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Assessment of the Spatiotemporal Variability of Urban Heat Island Intensity in Colombo Metropolitan Area

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Abstract

During the last few decades, the Colombo Metropolitan Area (CMA) has experienced rapid population growth and unplanned urbanization, resulting in the replacement of natural landcover with more impervious surfaces. The primary approach of current study was to determine the gradients of air temperature and assess the spatiotemporal variation of atmospheric urban heat island (AUHI) intensity in the CMA considering a range of rural sites extending in different radial directions from the urban center. A total of sixteen rural observation sites that extend from an urban center in four directions were selected within the CMA, with four sites 3.5 km apart from each other in any direction. The air temperatures at each site were measured using HOBO UX-100-003 temperature data loggers for an 8-day period from 21st to 28th, of February 2022. The normalized difference vegetation index (NDVI) and normalized difference building index (NDBI) were used to determine the influence of land use/land cover on air temperatures. The results revealed that air temperature had a strong positive correlation with NDBI. Thus, the current study suggests that the impervious surface/s is a significant predictor of air temperature over the study area. The higher air temperatures were observed at the urban center in relation to the selected suburban and rural observation sites. Hence, the current study confirms that AUHI exists within the selected study area over the CMA. It was found that AUHI tends to be present throughout the day in the CMA. However, it becomes strong between 12.00 A.M. and 6.00 A.M and mostly weakens in the late afternoon hours. Furthermore, this study found that the timing and magnitudes of AUHI vary from direction to direction across the study area depending on the site-specific characteristics of the rural observation sites. The current study emphasizes that site-specific land use/land cover characteristics can have a significant impact on the interpretation of UHI study results even within a single metropolitan area. Therefore, taking only one rural site might not be effective in determining the UHI intensity and a range of sites need to be considered (to select from) for in-depth analysis of UHI in any given area. The findings of the current study will provide firsthand knowledge for urban planners to identify future trends in UHI in the CMA and will promote further UHI research in this area.

Keywords: Rural observation site, Atmospheric urban heat island, Normalized Difference Vegetation Index