



The urban heat island and its influence on building energy consumption in England and South Korea

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1. Introduction

This paper examines the measurements of the urban heat island (UHI) in a number of sites around Manchester, England, UK and also Ulsan in South Korea. The measurements and the actual weather are considered and compared. Although a significant urban heat island intensity (UHII) is found in the UK site it is not as high as the intensity in Ulsan, South Korea.

The influence of the UHI on the heating and cooling loads of buildings is examined for Manchester and Ulsan. Previous work with simulated UHI data^{1,2} has shown that the UHI has a significant influence. This paper uses actual measured UHI data to assess the effect at sites in the UK and South Korea. The increase in energy consumption in the warm periods is increased by the UHII by about 8% in the UK and almost 20% in South Korea. The heating in cooler periods is consequently reduced but not by as much as the summer cooling.

2. Weather data in Manchester and Ulsan

Fig.1 and Fig.2 show the dry bulb air temperature for Manchester and Ulsan, showing Ulsan to be hotter and sunnier.

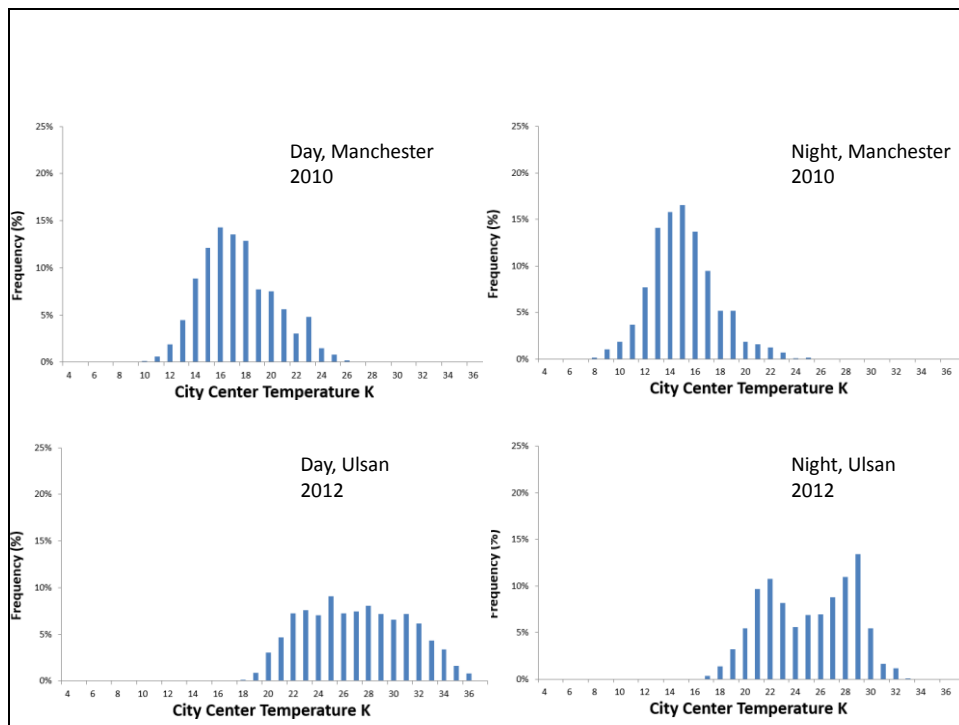


Fig.1 Dry bulb temperature for Manchester and Ulsan in summer

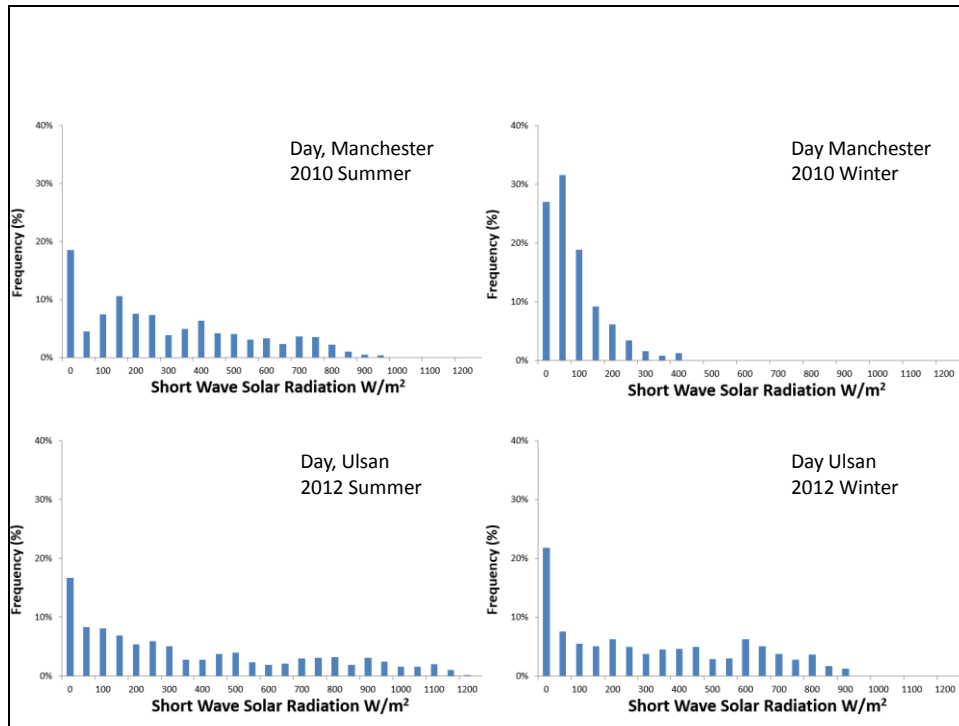


Fig.2 Solar irradiation for Manchester and Ulsan

2. UHI data for Manchester, UK and Ulsan, South Korea

During Prof Lee's sabbatical year at Manchester University the UHI in Manchester was compared with that of Prof Lee's home town of Ulsan. The measurements for Manchester were from 59 sensors around Greater Manchester as part of an extensive monitoring campaign with temperature sensors placed in radiation shields on lampposts³. The comparison rural site was at Woodford, 15 km from the city centre. A significant UHI was found⁴². The data for Ulsan in South Korea were from a rural and city centre meteorological stations.

