Linking Educational Attainment and Urban Green Equity through GIS in East Baton Rouge Parish, Louisiana, United States of America (USA).

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Abstract

Urban tree canopy represents a critical component of urban environmental systems, contributing to local climate regulation, ecosystem services, and community well-being. However, canopy coverage and its persistence often vary among neighborhoods. This study evaluates the spatial and temporal relationship between adult educational attainment and urban tree canopy cover in East Baton Rouge Parish, Louisiana, from 2010 to 2023. High-resolution remote sensing data were integrated with census tract–level educational indicators using geographic information systems to map annual canopy cover, assess canopy change, and compare outcomes across education categories. Results show that canopy loss was unevenly distributed and that the rate of decline increased after 2014. Areas with lower educational attainment had consistently lower baseline canopy cover and greater canopy reduction over time, while areas with higher educational levels retained more stable canopy coverage. These results suggest that canopy change in East Baton Rouge Parish followed a non-linear pattern, with accelerated decline in recent years. The findings highlight the relevance of educational attainment as a social factor influencing urban vegetation outcomes and underscore the need for planning strategies that promote balanced environmental conditions across communities.

Introduction

Urban tree canopy forms a foundational element of urban green infrastructure, supporting environmental sustainability, resilience, and public health. Vegetation in cities helps moderate temperatures, improve air quality, and enhance biodiversity, contributing to both physical and mental well-being (Ruijsbroek et al., 2017; Ning et al., 2016; Keith et al., 2024; Nieuwenhuijsen, 2020). As urban areas expand, integrating green infrastructure into land-use planning has become increasingly important for achieving long-term sustainability (Baker & Mehmood, 2018; Street, 2020).

Despite these benefits, the availability and distribution of tree canopy are often uneven among neighborhoods. Studies indicate that urban greenery tends to be concentrated in communities with greater socioeconomic resources (Nesbitt, 2017; Baró et al., 2021). This uneven distribution can influence local exposure to environmental stressors and overall quality of life, particularly in cities experiencing heat stress and ongoing land conversion (EPA, 2024; Namwamba, 2021). Consequently, understanding the social factors shaping tree canopy distribution is essential for effective urban management.

Previous studies on green infrastructure disparities have emphasized income, race, and land use as explanatory variables (Nesbitt, 2017; Wang et al., 2011). However, these factors do not fully capture community-level processes influencing environmental conditions. Adult educational attainment offers a complementary dimension for analysis, as education is often linked to environmental awareness, participation in community planning, and stewardship behaviors.

While much existing research explores the influence of green spaces on educational outcomes, fewer studies have considered the reverse relationship. Findings suggest that communities with greater educational resources may be better equipped to maintain and protect green infrastructure (Hodson & Sander, 2017; Kuo et al., 2018; Li et al., 2019).

In East Baton Rouge Parish, previous environmental studies have focused on land degradation, urban heat islands, and forest loss related to urbanization (Dadzie et al., 2025;

Namwamba, 2021; Loh et al., 2025). Remote sensing research has revealed notable vegetation and hydrological changes across the parish (Osei et al., 2025), while land-cover datasets point to ongoing conversion of forested areas to impervious surfaces (NLCD, 2021). However, limited attention has been given to education as a factor influencing these patterns.

This study addresses that gap by analyzing the spatial and temporal relationship between adult educational attainment and urban tree canopy cover in East Baton Rouge Parish from 2010 to 2023. By integrating remote sensing data with census indicators, this research provides new empirical insights into how education relates to vegetation dynamics in urban areas.

Research Objectives

1. Map annual tree canopy coverage in East Baton Rouge Parish from 2010 to 2023.
2. Analyze spatial and temporal changes in canopy cover from 2010 to 2023.
3. Examine the relationship between adult educational attainment and tree canopy coverage.
4. Provide policy recommendations for balanced and inclusive urban greening.

Methods

Study Area

This study was conducted in East Baton Rouge Parish (Figure 1), Louisiana, USA (30° 32' 24" N, -91° 05' 24" W). The parish includes urban and rural areas, spanning from Mississippi River plains to upland terraces (Heinrich, 2008). Historically dominated by hardwood forests and wetlands, much of the natural landscape has been modified by development (EPA, 2024; NLCD, 2021).

