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The Inequality of Mundane Environmental Change: Assessing the Impacts of Socioeconomic Status and Race on Neighborhood Land Development, 2001–2011

Matthew Thomas Clement[1] and Camila Alvarez[2]

Abstract

Theoretical frameworks in environmental inequality suggest that affluent, white, and educated communities have a greater ability to control local environmental change. With a focus on neighborhood-level land development, the authors evaluate this proposition considering the spatial shifts that are reshaping metropolitan areas across the United States at the beginning of the twenty-first century. With coverage for 52,473 metropolitan census tracts, the authors integrate sociodemographic variables from governmental sources with longitudinal data on developed land area from the National Land Cover Database, 2001–2011. Controlling for a host of other factors, results from spatial regression models with fixed effects show that new land development is negatively associated with affluence and educational attainment. Situating the notion of environmental privilege in a historical context, we propose that, with the "back to the city" movement, these groups are moving back into the urban core, which is already relatively built-out and thus has a lower rate of new land development.

Keywords

environmental inequality, land development, census tracts, spatial regression, suburbanization of poverty

Introduction

Environmental social scientists have long had an interest in the inequality or injustice of environmental change, especially along lines of race and socioeconomic status. Much of the conceptual and empirical work in this area concerns the unequal exposure to hazardous environmental conditions (Bullard 1990; Downey and Hawkins 2008). In this research, quantitative scholars have focused much attention on how demographic and economic factors influence exposure to noxious outcomes (Liévanos 2017), especially industrial air toxins (Ard and Fairbrother 2017; Crowder and Downey 2010). As the scholarship on environmental injustice matured, there was a

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concurrent, emerging focus on the notion of environmental privilege. Initially, environmental privilege was understood as the ability of dominant groups to avoid hazardous pollutants and dangerous ecological conditions (e.g., Pulido 2000); subsequently, work on environmental privilege has grown to include the flip side of this dynamic, that is, unequal access to highly valued environmental amenities or goods (e.g., parks, lakes, healthy foods, etc.) (Gould and Lewis 2012; Park and Pellow 2011; Pellow and Brehm 2013; Winkler 2013). As two sides of the same coin, environmental injustice and privilege are connected through their recognition that groups with greater political-economic power in society are better able to preserve the character of their local environments while displacing noxious change onto communities with less power (Rudel 2012; see also Logan and Molotch 2007).

Drawing from this framework of environmental inequality, we examine the construction of the built environment (i.e., land development), as a form of environmental change.[1] While the built environment certainly has negative ecological impacts (e.g., loss of habitat, nutrient pollution, urban heat islands; Raciti et al. 2012; Seto, Güneralp, and Hutyra 2012; Sobstyl et al. 2018; Wang et al. 2016), its impacts on humans are not as immediately noxious as the pollutants studied in much of the quantitative literature, such as industrial air toxins.[2] Moreover, the construction of the built environment (i.e., the development of land in the form of the impervious surfaces and structures that make up the built environment) represents, relatively speaking, a more mundane, or ordinary, process of environmental transformation. As a form of environmental change, land development is more visibly recognizable and present across time and space, compared to many of the hazardous outcomes previously examined by quantitative scholars. Furthermore, while there has been a historical decline in industrial air toxins (Ard 2015), the construction of the built environment is a mostly cumulative and relatively irreversible ecological impact. Indeed, natural resources are required simply to maintain the impervious surfaces and structures that make up the built environment. Therefore, expanding the area of developed land raises the floor on the minimum amount of natural resources consumed by society (Güneralp and Seto 2012; York 2008, 2012). Given this context, it is noteworthy that there have been far fewer quantitative studies focusing on inequality as a force behind the construction of the built environment; to that end, the following analysis contributes to the literature on environmental inequality.

