

A B S T R A C T

Modifications of the urban environment bring about changes in the urban thermal environment that often lead to significant deterioration of the comfort conditions of the urbanites. The main objective of physical planning is to optimize the distribution of land use since a lack of proper land use control results in poor land use compatibility. The thermal effect of the built form, and the irradiation, to a great extent, has an influence on the micro-climate, which is not effectively considered in the zoning regulations and building byelaws in India. Sustainability has been the recent concern of urban and regional planning including planning for conservation, protection and appropriate use of land and natural resources. Therefore, there is a need to understand the thermal effects of the built forms and the land cover compositions of urban areas.

Comfort conditions have been computed for the study area with an aim to identify the periods during which the local atmospheric thermal conditions are not conducive to human comfort. The thermal comfort condition existing throughout the year in Kolkata was analyzed using human-biometeorology indices such as PET, PPD and PMV. Typical Meteorological Year (TMY) climatic data (ASHRAE) has been analyzed for the physiologically significant assessment of the thermal environment based on established thermal indices derived from the human energy balance. Extreme thermal conditions and its corresponding stress on human health have been assessed.

A model for assessing the thermal response of urban land cover and built form based on satellite imagery and climatic data in the context of tropical metropolitan city of Kolkata has been developed in this study. The land cover and urban built form of sample sites have been assessed using GIS, remote sensing (using IKONOS and ASTER imageries) and landscape metrics as tools. The thermal fluxes have been estimated using a surface energy balance

algorithm. Finally study of thermal response with respect to different land cover composition and built form at Kolkata was carried out using biophysical metrics such as the fractional vegetation, normalized difference vegetation index (NDVI), Kauth Thomas Brightness (KTB), Kauth Thomas Greenness (KTG) and Kauth Thomas Wetness(KTW) and morphological metrics such as ratio of volumetric measure to surface area ratio (VbySA), sky view factor (SVF) and landscape metric parameters namely, interspersion or intermixing of patch types (IJI), shape complexity (FRAC), area-weighted mean patch size (AM_MN), aggregation of the built structures (LSI).

The study of thermal comfort conditions existing in Kolkata could establish that higher ambient temperature conditions existed for more than nine months in a year and even during winter months there are sustained periods of thermal conditions above the human comfort limits. The variations in ground heat flux were analyzed and about 88% variance could be established by NDVI, Kauth Thomas Wetness and Kauth Thomas Brightness indices. NDVI, Kauth Thomas Wetness and Kauth Thomas Greenness indices could explain more than 85% variance of the latent heat flux. Analysis was carried out with sensible heat flux as the dependant variable and NDVI, Kauth Thomas Brightness, Kauth Thomas Greenness Kauth Thomas Wetness indices and fractional vegetation cover as independent variables. No major correlations were found between the independent variables and the sensible heat flux.

Morphological parameters of the built forms and land cover composition have been analyzed therefore, to explore possible relation of sensible heat flux to the morphological parameters at a more detailed (sub-pixel) level. Regression analysis revealed quite a good fit and factorial analysis of variance yielded a significant main effect for percentage built area (BUILT, percentage vegetation cover (trees) (VEGTR), percentage water bodies (WATER), sky view factor

(SVF) and the aggregation of the built structures (LSI). However the interaction effect was significant for BUILT and VEGTR, BUILT and WATER, BUILT and LSI and not found significant for VEGTR and LSI, SVF & LSI and VbySA & LSI.

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