

ABSTRACT

Urbanization significantly alters land use and land cover, surface thermal properties, and near-surface meteorological conditions, thereby influencing outdoor thermal comfort and human heat stress in Indian cities. This thesis develops an integrated and scalable framework for assessing outdoor thermal comfort by combining satellite-derived urban surface characterization, data-driven mapping, and physics-based numerical modelling. The study comprises three major components. First, spatially explicit thermal comfort maps are developed by integrating Landsat-derived surface indices with meteorological observations. This approach enables city-scale identification of spatial variability in heat stress and highlights intra-urban contrasts that are often missed by sparse observational networks. Second, outdoor thermal comfort is evaluated using the Weather Research and Forecasting model coupled with the single-layer Urban Canopy Model (WRF-UCM), and the Universal Thermal Climate Index (UTCI) is used to represent physiologically based heat stress. Third, WRF-UCM performance is examined by incorporating reconstructed LULC, albedo, and green vegetation fraction derived from Landsat satellite data. The results show that urban expansion, reduced vegetation, altered albedo, and changes in land-surface representation can substantially modify near-surface thermal behaviour and thermal comfort. The framework provides useful evidence for urban-climate assessment, heat-mitigation planning, and future work on climate-resilient city development.

Keywords: Outdoor thermal comfort; WRF-UCM; Landsat; urban heat island; UTCI; machine learning; land use/land cover.