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Research note: Greater tree canopy cover is associated with lower rates of both violent and property crime in New Haven, CT

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HIGHLIGHTS

- Tree canopy cover was inversely associated with crime in New Haven, CT.
- A 10% increase in tree canopy was associated with a 15% decrease in violent crime.
- A 10% increase in tree canopy was associated with a 14% decrease in property crime.
- Results add to the body of evidence suggesting trees' crime prevention potential.

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ABSTRACT

Evolving literature suggests that modifiable neighborhood characteristics such as trees and other vegetation are inversely associated with crime. This study examines the relationship between vegetation and crime in New Haven, CT, a midsized city with high crime rates. Spatial lag analyses were used to test the association of tree canopy coverage, measured through high-resolution aerial imagery, with rates of violent (murder, rape, robbery and assault), property (burglary, theft, motor vehicle theft and arson) and total (violent + property) crimes. Greater tree canopy coverage was associated with lower rates of violent, property and total crime, independent of block group level educational attainment, median household income, racial/ethnic composition, population density, vacancies and renter-occupied housing, as well as spatial autocorrelation. Results support the general findings from studies conducted in larger cities, including Chicago, Portland, Baltimore and Philadelphia and points toward trees' crime prevention potential.

1. Introduction

Crime, particularly violent crime, is a major concern for many cities in the United States and worldwide (United Nations Centre for Human Settlements, 2005). Solutions to the problem of urban crime require a multi-faceted approach. Evolving literature suggests that potentially modifiable neighborhood characteristics such as trees and other vegetation are inversely associated with crime, so urban greening could be a relatively low-cost component of the solution.

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The traditional law enforcement view was that dense vegetation encouraged crime by obstructing surveillance and providing concealment for criminal activity (Jeffery, 1971; Michael & Hull, 1994; Michael, Hull, & Zahm, 2001; Newman, 1978). This view was reinforced by studies that linked dense vegetation with crime and fear of crime (Fisher & Nasar, 1992; Nasar & Fisher, 1993; Shaffer & Anderson, 1985). The prevailing message from these studies was that removal of vegetation could aid in crime reduction efforts, despite the fact that none of these studies measured crime occurrence.

However, more recent studies using crime data from police reports and other sources have found a negative relationship between vegetation and crime. A 2001 study of a public housing development in Chicago was first to link vegetation with actual counts of crime from police reports (Kuo & Sullivan, 2001). The authors posited that some vegetation may offer crime-reducing benefits through three mechanisms: (1) actual surveillance, since green spaces attract people for recreation and other activities, leading to more "eyes on the street"; (2) implied surveillance, whereby attractive landscaping is a "cue to care" suggesting that residents pay attention to property; and (3) by mitigating mental fatigue, a precursor to violent behavior. Greater vegetation surrounding apartment buildings, as measured via aerial and ground-level photographs, was associated with fewer reports of total, property and violent crimes, even after controlling for potential confounders (e.g., number of apartments per building, vacancy rate, building height).

A 2012 study in Portland, Oregon examined associations of different types of vegetation with crime (Donovan & Prestemon, 2012). On private lots, smaller trees that obstructed views were associated with more crime, while taller trees and street trees were associated with less crime. Another study employed spatial analyses to control for spatial autocorrelation and used high-resolution aerial imagery to measure tree canopy cover across block groups in Baltimore County, Maryland. A 10% increase in tree canopy cover was associated with a 12% decrease in the density of robbery, theft, burglary and shooting crimes per km^2, after adjusting for socio-demographic characteristics (Troy, Morgan Grove, & O'Neil-Dunne, 2012). Similarly, a spatially explicit study in Philadelphia found that greater vegetation, measured using satellite imagery, was associated with lower rates of assault, robbery, and burglary (i.e., breaking, entering to steal property), but not theft (i.e., stealing alone) (Wolfe & Mennis, 2012). Suggestions of a causal relationship between vegetation and crime was found in a quasi-experimental study of a vacant lot greening program in Philadelphia. This study compared differences in crime rates before and after a 10-year long greening program between greened lots and control lots and found that vacant lot greening was associated with reductions in gun assaults and vandalism (Branas et al., 2011). Taken together, these studies highlight the association between increased vegetation and less crime and provide insight into the nuances of this relationship including how different types of vegetation are differentially related to various crime categories.

