Climate change impacts on workplace heat and labour productivity: Thermal monitoring case study in Egypt

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BACKGROUND

Increased workplace heat in hot developing countries as a result of ongoing climate change is expected to result in work productivity losses and significantly impact population health and regional economies [1].

AIM

This preliminary study forms part of a larger ongoing project that aims to explore ways to mitigate climate change induced health and productivity impacts in workplaces through architectural and urban design interventions. The objective of this pilot study, in line with existing guidance [2], is to assess the current levels of thermal discomfort and potential reduction of labour productivity in two workplaces in peri-urban areas in Egypt.

METHODS

The sites under examination in Egypt were identified as heat risk 'hotspots' where extreme heat conditions coincide with other potential risk magnifying factors, such as rapid urbanisation (Figure 1). Information about the two case studies, which are typical small business workplaces, are provided in Table 1.

Figure 1

Table 1

	Factory A	Factory B
General Description	A basement manufacturing space located in a 4 storey building . Approx area: 250 sqm	Top (mezzanine) floor manufacturing space located in a 2 storey building . Approx area: 480 sqm
Building Fabric	Structure: Reinforced concrete Walls: Concrete blocks Ceiling/Roof: Reinforced concrete Windows: Single glazed (no shading)	Structure: Reinforced concrete Walls: Red brick Ceiling/Roof: Reinforced concrete Windows: Single glazed (no shading)
Activity Overview	Occupancy: Shift-based,12 workers/shift. Schedule: 5 days/week (08:00-18:00) + 1 day/ week (08:00-1300)	Occupancy:102 workers per shift. Schedule: 6 days/week (08:00-18:00) + 1 extra day per/month (08:00-18:00)

Dry Bulb Air Temperature, Dew Point Temperature and Relative Humidity were monitored at 5-minute intervals inside the two medium-sized factory buildings located in sites A and B during October and November 2013 using the non-intrusive Lascar data loggers (Figure 2) [3].

Figure 2

RESULTS

The monitoring data were statistically analysed to investigate the buildings' thermal response in relation to external climate conditions. As can be observed in Figures 3 and 4 below, indoor Dry Bulb Temperature frequently exceeded 25 °C in both buildings and there were multiple occurrences of temperatures above 30 °C in Factory B. In Factory A, this was often combined with high humidity levels (Relative Humidity > 60%).

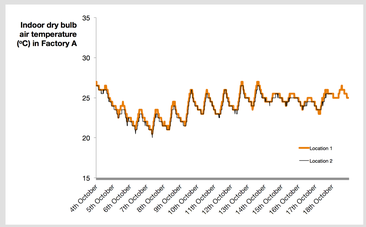

Figure 3

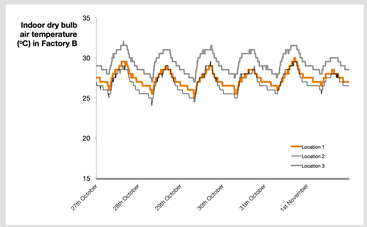

Figure 4

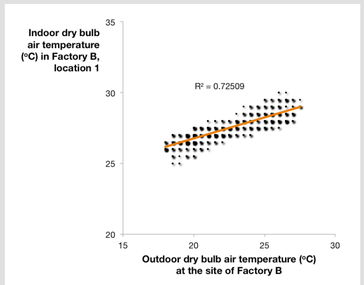

Figure 5

The internal temperature closely followed the external (Figure 5), indicating that future increases in ambient temperature will exacerbate overheating.

DISCUSSION

Heat stress indices (Figure 6) were calculated using the Climate Change Health Impact and Prevention (Climate CHIP) tools [4]. It was found that in October and November the Wet Bulb Globe Temperature (WBGT) index in one shaded location in location 3 of Factory B was 25 °C and above (the threshold for heavy, continuous work) for approximately 1/3rd of the monitored period. Taking into account that monitoring was carried out during the cooler months, the levels of heat stress are expected to be significantly higher during the main summer period, as illustrated in Figure 7 that shows WBGT from 1980 to 2014 at Cairo Airport as calculated by the Hothaps software [2].

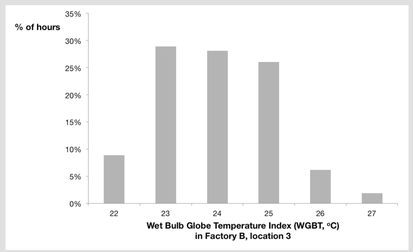

Figure 6

This study has indicated that heat stress is likely to occur in this typical workplaces even during the cooler months under the current climate, which is a cause for concern.

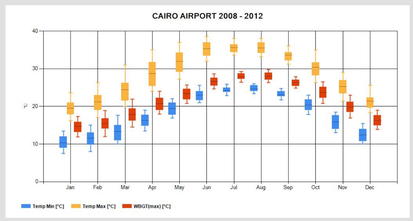

Figure 7

Ongoing work will assess future overheating and heat exposure risk under the current warming trends using building thermal simulation modelling.

ACKNOWLEDGEMENTS

The assistance of Yasmina Taha and Mohamed Amer with monitoring equipment set-up is thankfully acknowledged.

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