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Urban Ecosystem Transformations in New York City: Insights from Multi-temporal Remote Sensing and Machine Learning

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Abstract:

Urban ecosystems, home to over half of the global population and the powerhouse of worldwide economic activity, are crucial for observing anthropogenic impacts on the environment. In this study, we leveraged advancements in multi-temporal remote sensing and machine learning to analyze ecosystem transformations in a large urban area over nearly a decade, spanning the pre-coronavirus pandemic, pandemic, and post-pandemic periods.

The study area, New York City, served as a bellwether for the United States in containing the pandemic by enforcing a strict "stay-at-home" order for almost two months in 2020. We utilized a dense time series of satellite imagery and ground-based data to analyze changes in air quality, vegetation growth, and thermal patterns. While the city overall became greener and cooler with improved air quality, our statistical and machine learning models revealed complex responses with significant implications for urban sustainability and resilience.

Specifically, the spatial and diurnal variations in land surface temperature highlight the intricate relationship between human activities and the urban ecosystem. The seasonal uncertainties in the impact of reduced air pollutants on urban temperatures emphasize the need to consider changes in energy consumption and residents' heat exposure when developing sustainable urban strategies. The varied responses of green spaces to reduced anthropogenic interference provide insights into their ecological vulnerability during crises.

These findings suggest the complexity of ecological responses to dramatically reduced anthropogenic activities, which have not been adequately addressed in existing literature. Using NYC as a reference, this study enhances our understanding of green spaces' responses to changes in human activity, aiding in the development of targeted management measures and promoting sustainable urban development.

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