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Temporal Analysis of Urban Sprawl Growth in the Metropolitan Area of Panama Using Google Open Buildings 2.5D Data

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Abstract

Accelerated urban growth in Panama's Metropolitan Area constitutes one of the principal challenges for territorial planning, environmental sustainability, and the efficient provision of essential services. The uncontrolled expansion of urban zones exerts pressure on road infrastructure, natural resources, and the management capacity of local authorities. In this context, the present study develops a spatiotemporal analysis of urban sprawl evolution across the districts of Panama, San Miguelito, Arraijan, La Chorrera, and Colón during the period 2016–2023, using the Google Open Buildings 2.5D dataset, generated from Sentinel-2 satellite imagery with an effective spatial resolution of 4 meters. Building Presence data were processed in Google Earth Engine to delineate built-up area polygons for each district and year, while Building Fractional Count data were used to estimate changes in the number of buildings over time. To evaluate the dynamics of urban expansion, the Standard Deviation Ellipse (SDE) method was applied, enabling the evaluation of growth directionality and spatial dispersion across the study area. The results show sustained growth in urbanized areas between 2016 and 2023 across all districts analyzed, although with spatially distinct patterns depending on their geographic characteristics. Based on the data analysis, highly significant trends were identified that reveal a strong correlation between each district's metrics, spectral bands, and the spatial distribution of the urban footprint. This study significantly expands the available spatial and temporal data of Panama and provides open data to support urban planning processes and strategic decision-making.

Keywords
Temporal Analysis, Urban Sprawl Growth, Metropolitan Area of Panama, Google Open Buildings 2.5D Data.

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