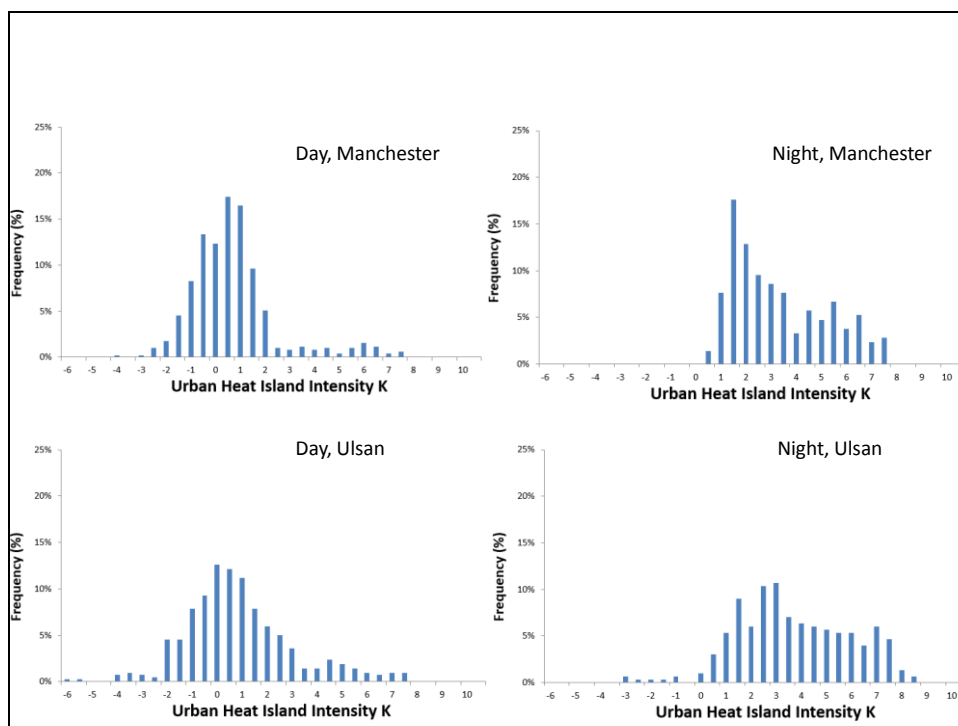


Fig.3 The UHI for Manchester and Ulsan in the summer during the day and night

3. The buildings used for the load assessments

The basic building used for the simulation with and without the urban heat island effect is shown in Table 1. The internal gains were the same for both Manchester and Ulsan offices.

Office simulation (IES) with and without UHI			
Building envelope parameters			
		Area(m ²)	U-value
Floor		100	0.250
Ceiling		100	0.250
Wall	Exterior	60	0.350
	Windows	60	1.977
Height (m)		3	
Story		1	

Table 1 The details of the building for heating and cooling analyses in Manchester and Ulsan

4. The heating and cooling loads

Fig.4 shows that even in Manchester the UHI affects the cooling load in June.

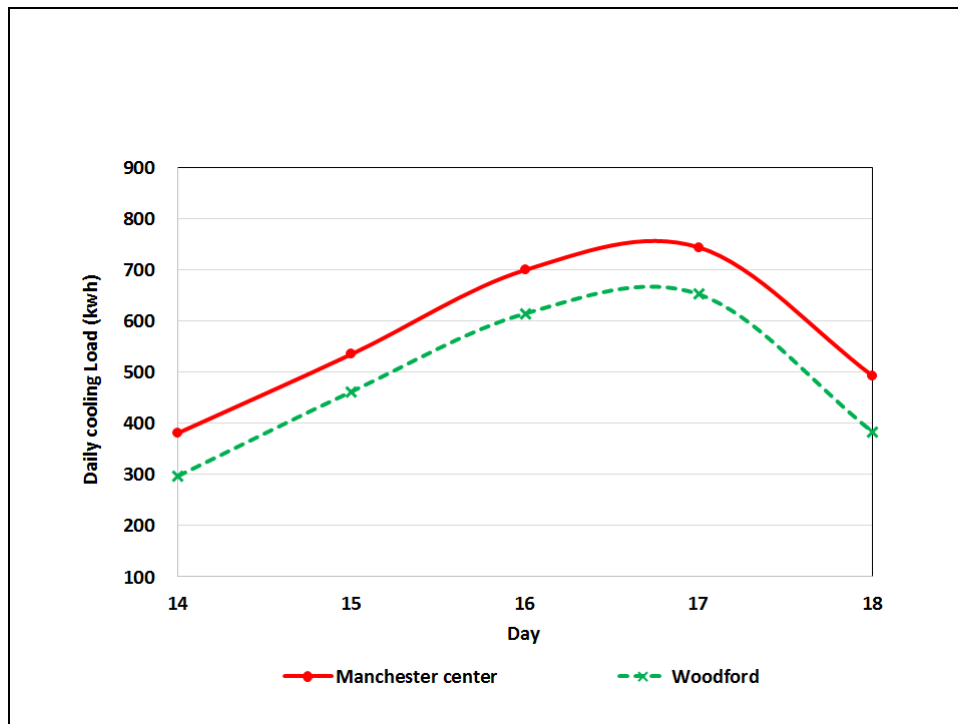


Fig.4 The daily cooling load for June days in Manchester, UK

Fig.5 shows that the Manchester heating load is reduced by the UHI and that it is higher than the cooling load.