Meanwhile, utilizing the notion of privilege, theoretical frameworks in environmental inequality suggest that affluent, white, and educated communities have a greater ability to control local environmental change. We evaluate this proposition with respect to land development in a specific historical context, that is, the spatial shifts that are reshaping the demographics of American metropolitan areas at the beginning of the twenty-first century. Described as the "urban revival" or the "back to the city" movement and its correlate the "suburbanization of poverty" (Couture and Handbury 2016; Florida 2010, 2016; Kneebone and Garr 2010), the spatial redistribution of metropolitan demographics presents novel questions for scholars studying the inequality of environmental change. In the following study, we ask: With a focus on the built environment, what are the environmental consequences of the "back to the city" movement and the "suburbanization of poverty"? Are groups with greater political-economic power moving into the built-out urban core rather than using their influence to preserve undeveloped land and open space in their home communities? If so, what implications do these spatial shifts have for our understanding of inequality and privilege as forces behind ordinary processes of environmental change?

To address this question, we first review the relevant literature on environmental privilege and then derive hypotheses considering how recent spatial demographic shifts might be modifying the dynamics of environmental inequality. Next, we describe the data and analytic techniques we use to evaluate these hypotheses. For the analysis, we collect sociodemographic information on all metropolitan census tracts within the continental United States (N = 52,473) and integrate these data with longitudinal information on built-up (i.e., developed) land area from the National Land Cover Database (NLCD), 2001–2011. In spatial regression models with fixed effects, we estimate the independent effects of changes in affluence, race, and educational attainment on the construction of the built environment (i.e., land development). At the level of the census tract, results from these models show that change in built-up land area is negatively associated with rising affluence and educational attainment. In the conclusion, we discuss the implications of this finding for theory and policy.

Literature Review

In this literature review, we present two alternative yet complimentary perspectives regarding the impact of environmental inequality and privilege on land development. The first perspective includes the bulk of sociological research on land development, describing how communities with greater political-economic power will slow down the development of land, through a process that Harvey Molotch (1976) termed "aristocratic conservation" and Thomas K. Rudel (2012) called "defensive environmentalism."[3] The second perspective takes into consideration the "back to the city" movement and the "suburbanization of poverty." With this perspective, we propose that the spatial redistribution of metropolitan demographics in the beginning of the twenty-first century is potentially modifying the conventional dynamics of environmental inequality and privilege. Ultimately, we frame these perspectives as complementary approaches to environmental privilege, simply differing in the degree of historical specificity; the "back to the city" movement and the "suburbanization of poverty" offer a unique historical context to the discussion about environmental privilege.[4]

Defensive Environmentalism/Aristocratic Conservation

Much qualitative and quantitative research on the built environment and landscape transformation has taken one of two tracks. Scholarship on the first track, which is typically qualitative, has conducted localized or comparative studies, identifying how the features of inequality in a particular community have influenced processes of land development (e.g., Gould and Lewis 2012; Rudel 2009; Winkler 2013). For instance, Thomas K. Rudel (2009), in his case study of suburban land development in New Jersey, identifies a process of environmental inequality that he later calls "defensive environmentalism" (Rudel 2012); in other words, communities with greater political-economic power, which tend to be affluent, white, and educated, are better able to shape decisions about local land development, which in the case of suburban New Jersey meant slowing down the construction of the built environment to preserve undeveloped land and open space. While he describes this process as defensive environmentalism, it is similar to what others have called "aristocratic conservation" (Molotch 1976:328) or "green gentrification" (Gould and Lewis 2012), and part of the broader framework of "environmental privilege" (Pellow and Brehm 2013), which, as previously noted, is the obverse of "environmental injustice." All the same, while environmental privilege case studies illuminate important socioecological dynamics unique to a specific time and place, their findings are not readily generalizable to a larger population.

On the second track, more generalizable, quantitative scholarship has focused on the demographic dynamics behind land development at the county level, with race and socioeconomic status playing secondary roles as control variables (e.g., Clement, Chi, and Ho 2015; Clement and Podowski 2013; Clement and York 2017). In this research, there is some evidence to suggest that race and socioeconomic status might have effects on the construction of the built environment comparable to research on the qualitative track, but the results from the quantitative studies are not consistently significant. Considering their focus on demographic dynamics, it is important to reiterate that these quantitative studies treat race and socioeconomic status as control variables. Moreover, as a level of analysis, the county is suitable for assessing the impact of population size on land development; nevertheless, given its scale, the county is not adequate for testing propositions about the unequal exposure of environmental change, including land development, by race and socioeconomic status.

