

**Title:**

GIS-based analysis of the relationship between outdoor and indoor air temperature in the Taiwan metropolitan area

**Authors & affiliations:**

S. Hsu<sup>\*1</sup>, I. Hamilton<sup>1</sup>, A. Mavrogianni<sup>2</sup>, A. O'Sullivan<sup>1</sup>

<sup>1</sup>UCL Energy Institute, London WC1H 0NN, UK

<sup>2</sup>UCL Institute for Environmental Design and Engineering, London WC1H 0NN, UK  
[shih-che.hsu.15@ucl.ac.uk](mailto:shih-che.hsu.15@ucl.ac.uk)

**Abstract:****Introduction:**

Under a global warming trend, cities are at a greater risk of experiencing a higher change in air temperature due to the urban heat island effect, which captures more heat in the urban area compared to the surrounding rural area. The distribution in the pattern of heat in cities will affect the concentration of heat exposure and will influence how and when people are exposed to heat. People spend a considerable amount of time indoors and this means that the influence of buildings and available cooling systems play an important role in heat exposure and heat-risk to health. It is therefore important for city-planners and policy-makers to understand how a changing temperature outdoor will affect indoor air temperature for health and energy demand and the implications for climate change mitigation measures that aim to reduce emissions but also ensure a comfortable living quality. A GIS-based analysis tool that visualizes the distribution of urban indoor and outdoor air temperature and allows for quantitative comparison to be mapped can provide policymakers with useful information for guiding policy. In this study, we compare the outdoor and indoor air temperature in the Taiwan metropolitan area to explore the impacts of climate change on people's life in East Asia.

**Methods:**

In last 30 years, Taiwan, which is in the subtropical and tropical climatic zones, has experienced warmer winter and hotter summer, and has experienced a rate of change three times the global average. The outdoor and indoor air temperatures we used in this study are from five metropolitan areas in Taiwan. Outdoor air temperatures are extracted from the results of GIS spatial interpolation by cokriging the monitored air temperatures and indoor air temperatures are recorded by Airboxes that are installed indoors in these five areas. Both temperature datasets are open on the public domains. We used the toolboxes in ArcGIS 10.3.1 to undertake analyses. The cokriging toolbox was used to interpolate to downscale the spatial resolution of the outdoor air temperature from sparse monitoring stations, and the regression statistics tool was used to analyse the correlation between outdoor and indoor air temperature. The image comparison tools were also used to visualize the distribution of outdoor and indoor air temperature.

**Results:**

We compared the outdoor and indoor temperatures at the same location combined with the neighborhood characteristics of the built environment along with socio-economic statistics. Although the differences between day and night outdoor temperatures are different in the five metropolitan areas, the neighbourhoods with higher outdoor temperature generally have higher indoor temperature. However, the night indoor temperatures vary with neighborhood characteristics. For example, the villages which consume more electricity show a larger difference between outdoor and indoor temperatures.

**Discussion:**

Understanding the variation of indoor temperatures is important for evaluating the risk to health by predicting overheating risk accounting for underlying determinants in the built environment. Comparing outdoor and indoor temperatures provides a means to understand how climate change can impact human life through changes in heat exposure and what activities might mitigate these risks.