The current study extends previous work in several important ways. First it tests the generalizability of previous findings in major cities, i.e. Chicago (population 2.7 million), Portland (population 600,000), Baltimore (population 600,000) and Philadelphia (population 1.5 million), by examining the relationship between vegetation and crime in New Haven, Connecticut, a medium-sized city (population 130,000) with a high crime rate (US Department of Justice, 2012). Second, this is the first study of vegetation and crime to use the Federal Bureau of Investigation's Uniform Crime Report (UCR) codes to categorize crime incidents into property crimes and violent crimes while also using high-resolution aerial imagery and spatial analysis techniques. Our crime outcomes provide a nationally replicable measure of crime and are consistent with criminology and economic literature on differential incentives and deterrents to property and violent crime (Kawachi, Kennedy, & Wilkinson, 1999; Kelly, 2000). Lastly, the crime outcomes examined in this study include crimes such as rape, murder, and arson, which were not often considered in other studies of vegetation and crime.

2. Methods

2.1. Study setting

New Haven, CT has a land area of 18.7 mi^2 and a population of approximately 130,000 (US Census Bureau, 2013). Neighborhood boundaries were defined by 2010 Census block groups ($N = 106$). Overall, New Haven's crime rate is 64.5 crimes per 1000 people, or 2.7 times the state rate and 2.0 times the national rate, but rates within block group vary from 0.5 to 10.0 times the state rate and from 0.4 to 7.5 times the national rate (US Department of Justice, 2012). Known as the Elm City, New Haven is home to 32,000 street trees and parks covering 2200 ac (City of New Haven, 2015). Approximately 38% of all land is covered by tree canopy, higher than the average tree canopy cover for U.S. cities of similar size (Pelletier & O'Neil-Dunne, 2009).

2.2. Measures

2.2.1. Crime rates

Crime data came from Data Haven, an organization based in New Haven, CT that provides research support to local non-profits. Using crime incident data from the New Haven Police Department, Data Haven, in conjunction with the Connecticut FBI field office, categorized crime incidents according to official UCR crime categories and geocoded crime incidents to summarize the number of crimes per year by block group for each UCR crime category (Federal Bureau of Investigation, 2011). We used rates of violent (murder, rape, robbery and assault), property (burglary, theft, motor vehicle theft and arson) and total (violent + property) crimes, as outcomes in separate regression models. For each block group, we calculated crime rates as average number of crimes annually from 2008 to 2012 per 1000 residents. Block group populations were drawn from the 2008–2012 American Community Survey (ACS) (US Census Bureau, 2013).

2.2.2. Tree canopy cover

Data on tree canopy cover, defined as the percent of ground for each block group that is covered by leaves, branches and stems of trees when viewed from above (Pelletier & O'Neil-Dunne, 2009), were provided by the Spatial Analysis Laboratory at the University of Vermont. This was mapped in summer 2008 by calibrating 30-m land cover data from the National Land Cover Database (Vogelmann et al., 2001) with 1-m aerial imagery (Pelletier & O'Neil-Dunne, 2009). This process was able to isolate and geo-locate individual trees crowns, from which canopy cover was derived.

2.2.3. Control variables

Correlates of crime known from previous research (Ellis, Beaver, & Wright, 2009; Troy et al., 2012; Wolfe & Mennis, 2012) were included to test the association of tree canopy cover with crime, independent of potentially confounding block group-level variables. Socio-demographic control variables included educational attainment (% of block group population without a high school degree), race/ethnicity (% Black, % Hispanic), and median household income. Population density (1000 people/sq. mi.), percentage of vacant housing units and percentage of renter occupied housing units were also included as controls. These data were obtained from block group level estimates from the 2008–2012 ACS (US Census Bureau, 2013).

2.3. Statistical analysis

To describe characteristics of our sample of block groups, we calculated mean, standard deviation and range for each variable. We examined choropleth maps shaded in proportion to tree canopy cover and levels of crime to compare spatial patterns and check for spatial clustering of crime, which is often confounded by spillover effects from neighboring locations. Next, we fit ordinary least squares (OLS) regression models to test association between tree canopy cover and each crime outcome (violent, property, total), independent of control variables. We tested linear regression assumptions and model fit with residual, influence and fit statistics. Due to non-normally distributed error terms, we applied a natural log transformation to the outcome variables after histograms