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Characteristics of Extreme Hot Weather in a Sub-tropical High-density City: Implications on the Heat-health Warning System

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Abstract Text:

Extreme hot weather is likely to become more frequent and intense under future climate change, particularly in urban areas due to the complex urban settings. It causes implications on public health such as heat stroke, heat-related diseases and excess mortality due to negative physiological consequences of prolonged exposure to extreme heat. In the high-density urban environment of Hong Kong, such intense heat is exacerbated by urban heat island phenomenon due to the compact urban form and settings, which is also more prominent during night-time. According to the WMO-WHO's *Heatwaves and Health: Guidance on Warning-System Development*, it is important to consider the characteristics of local meteorological conditions and living environment in the impact assessment and forecasting of extremely hot weather, especially in the aspect of local heat stress information and warning services. The present paper aims to review the current situations of extreme hot weather of Hong Kong, as a case study of high-density cities, and identify the key characteristics that the Heat-Health Warning System (HHWS) in Hong Kong may consider. It also proposes a methodological framework to inform relevant policy actions and professional practices for increasing the resilience to future climate change. This study is based on the collaboration with the Hong Kong Observatory (HKO) which contributes to improve the understanding the impacts of extreme heat events on public health in Hong Kong and provide useful scientific basis for future enhancement of the local heat stress information services.

Hong Kong has experienced considerable warming in the last few decades. According to *Hong Kong Climate Change Report 2015*, the rate of increase in air temperature in the last 30 years (0.16°C per decade) than that in the last century (0.12°C per decade). In particular, the probability of daily maximum temperature reaching 35°C increased to 22% in early 21st century, compared to 3% in early 20th century. Climate projection also suggested that temperature will continue to increase by 1.5-3°C and 3-6°C in the mid- and late-21st century respectively (HKO, 2016).

The effect of the built environment is also prominent in the meteorological record. Lau et al. (2013) found that the increasing rate of summer temperature was higher in the urban areas, particularly for night-time temperature due to the intense heat retained in the building bulk. The annual number of very hot days (VHDs; daily maximum temperature ≥ 33°C) and hot nights (HNs; daily minimum temperature ≥ 28°C) increased to 10.2 and 17.8 respectively in the last three decades (HKO, 2016). Night-time (or daily minimum) temperature therefore forms an important part of the HHWS, which conventionally consider daily maximum temperature in the assessment of heat stress.

HHWSs are supposed "to suit local conditions in terms of the data available for analyzing historical heat-health relationships, weather-forecasting capacity and human resources dedicated to running an HHWS" (WMO-WHO, 2015, p.24). In Hong Kong, there are substantial intra-urban variations in temperature due to the high-rise compact urban form with great variations within short distances (Cai et al., 2017). Therefore, the HHWS needs to take into account local built environment in weather forecasting of extreme hot weather, i.e. the selection of reference stations for information services of extreme hot weather.

Another important dimension of the HHWS is that the threshold is associated with actual heat-health outcomes. The thresholds currently used in Hong Kong (VHD and HN) are meteorologically based without the consideration of historical mortality. However, the relationship between these thresholds and actual mortality is not well understood. Previous studies determined the effect of certain temperature thresholds on mortality in Hong Kong (Goggins et al., 2012; Ho et al., 2017). Such findings can be applied in the HHWS to determine possible categories of extreme hot weather events for corresponding actions taken by government authorities, relevant industries, non-profit organizations and the general public.

As an integral part of the wider heat-health action plan, the HHWS aims to enhance the response to extreme hot weather and ultimately build up the resilience of cities to future climate change. Better tools are required to communicate weather and climate risks with stakeholders. Adaptation measures can therefore be formulated and executed to safeguard public health and ensure the living quality of urban environment. Current responses of government authorities and social welfare services largely focus on daytime heat stress while the high night-time

temperature needs better attention. The proposed framework for actions responding to extreme hot weather is built upon scientific studies on the effect of extreme hot weather on public health such as mortality and hospitalization rate, particularly for vulnerable groups such as elderly, children, and people with chronic diseases (see the attached figure). The HHWS can therefore be enhanced to delineate different categories of extreme hot weather according to the impacts on public health issues.