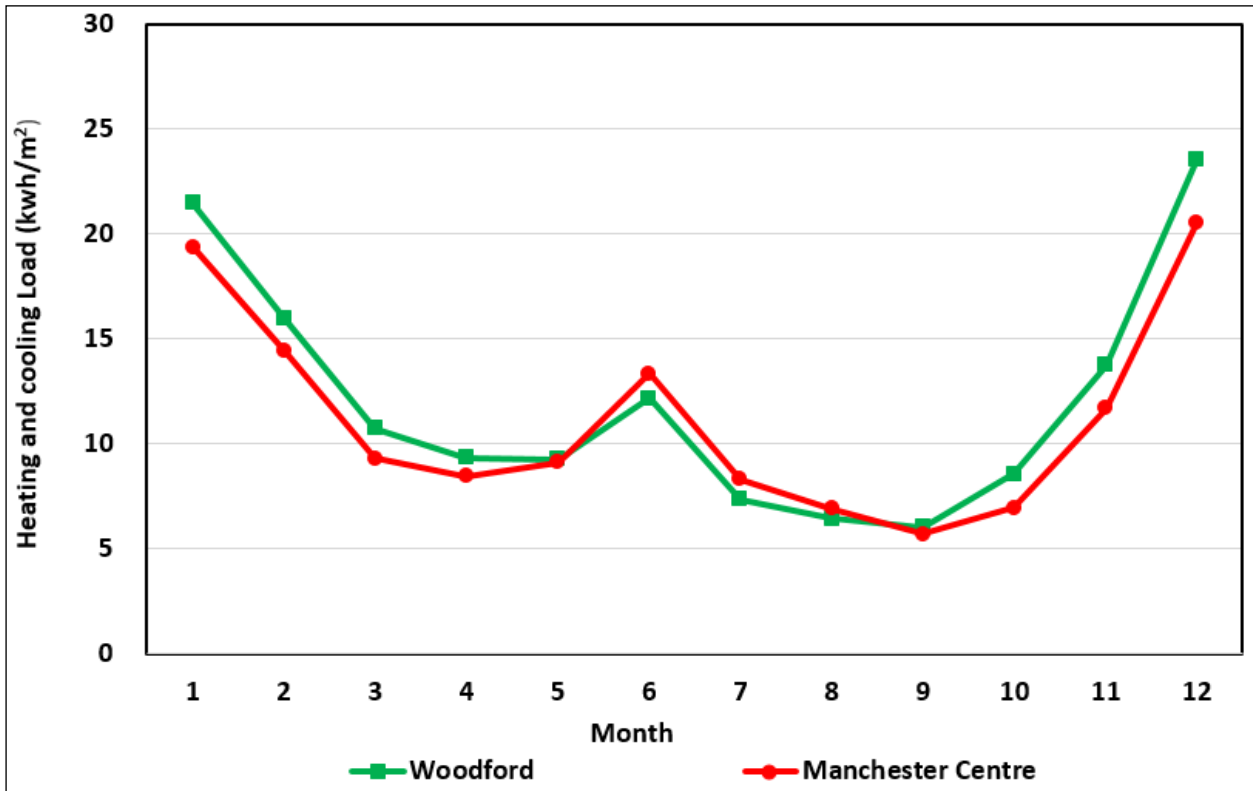


Fig.5 The monthly heating and cooling loads for Manchester with and without the UHI

Fig.6 shows the UHI has a greater effect on the heating and cooling loads in Ulsan. It also shows that the cooling load is much larger than the Manchester cooling load and larger than the heating load.