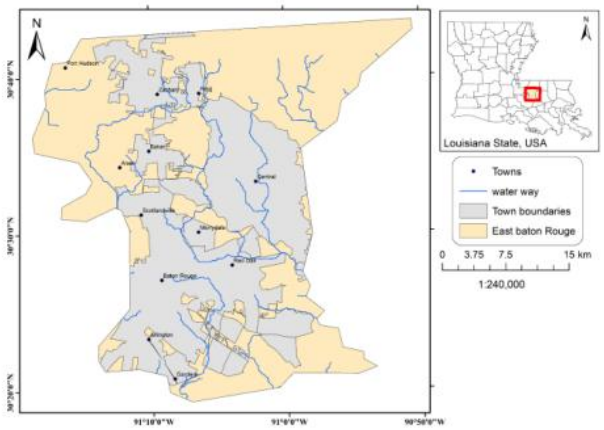

Figure 1: Study Area Map (East Baton Rouge Parish)

Source: Osei et al. (2025)

Data Sources and Processing

Tree canopy data were derived from the Hansen Global Forest Change dataset (2010-2023) and processed in Google Earth Engine. Annual canopy data were aggregated at the census tract level to align with socioeconomic variables.

Educational attainment data were obtained from the U.S. Census Bureau, measuring the share of adults aged 25 and older with a high school diploma or higher and those with bachelor's degrees or higher. Additional variables, median household income, housing age, and impervious surface coverage were compiled for context (Nesbitt, 2017; Wang et al., 2011).

Spatial analyses were conducted in ArcGIS Pro using overlay and zonal statistics to generate annual canopy estimates and visualize spatial change patterns (Figure 2).

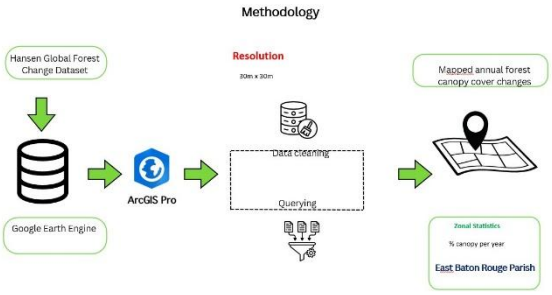

Figure 2: Methodological work flow

Results and Discussion

Between 2010 and 2023, East Baton Rouge Parish experienced a measurable decline in urban tree canopy

cover, consistent with earlier findings on land degradation and vegetation loss in the region (Dadzie et al., 2025; Loh et al., 2025).

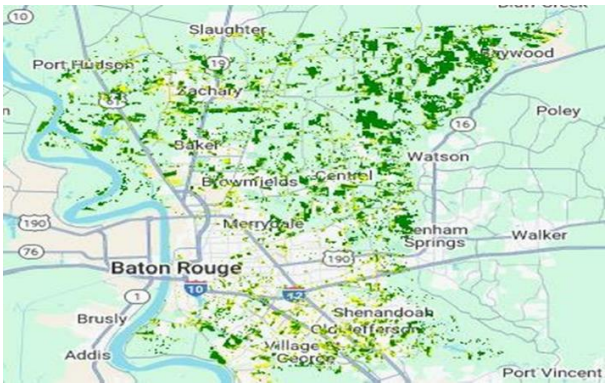

Figure 3: Spatial representation of Tree Canopy distribution in 2010

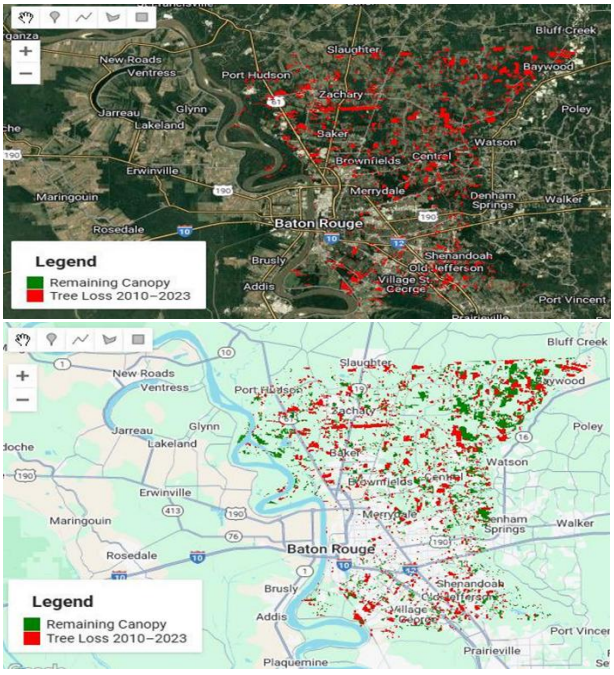

Figure 4: Spatial representation of Tree Canopy distribution in 2023

Spatial analysis indicates that canopy loss was not evenly distributed across the parish (Figure 4 and 5). In addition to spatial heterogeneity, the temporal pattern of tree canopy change reveals a pronounced shift in the rate of canopy decline over the study period. Specifically, East Baton Rouge Parish experienced a relatively modest reduction in tree canopy cover between 2010 and 2014, followed by a markedly sharper decline from 2014 to 2023. This acceleration in canopy loss suggests a temporal intensification of landscape change processes affecting urban and peri-urban vegetation (Figure 3, and 4).

