Title

Machine Learning Based Land Surface Temperature Detection and Health Risk: A Comparative Study in Kibera Slum and Nairobi City

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Abstract

Rapid urbanization in Nairobi City has led to the expansion of informal settlements, with over 60% of the population currently living in slums including Kibera. Consequently, this unregulated growth, characterized by inadequate infrastructure, congested high-density housing made of galvanized iron sheets, impervious surfaces, and extremely limited greening, has been linked to elevated Land Surface Temperature (LST), thereby imposing significant environmental and health risks. Several scholars globally have verified the effectiveness of Machine Learning (ML) in analyzing the relationship between spatio-temporal expansion of urban areas and the LST. In addition to that, recent studies on temperature in informal settlements in Nairobi city have relied on field-based mobile sensors, overlooking time-series analysis and comparative modeling of slums and the city using ML techniques. Therefore, this study integrates ML and remote sensing to assess urban LST dynamics in Kibera Slum and Nairobi City from 2002 to 2025. Specifically, it aims to (1) analyze spatio-temporal dynamics of Kibera slum and Nairobi city using ML algorithms, (2) examine LST trends using MODIS-LST data and (3) investigate the correlation of LST with NDVI, NDBI, population, and population density. Accordingly, Landsat 7, 8, and 9 imagery (30-meter resolution) were processed in Google Earth Engine (GEE) using Random Forest, with 70% of samples for training and 30% for testing. The model achieved overall accuracy of 94.87% for Kibera slum, and 96.21% for Nairobi city. In addition, MODIS-LST data (250-meter resolution) for January were extracted for both locations. Moreover, NDVI and NDBI samples (10 and 50 points in Kibera slum and Nairobi, respectively) were taken and analyzed in areas transitioning from non-built-up to built-up. Results reveal substantial urban expansion and demographic pressure: (i) Kibera slum's population grew by 204% from 134,829 to 406000, with density rising from 53,932 to 162,400 persons/km²; Nairobi city's population increased by 141% from 2,388,000 to 5,767,000 with density rising from 3,430.00 to 8,283 persons/km². This caused Built-up expansion by 16.58% in Kibera slum and 19.66% in Nairobi city, while non-built-up declined by 16.56% and 19.76%, respectively. (ii) Also, LST increased by 8.03°C in Kibera slum, compared to the 3.05°C increase in Nairobi city. (iii) Correlation analysis showed strong associations in Kibera slum between LST and built-up (r2= 0.91), population density (r2= 0.91), and NDBI (r2=0.86), with NDVI negatively correlated (r2=-0.89). Nairobi city exhibited weaker but consistent trends. NDVI declined from 0.35 to 0.10 in Kibera slum and from 0.23 to 0.16 in Nairobi city, while NDBI increased from -0.09 to 0.14 in Kibera slum and -0.04 to 0.20 in Nairobi. These findings highlight the intensification of LST in Kibera slum due to

extreme population density, poor housing, and lack of biophysical buffers. The study aligns with prior research linking elevated LST to increased mortality among children and the elderly in Kibera slum. It recommends the demolition of informal settlements, development of model villages for slum dwellers, and equitable distribution of biophysical infrastructure to mitigate LST effects.

Keywords

Machine Learning; Land Surface Temperature; Health Risk; Informal Settlements; Remote Sensing

Type

Poster / Talk (consider me for oral presentation)