Having said that, we recognize that there are other quantitative studies by social scientists utilizing lower levels of analysis to examine the relationship between inequality and land cover within the United States. However, these studies tend to be regionally focused (e.g., Wilson and Brown 2015) or cross-sectional snapshots of the distribution of tree cover within, at most, a handful of urban areas (e.g., Harlan et al. 2008; Schwarz et al. 2015). Results from the tree cover studies suggest that, at one point in time, communities with greater affluence and more white households have more tree cover. On that note, we reiterate a few points: First, these scholars are not looking at general effects across metropolitan areas; second, the tree cover studies are not explicitly looking at developed land; and third, these researchers either do not incorporate longitudinal data or do not control for unit and period fixed effects to minimize omitted variable bias (Allison 2009). Therefore, given the above overview, we emphasize that quantitative scholars have not thoroughly examined the longitudinal relationship between demographic change and change in the built environment across the United States. In other words, as the focus of generalizable, quantitative scholarship, the link between privilege and land development is still underexplored.

To address that gap, we present a second, complementary perspective on the potential link between environmental privilege and land development, which we frame in terms of the recent spatial redistribution of metropolitan demographics.

Back to the City/Suburbanization of Poverty

Since the 2000 Census, one of the more noticeable changes in the geographic distribution of the U.S. population is what scholars have called the “urban revival” or the “back to the city” movement and its correlate the “suburbanization of poverty” (Couture and Handbury 2016; Florida 2010, 2016; Kneebone and Garr 2010).[5] In the United States, between the 2000 and 2010 Census, the number of impoverished people living in the suburbs exceeded the number living in the inner city. This was a historical shift; in post–World War II America, corporate capital had been concentrated in the inner city, and residential affluence had been dispersed in the suburbs (Smith 1979). Social scientists in the late 1990s, using the data available, continued to frame residential mobility in terms of “white flight” to the suburbs, finding that high crime and low employment were inhibiting back-to-the-city moves (South and Crowder 1997). In the beginning of the twenty-first century, however, the demographics of residential mobility were starting to change, picking up speed especially around 2005 (Raphael and Stoll 2010). Increasingly, affluent households were, and are still, moving back to the urban core, ultimately displacing impoverished communities from the inner city and into the suburbs, where the cost of living became less expensive. To be clear, inner cities also experienced an increase in the number of impoverished people, but the absolute and relative changes in the poor population are far higher in the suburbs. This relative redistribution of affluent households from the suburbs to the urban core is a defining characteristic of the twenty-first century “urban revival” of metropolitan America.

Other urban scholars argue that this spatial redistribution has been changing not only the overall level of affluence in urban neighborhoods but also their racial composition (e.g., Hyra 2015). Indeed, the changing racial demographics of metropolitan areas has been the focus of news stories in the popular press (Saunders 2017). According to this literature, the population of white households has experienced a relative decline in the suburbs and a relative increase in the urban core. Thus, in terms of its racial composition, the “back to the city” movement is said to be comprised of white households. Likewise, in this spatial-demographic shift, social scientists also observe that highly educated households are leaving the suburbs to take up residence in the urban core (e.g., Couture and Handbury 2016). This change became a key proposition for Richard Florida's (2010) argument about the rise of the creative class. While the creative class, according to Florida, is not reducible to a group of highly educated people, educational attainment is an essential dimension of the concept. Moreover, like affluence and race, changes in overall educational attainment represent one of the neighborhood-level effects of the "back to the city" movement, particularly as it has resulted in a "powerful wave of gentrification [that] has swept urban areas" (Florida 2010:93). Indeed, according to Richard Florida (2016), the forces that are reshaping American metropolitan areas in the twenty-first century "have drawn the affluent, educated, and white to the urban core," thereby displacing other demographic groups to the suburbs.

