CHARACTERIZING NOCTURNAL HEAT INDEX RECOVERY RATES ACROSS DIFFERENT PHILIPPINE MICROCLIMATES FROM 1996 TO 2025

Roumjer Jomes C. Mojado

Thesis Adviser: Rafaela Jane P. Delfino, PhD

Institute of Environmental Science and Meteorology

College of Science

University of the Philippines Diliman

ABSTRACT

Most of the studies about the heat index in the Philippines do not assess its nocturnal behavior, which has been studied far less than the daytime extremes that typically occur during the hot dry season. In this study, a 30-year analysis is carried out on nocturnal Heat Index recovery rates (m_{HI}) at six microclimate stations in the Philippines, covering March to August of 1996–2025, the months that include the hot dry season and the onset of the southwest monsoon (Habagat). The microclimate classification of the six stations is objectively verified using the Global Local Climate Zone (LCZ) map, which quantifies the built-up, dense-urban, and water shares within 2, 5, and 12 km of each station. For each hour, the 2-meter air temperature and dew-point temperature from the ERA5 reanalysis data are verified against the DOST-PAGASA observations using the root mean square error, mean absolute error, Willmott's index of agreement, and Pearson correlation at four validation times during nighttime hours (20:00, 23:00, 02:00, and 05:00 PHT). A quantile-mapping (EQM) bias correction, using a calibration period and holdout validation, is applied to the ERA5 reanalysis temperature and dew-point temperature, the relative humidity is derived from the corrected fields, and Heat Index values are calculated based on these corrected data. The official Rothfusz method is used for the calculation of HI, from 18:00 to 05:00 PHT, corresponding to the 12 hourly observations and 11 elapsed hours per night. The analysis centers on the nocturnal recovery rate (m_{HI}), which is obtained through ordinary least-squares regression of the 12 hourly Heat Index values, together with the hourly HI changes that identify the intervals during which nocturnal recovery slows, stalls, or is rarely reversed. The trends in m_{HI} are assessed using the Mann-Kendall test and Sen's slope, while the differences among the six station cases are tested with the analysis of variance and Tukey's HSD for station-period summaries, reported with their mean, median, and variability. The m_{HI} is further summarized using a descriptive gridded layer across the corrected ERA5 grid cells surrounding each station. Station-separated Pearson and Spearman correlations are then used to quantify the association

between m_{HI} and localized atmospheric variables for each season separately. Partial correlation is additionally computed for each season as a validity check, with the month held constant. By identifying the hourly intervals in which the nocturnal HI recovery slows down, stalls, or is rarely reversed, and the environments in which high apparent heat persists the longest, this study presents a validated and reproducible framework for comparing nocturnal thermal behavior among different Philippine stations. The results are baseline values of m_{HI} which can be used as heat-exposure indicators in future research, heat-exposure awareness, and heat mitigation measures. Health outcomes are not estimated in this study, and because each microclimate is represented by a single station case, the findings apply to the station cases analyzed and are not generalized to all locations with similar microclimates.

Keywords: Nocturnal Heat Index recovery rate; hourly HI change; ERA5 validation; quantile mapping; Local Climate Zones; Philippine microclimates