



*Exploring the seasonal variability and nexus between urban air pollution and urban heat Islands in Lahore, Pakistan*



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## Abstract

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In urban settings, the interplay between air pollution and the effects of urban heat islands (UHIs) has a substantial impact on the health of residents as well as the delicate equilibrium of urban ecology and climate. Lahore faces severe environmental issues, notably high levels of urban air pollution stemming from industrial, vehicle, and agricultural practices emissions and urban warming due to urbanization, land use, and local climate change. This study aimed to use remotely sensed data to analyze the seasonal variations in nighttime surface urban heat island intensity (SUHII) as extracted from the MODIS satellite. Furthermore, the study examined the potential use of Sentinel-5 satellite imagery for pollution analysis through the seasonal distribution of significant air pollutants, such as carbon monoxide (CO), sulfur dioxide (SO<sub>2</sub>), and nitrogen dioxide (NO<sub>2</sub>). These pollutants were extracted from the European TROPOspheric Monitoring Instrument (TROPOMI) from March 2019 to February 2023. In

comparison with rural areas, the study found that the concentration of pollutants in urban areas is substantially higher. The findings of the research also reveal the presence of a pronounced nocturnal surface urban heat island over Lahore, particularly in the downtown region, which is mostly composed of urban land use, densely populated areas, high vehicle emissions, and industrial and power generation locations. Summertime is when the SUHII is highest. However, the chosen pollutants also serve as an urban pollution island (UPI) that limits the areas that have higher SUHII. The UHI indicator exhibits a significant positive correlation with pollutants such as CO and NO<sub>2</sub> and a weak positive correlation with SO<sub>2</sub> in urban environments. Urban heat and air pollution have detrimental effects on human health as well as ecology, so this study is crucial for determining the ecological state of the fastest-growing megacity Lahore. This study is noteworthy because, without a regular network of monitoring points, it creatively uses Sentinel-5 satellite data to analyze pollution and air quality over wide areas. This study contributes to a comprehensive understanding of UHI-pollution dynamics and implications, which in turn informs urban planning and policies for urban air quality adaptation and urban environment management.

**Keywords:** - Urban Pollution Islands, Urban Heat Islands, Modis, Sentinel-5P  
Lahore