low-income communities in the global South are particularly vulnerable to climate-related hazards such as deadly heat and flooding. Yet relatively little is known about these extremes in terms of their severity and socio-economic impacts, or about the effectiveness of various coping strategies. Drawing on a 15 month research project in Ghana, this brief provides a glimpse into the extraordinary temperatures endured by communities in Accra and Tamale. Over 10 million data points gathered from a network of more than 130 temperature sensors are beginning to reveal the extent to which the urban heat island, building size, design and materials, all effect indoor temperatures. This understanding of 'hot spots' is a necessary first step towards co-developing low-cost solutions at the household and community level, whilst informing adaptation plans at institutional and city-scales.

Project design and methodology

This brief is an output from the research project entitled *Vulnerability to Extreme Weather Events in Cities: Implications for Infrastructure and Livelihoods* (VEWEC), supported by the British Academy. An interdisciplinary team of investigators from geography, climatology, health, water engineering, social and development studies undertook the research. The main objectives of the project were to deepen understanding of human vulnerability to extreme heat and urban flooding, and to gather evidence of coping strategies within low-income communities of Ghana. Quantitative and qualitative data were also collected on the impacts of extreme weather events on water, electricity and health services. Fieldwork was undertaken in four communities in Accra (Alajo, Agbogbloshie, Bortianor, Odawna) and four in the northern city of Tamale (Gumani, Kukuo, Lamashegu, Ward K). The work was facilitated by community champions.

This brief focuses on the methods used to monitor extreme heat within the homes, work and public spaces of these eight communities. The preliminary findings provide evidence of extraordinary indoor temperatures – an important part of raising awareness about the threats and then co-developing low-cost adaptation strategies.

Temperature reports for heatwaves tend to originate from official weather stations. This gives important information about short-term extreme conditions, as well as long-term trends in *outdoor* temperatures (in the shade). To record the air temperatures that people experience in their daily lives, *Tinytag Transit 2* thermistors were installed in 131 homes and workplaces in January 2018, including several health clinics from May 2018.

Houses and workplaces were sampled within each settlement to represent different structures, building materials and locations. A tiny tag was installed in the shade to measure temperatures outside each home, and then up to four were fixed in rooms with various roofing types, usage/ size, and differing numbers of occupants. Such parameters were documented and codified in a standard worksheet to enable later statistical analysis.

All tiny tags were sited at about 2 metres above the ground, away from direct sunlight and artificial heat sources. In order to cross-check VEWEC temperatures with official recordings, tiny tags were also housed in the instrument screens of national meteorological weather stations of Accra and Tamale airports. All tags were set to sample air temperature at 10 minute intervals with instruments checked and data downloaded every six weeks.

Example indoor temperatures

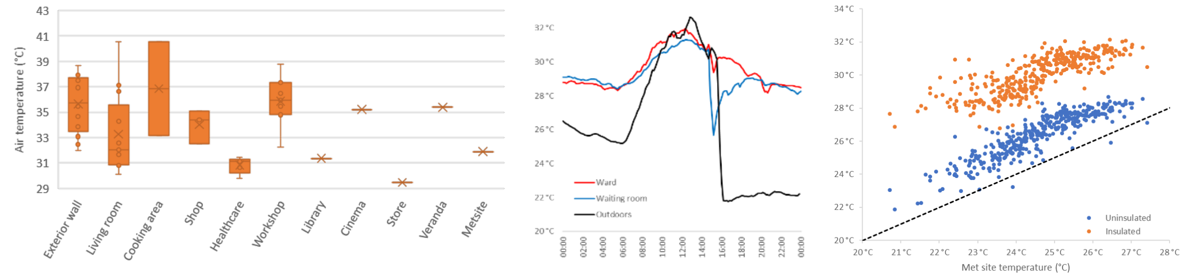
VEWEC data for 2018 reveal considerable variations of indoor temperatures within the sampled communities of Accra. In some parts of the city, the nocturnal urban heat island adds 3.5°C to local temperatures. Mean day-time maxima above 40°C were recorded in some living rooms (Figure 1a). On average, the hottest spaces were cooking areas and workshops – these were about 5°C warmer than the reference metsite. The coolest spaces were thatched rooms, air conditioned living rooms and some health care facilities. Even so, some wards and waiting areas can exceed 30°C in the day and are warmer than outdoors at night (Figure 1b). Some residents have adapted their homes to manage the heat. For example, in one home ceiling insulation reduces the mean day-time maximum by 2.5°C but increases night minima by about the same amount (Figure 1c).

Figure 1 *Examples of indoor temperatures in various locations across Accra, Ghana*

(a) Mean maximum indoor temperatures sampled in various locations across Accra, compared with reference values at the University of Ghana campus metsite in 2018

(b) Air temperatures in a ward (red) and waiting area (blue) compared with outdoors (black)

(c) Indoor night minimum temperatures for a room with (orange)/without (blue) insulation compared to outside (metsite)



Relevance to policy and practice

Approximately 10 million temperature measurements have been gathered by VEWEC. These data provide a wealth of information about ‘hot spots’ within homes and communities, and hence a basis for focusing remedial actions. In due course, statistical analysis will quantify the effects of choices about roofing materials, insulation, ventilation, use of shade and other measures on indoor temperatures. Such knowledge will be used to develop guidance for communities and city authorities about how best to adapt to the threat of rising temperatures.

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Further reading:

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