Proceedings of the 5th International Conference on Environmental Science and Applications (ICESA 2024)
Lisbon, Portugal- November 18 - 20, 2024
Paper No. 120
DOI: 10.11159/icesa24.120

Case Study Of The Cooling Effect Of Trees In The Metropolitan Area Of The Valley Of Mexico In The Context Of The Urban Heat Island

Juan Manuel Núñez[1], Andrea Paola Pérez-Rojas[2], Andrea Santamaría[1]
[1]Centro Transdisciplinar Universitario para la Sustentabilidad, Universidad Iberoamericana Ciudad de México
Prol. Paseo de la Reforma 880, Álvaro Obregón, 01219 Ciudad de México, México
juan.nunez@ibero.mx
[2]Facultad de Ingeniería, Universidad Nacional Autónoma de México
Av. Universidad 3000, C.U., 04510, Coyoacán, México

Extended Abstract

In highly urbanized areas, global warming increases the occurrence of meteorological phenomena such as the urban heat island effect (UHI). This phenomenon is defined as the thermal difference between the urban area and its surroundings, being a clear manifestation of the impact of anthropogenic activities in the urban space, mainly due to the replacement of vegetation by impermeable surfaces whose materials normally have greater thermal inertia. The Metropolitan Zone of the Valley of Mexico (MZVM), one of the largest and most populated urban areas in the world, faces serious UCI problems, which increases energy demand, deteriorates air quality, and affects public health. The MZVM covers around 7866 km2, made up of the 16 municipalities of Mexico City, 59 municipalities of the State of Mexico and 1 municipality of the state of Hidalgo.

This study investigates the cooling effect of urban trees in the MZVM, evaluating their potential to mitigate UCI and improve the quality of life of its inhabitants. Through the estimation of Land Surface Temperature (LST) estimated by using satellite images from the Landsat-8 collection. The period for the heat wave analysis was defined from June 1, 2023 to June 22, 2023. The start and end dates were selected based on temperature metrics performed by the National Meteorological Service [2]. In addition, two more dates were assigned, one before the event, in January, and another after, in July, to be able to compare the results. The images used were obtained with code, with atmospheric correction and 10% cloudiness. Band 10 (TIR) was used for brightness temperature, and bands 4 (RED) and 5 (NIR) were used to calculate NDVI [2]. All within the Google Earth Engine (GEE) platform. In addition, data from the global canopy height map and a high resolution building footprint dataset were used to evaluate the cooling effect of the tree canopy on the built-up area of the city.

The results indicate that areas with higher tree density have significantly lower temperatures than those with little or no tree cover. On average, a decrease of up to 3°C in surface temperatures was observed in areas with high tree cover compared to predominantly urbanized areas. In general, for the three dates, there is a band of high temperatures with a northwest-southeast orientation. It was found that the areas with the highest surface temperature are detected in the center east of the city associated with a higher urban density, as well as in the north of the MZVM, associated with crop areas. During the heat wave of June 2023, for Mexico City, the areas with the least cooling effect are located in the municipalities with the least amount of urban trees: Tláhuac, Milpa Alta, Xochimilco, Tlalpan, Venustiano Carranza, Iztapalapa, Azcapotzalco and Iztacalco. In conclusion, urban trees in the MZVM play a vital role in reducing urban temperatures and mitigating the heat island phenomenon. This study provides empirical evidence on the benefits of trees and offers recommendations for improving urban planning strategies in the MZVM.

References

[1] Minerva López Quiroz, Yenifeer Loranca Domínguez, Aurora Guadalupe Zavala Fajardo, Ana Elena Martínez Melgarejo, Julio Gómez Camacho, Octavio Arturo Farias Nuñez, Vianey Irais Olmos Caballero, José Alfredo López Trujillo. 2023. "Reporte del clima en México" Servicio Meteorológico Nacional (SMN), Coordinación General del Servicio Meteorológico Nacional. Año 13, número 6, pp. 36.

[2] Juan C. Jiménez-Muñoz, José A. Sobrino, Dražen Skokovic, Cristian Mattar, and Jordi Cristóbal. Land Surface Temperature Retrieval Methods from Landsat-8 Thermal Infrared Sensor Data. *11*(10), 1840-1843. 2014.