The post-2014 period corresponds to increased urban expansion, infrastructure development, and land-use conversion documented within the parish, which have been associated with forest fragmentation and vegetation removal (NLCD, 2021; Dadzie et al., 2025). Remote sensing evidence further indicates that canopy reduction during this later period was spatially concentrated in rapidly developing neighborhoods and areas characterized by increasing impervious surface coverage, reinforcing the role of urbanization pressures in shaping canopy trajectories (EPA, 2024; Osei et al., 2025).

Importantly, the magnitude of canopy decline from 2014 to 2023 was substantially greater than that observed during the earlier 2010–2014 interval, indicating that canopy loss in East Baton Rouge Parish has not followed a linear or uniform trend over time (Figure 5). Rather, the observed pattern reflects a phase of accelerated canopy degradation in the latter years of the study period. This temporal discontinuity underscores the importance of long-term, high-resolution monitoring in urban forestry research, as shorter study windows may underestimate the intensity and timing of canopy loss.

When examined alongside socioeconomic patterns, the accelerated post-2014 canopy decline disproportionately affected census tracts with lower baseline canopy cover and lower levels of adult educational attainment, further reinforcing the intersection between temporal canopy dynamics and social vulnerability. While this study does not formally model causal mechanisms, the convergence of spatial concentration and temporal acceleration highlights critical periods during which urban greening interventions may be most urgently needed.

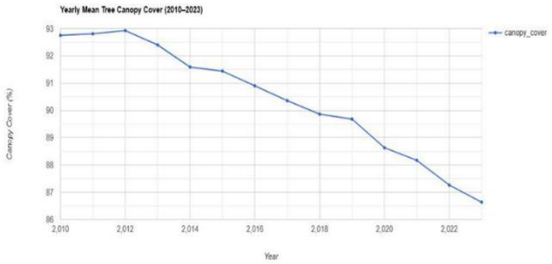

Figure 5: Graphical representation of Tree Canopy distribution (2010-2023)

Census tracts characterized by lower levels of adult educational attainment (Figure 6) consistently exhibited lower baseline canopy cover and greater canopy decline over time. In contrast, tracts with higher proportions of college-educated adults maintained higher average canopy coverage and experienced lower rates of canopy loss. On average, higher-education tracts exhibited approximately 11.3% greater canopy cover and roughly 17% less canopy decline over the study period, based on tract-level aggregation.

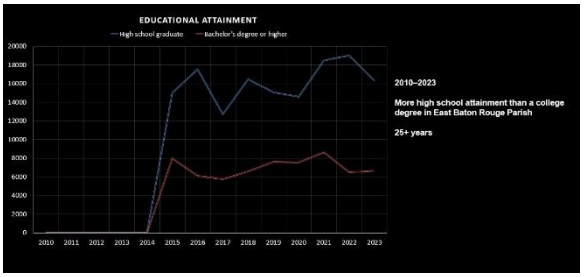

Figure 6: Educational attainment of residents in East Baton Rouge 2010-2023

Source: USA Census Bureau (2024) [EAST BATON ROUGE PARISH]

These spatial patterns align with broader literature on urban green inequities, which shows that socially advantaged communities tend to have greater access to and retention of green infrastructure (Nesbitt, 2017; Baró et al., 2021). Although this study does not statistically isolate the independent effect of education, the persistence of these patterns across space and time suggests that education is meaningfully associated with urban tree canopy outcomes.

Potential mechanisms linking education and canopy outcomes include greater environmental awareness, stronger civic engagement, and increased participation in local planning processes among more educated communities. These findings complement previous studies demonstrating the benefits of green spaces for educational outcomes (Hodson & Sander, 2017; Kuo et al., 2018; Li et al., 2019) and extend the literature by suggesting a reciprocal relationship in which education may also influence environmental conditions.

Policy Implications

Findings highlight the value of incorporating education-related indicators into urban forest management and planning. Integrating environmental learning into local education systems may promote long-term stewardship. Municipal programs can strengthen canopy management by prioritizing maintenance and planting in areas with limited canopy cover and by supporting community-based greening initiatives. These approaches can enhance environmental quality and promote locally driven, sustainable management of natural assets.

Limitations

This study focused on education as the primary social factor associated with canopy variation. While other socioeconomic variables were included for context, their interactions were not modeled. The remote sensing data used provided consistency across years but may be limited by image resolution in highly urbanized zones. Moreover, this ecological-level analysis does not capture individual-level attitudes or behaviors related to tree management or environmental participation.

Conclusion

The study demonstrates a clear spatial and temporal association between educational attainment and urban tree canopy cover in East Baton Rouge Parish from 2010 to 2023. Areas with lower education levels experienced greater canopy reduction, while those with higher education maintained more stable coverage. These results underscore the relevance of education as a factor shaping urban vegetation outcomes. Promoting canopy resilience will benefit from strategies that integrate environmental management, community participation, and education-based capacity building.

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