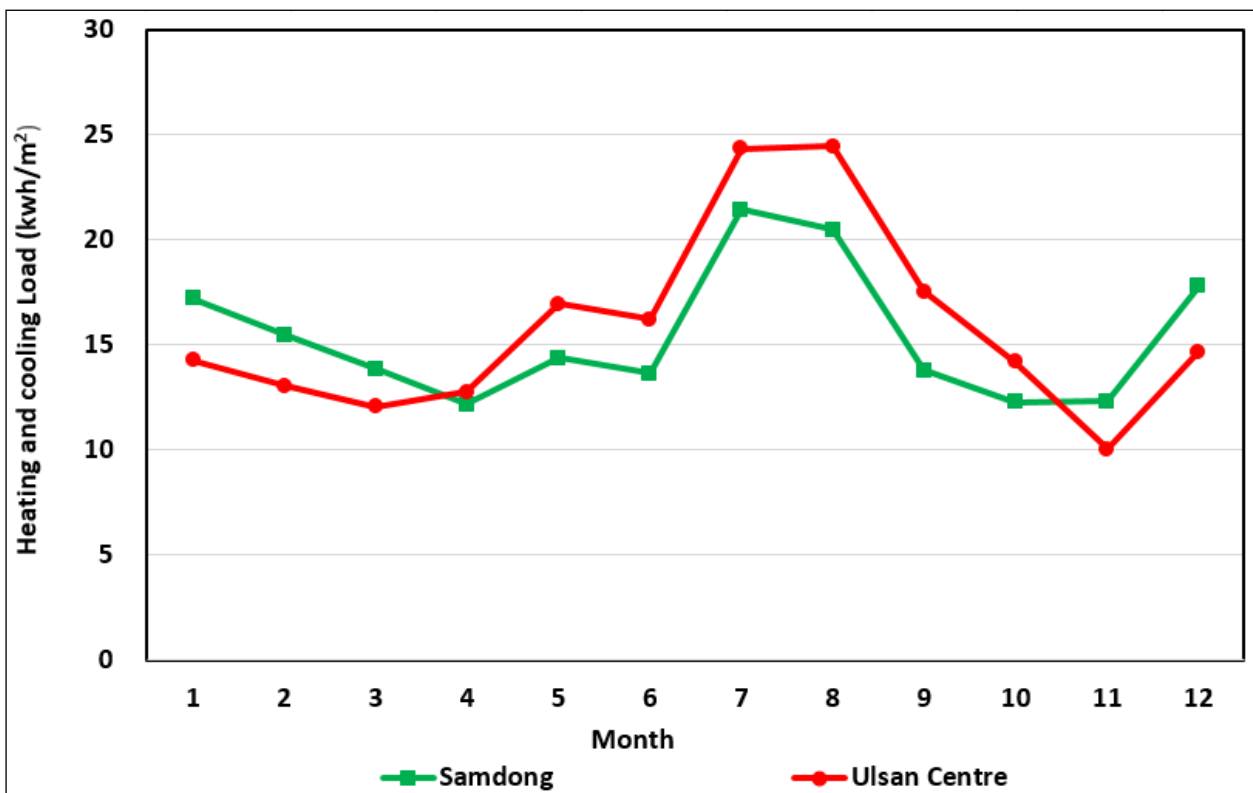


Fig.6 The monthly heating and cooling loads for Ulsan with and without the UHI

5. Conclusion

The UHI does have a significant effect on the heating and cooling loads for Manchester and an even greater effect on the loads for Ulsan.

¹ Crawley, D B. (2008) Estimating the impacts of climate change and urbanization on building performance. *Journal of Building Performance Simulation*. Vol. 1, No. 2, June 2008, 91–115

² Skelhorn, CP, Levermore G J and Lindley, SJ. (2014) Impacts on Cooling Energy Consumption Due to the UHI and Vegetation Changes in Manchester, UK 3rd International Conference on Countermeasures to Urban Heat Island, Venice, October, 2014.

³ Levermore, G.J., Cheung, H. (2012) A low order canyon model to estimate the influence of canyon shape on the maximum urban heat island effect. *Building Services Engineering Research and Technology* pp 371-386, Vol 36, (4), Nov 2012.

⁴ Cheung, H., Levermore, G.J., Watkins, R. (2010) A low cost, easily fabricated radiation shield for temperature measurements to monitor dry bulb air temperature in built up urban areas. *Building Services Engineering Research and Technology* (31)4, 371-380