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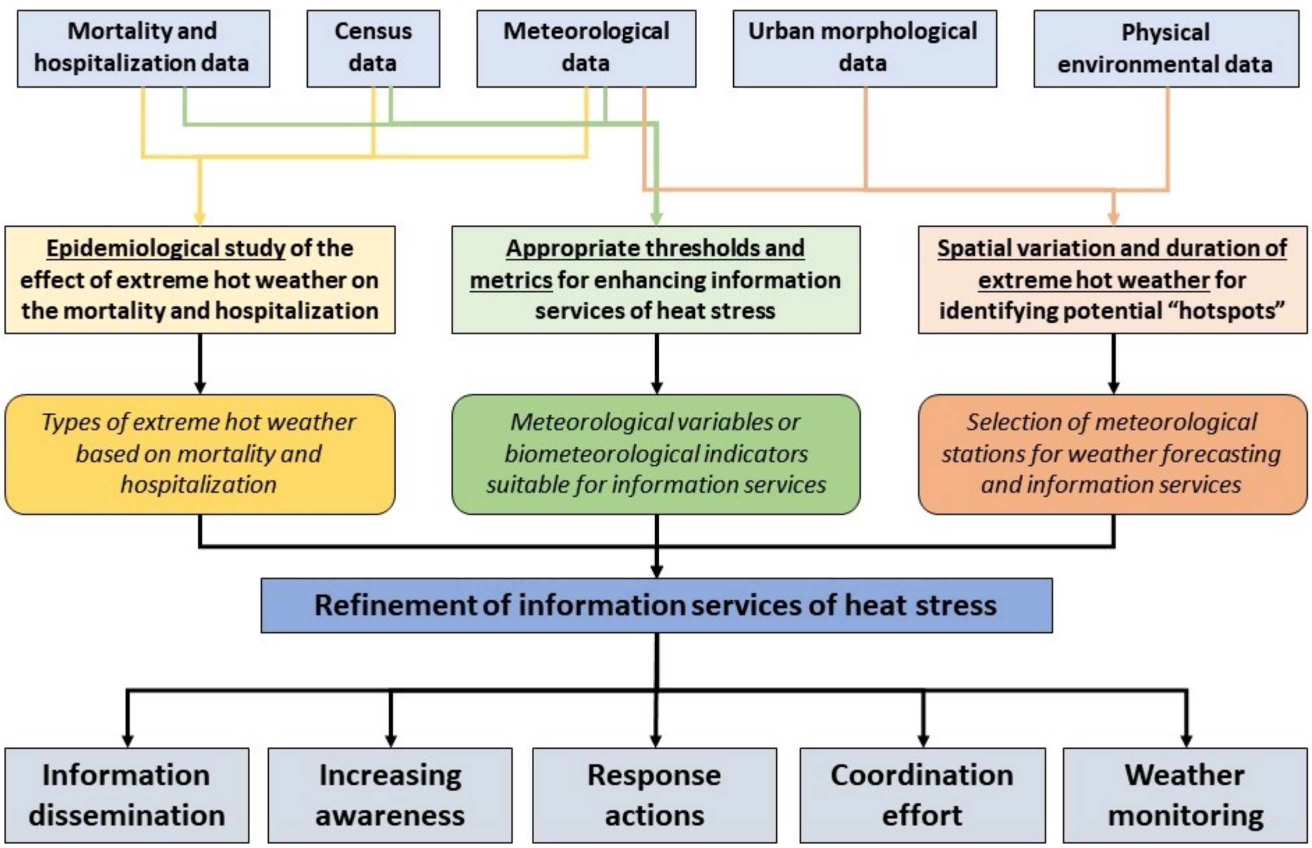

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