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Analysis of spatial and temporal variations of surface urban heat island in Kolkata, India using LANDSAT and MODIS data

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The urban heat island (UHI), the phenomena by which the urbanized areas experience relatively warmer temperatures compared to suburban areas, is a major evidence of anthropogenic impact on urban climate. It has potential health effects such as mortality due to high temperatures and heat waves. Additionally, UHI demands more energy, required for running cooling systems such as air-conditioners that would generate greenhouse gas emissions. This study presents a comprehensive analysis of surface urban heat island, during both day and night and across all seasons, of an Indian megacity, Kolkata, which has a population of about 15 million, using high spatial (LANDSAT) and temporal resolution (MODIS) satellite observations. The land surface temperature (LST), retrieved using thermal infrared (10.78–12.2 microns) by means of split-window algorithm, is used as the indicator of UHI. The difference in LST of urban and surrounding rural areas is defined as the surface urban heat island intensity (SUHII). A significant UHI exists in Kolkata with an annual mean SUHII of 1.3 ºC and 1.01 ºC during day and night, respectively. The maximum daytime SUHII was observed during post-monsoon season (1.4 ºC) and maximum night-time SUHI in winter season (1.5 ºC). The city shows a significant positive trend in night-time SUHII for summer, winter and post-monsoon seasons. The analysis of LANDSAT data confirms that the city witnessed about 9% increase in its built-up area during the period 2006-2017. These new urban settlements are built at the expense of clearing vegetated areas, which play a crucial role in mitigating the UHI effect. The hotspots of the UHI in the city are also analysed and the results show that the anthropogenic forcing amplifies the effects of UHI. Therefore, the results of this study is expected to be key for devising effective urban planning strategies in the future in a perspective of UHI mitigation.

KEYWORDS: Urban heat island, land surface temperature, thermal remote sensing, anthropogenic forcing