Heat Stress and Extreme Heat Events in Singapore and Hong Kong

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Climate change has resulted in rapidly warming temperature trends, as well as increases in the number of record-level hot days and extreme heat events, which have come to be a critical public health concern. They have a large impact on populations experiencing severe heat stress and heat-related mortality and morbidity. Our society's vulnerability to such impacts is further intensified by a range of factors such as urbanisation and urban pollution, as well as population groups such as the elderly and people with low socio-economic status. These factors are characteristic of Southeast Asian countries that have fast developing cities with growing urban sprawl, and demographic trends that exacerbate the level of society's vulnerability to heat stress. This thesis aims to identify the trends in heat stress based on the heat stress Discomfort Index (DI) in Singapore and Hong Kong over a recent 30-year period. It also considers the implications of using HadCM3 climate model projections of future heat stress under the A2 emission scenario. It then examines the occurrence of heatwave events and associated meteorological conditions, which may assist in understanding the likely occurrence of future events.

Singapore demonstrated an increasing temperature and relative humidity trend, resulting in an overall increase in the DI. Particularly, during March, April, and May, where high temperatures and relative humidity are recorded, the DI reflected that most of the population suffers from heat stress. Results also show a shift towards more severe heat stress over the decades. Similar rising temperature trends were observed for Hong Kong, although relative humidity decreased over time. This resulted in summer and winter DI increasing over the decades, while spring and autumn DI increased followed by a decrease in 2001-2010. Future projections of monthly DI suggests that Singapore would likely have a greater increase than Hong Kong, with everyone feeling severe heat stress by 2071-2099.

Increases in the frequency of hot days and longer lasting heatwave events over the decades were also observed for Singapore and Hong Kong. The case study analysis of meteorological conditions found that Singapore's heatwaves were associated with positive temperature anomalies and persistent high-pressure anomalies, resulting in longer lasting heatwaves. Case study examples of Hong Kong heatwave events suggest that they may occur under similar conditions as Singapore, but also together with tropical cyclone conditions.

This thesis provided insights to aspects of the nature, frequency, and variation in heat stress and extreme heat events. It also identified possible future heat stress conditions that need to be consider within the context of changing urban environments and pollutions levels, as well as a growing and ageing population, for developing adaptation measures and policy planning.