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The increasing trend of the urban heat island intensity

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ABSTRACT

This paper examines the urban heat island intensity in detail in the city of Manchester, UK. An increasing intensity is found over time. The urban heat island intensity (UHII) data is examined in more detail giving relationships between weather parameters, cloud cover, wind speed and the urban morphology. The urban heat island intensity in Manchester has a highly significant rising trend which by the end of the century could add 2.4 K to the average annual urban temperature, on top of the predicted climate change increase. An analysis of the urban morphology showed that the urban site had indeed become more urban over 9 years of the study, losing green spaces which mitigate against the UHII.

1. Introduction

The urban heat island intensity (UHII), the difference in temperature between an urban site and a rural site, is a measure of the urban heat island (UHI) effect. The UHI means that cities and towns are warmer at night than rural areas due to the absorption of the sun's radiation in the urban concrete and buildings, the fact that the urban buildings are shaded at night from heat loss to the cold clear sky and that there are heat gains in the urban areas due to cars and transport and buildings' energy use. This is important in the design and energy assessments of buildings in urban areas. It will be especially important in the future with climate change and potential global warming as the temperature is likely to increase and the UHI will add to it. Recent measurements in Manchester show a summer maximum urban heat island intensity of 8 °C. Climate change,

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UKCP09 projections (UKCIP, 2016), indicate that summer mean temperatures in the north west of the UK could rise by 5 °C (50% probability, 7 °C top of the range) by the 2080s (high emissions scenario). The UHI will add to the urban area temperature on top of climate change.

The UHI is important as buildings need to cool off at night to get rid of their stored heat. Research in Manchester (Lee and Levermore 2013), modelling an interwar house indicated 3 K rise in internal temperature for a modest UHII of 5 K with a 60% rise in discomfort hours in 2050. Overheating in summer is also a problem for modern, low energy, well insulated houses (Good homes alliance, 2013) climate change and overheating: opportunities and risks for designers and the supply chain. London: The Building Centre, 2013. http://www.goodhomes.org.uk/events/138 (accessed 14 November 2013). This overheating results in the occupants having difficulty sleeping and possibly resorting to installing fans or full air-conditioning leading to more electricity consumption. Non-domestic buildings are similarly affected and even low energy non-domestic buildings utilising natural ventilation, have greater difficulty discharging their stored heat overnight in urban centres due to the UHI maintaining a warmer microclimate around them.

The UHI is probably a contributor to the considerable performance gap of new buildings between the declared design energy consumption and the actual consumption, the latter being between 1.5 and 2.5 greater than the former (Kimpian, 2013).

All these problems will be even worse as the UHI increases as this paper suggests, especially for Manchester, UK.

2. Manchester UK results

Fig. 1 shows the location of Manchester UK.

For Manchester, UK, the weather data at Hulme, just 2 km south of the city centre was available for a number of years. As it is not in the true centre of the city the UHI effect measured here would be expected to be slightly diminished by comparison with the true centre. The rural site is actually Manchester Airport, referred to as Ringway, which is about 12 km from the city centre Hulme and Ringway are UK Met Office sites. But since

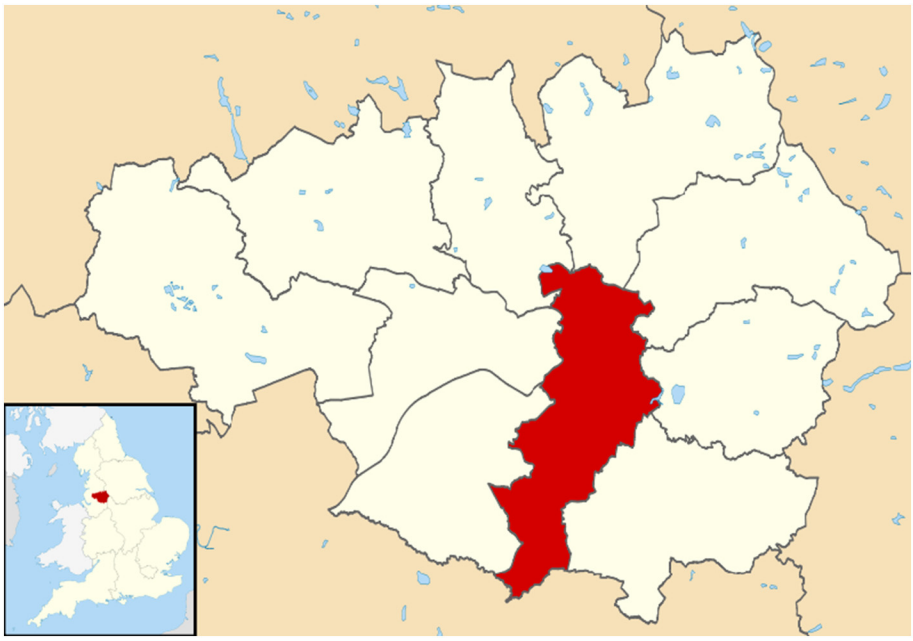

Fig. 1. The main map shows Manchester City (red) within Greater Manchester (light grey). Inset shows Manchester UK in the North West of England, UK. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

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