The above literature review summarizes the key propositions of the "urban revival," the "back to the city" movement and its correlate the "suburbanization of poverty." In this study, we assess whether and how these processes affect neighborhood-level land development across metropolitan areas in the United States. We frame this discussion considering that the inner city is receiving a disproportionate number of "affluent, educated, and white" households, and the suburbs are experiencing a relatively greater influx of impoverished households, racial minorities, and residents with low educational attainment. Meanwhile, the rates of land development vary as one moves between the urban core and the suburbs. On average, inner-city neighborhoods are already built-out; that is, compared to the suburbs, the urban core has less land to develop because it is already covered in human-constructed impervious surfaces (e.g., Raciti et al. 2012; Sobstyl et al. 2018; Wang et al. 2016). As a result, the *rate* of new land development is lower in the urban core than in the suburbs. In other words, suburban neighborhoods have more new land development because they have more developable land.[6]

Thus, this alternative perspective does not focus as much on how groups with greater political-economic power can use their influence intentionally to preserve undeveloped land in their home communities, thereby slowing down land development. Rather, the varying degrees of political-economic power of different demographic groups is expressed in terms of their mobility between suburban and inner-city neighborhoods. In the early twenty-first century, affluent, educated, and white households have been using their resources to move out of the suburbs and into the urban cores of metropolitan areas across the United States. In this light, the "urban revival" perspective offers a historically specific context for studying the relationship between land development and environmental privilege. This perspective differs from the notions of "aristocratic conservation" and "defensive environmentalism" in describing how these demographic groups related to the rate of land development.

To summarize, the conventional approach to environmental privilege suggests that those groups with more political-economic power have a greater ability to control local environmental change. Meanwhile, in the beginning of the twenty-first century, there has been a spatial redistribution of the demographics of American metropolitan areas. Based on this alternative perspective, affluent, white, and educated groups use their political-economic power not to preserve undeveloped land and open space in their home communities; rather, they are moving into the built-out urban core where the rate of land development is lower. As affluent, educated, and white households are moving to the inner city, which is already built-out and thus has a lower rate of new land development, we expect to see that the increase in the size of these groups is negatively correlated with the change in the amount of developed land. This is the context in which we formulate our hypotheses.

Hypotheses

Based on the above literature, we present a set of three hypotheses regarding the impact of changing demographics on neighborhood-level land development over time:

Hypothesis 1 (H1): As the median household income goes up, the rate of land development slows down.

Hypothesis 2 (H2): As the proportion of the population who is White increases, the rate of land development goes down.

Hypothesis 3 (H3): As the proportion of the population who have greater than a high school degree increases, the rate of land development goes down.

In other words, the slope estimates for all three variables are expected to be negative.

Data

To test these hypotheses, we integrate data from three different sources: the NLCD, the Longitudinal Tract Database (LTDB), and the Wharton Residential Land Use Regulation Index (WRLURI).

First, we collect land cover and land area data from the NLCD (Fry et al. 2011). The NLCD is published by the Multi-Resolution Land Characterization consortium, which is a collaboration of several federal agencies, including most prominently the U.S. Geological Survey and NASA (National Aeronautics and Space Administration). The NLCD data have been utilized by social scientists studying land development (e.g., Chi and Ho 2018; Liévanos 2015; Wilson and Brown 2015); they are based primarily on satellite images of 30 × 30 square meter parcels taken across the continental United States; the images of the parcels of land are then categorized into sixteen different types of land cover. Of these sixteen types, there are four categories of developed land, which are distinguished by the proportion of the parcel covered by human-constructed impervious surfaces. These categories include (1) developed open space (<20 percent covered); (2) developed, low-intensity space (20–49 percent covered); (3) developed, medium-intensity space (50–79 percent covered); and (4) developed, high-intensity space (80–100 percent covered). For this study, we download data on the four categories of developed land for the 2001 and 2011 waves of the NLCD data. For each wave, using the NLCD raster file and a harmonized shapefile from the LTDB (see below), we tabulate the areas for each of the four categories of developed land for all the metropolitan census tracts in our study (N = 52,473) (see Figure 1). Next, we weight and then sum up the four categories of developed land; at the level of the census tract, this calculation gives us two waves of data (for 2001 and 2011) for the total amount of area covered by the impervious surfaces and structures that make up the built environment; we then divide this value by total land area.[7] This procedure yields the information we use to construct our dependent variable: *developed land area as a proportion of total land area*. Because this is measured over time, the dependent variable represents change in developed land area at the neighborhood level between 2001 and 2011. (See Table 1 for a description of all variables used in the study.) The 2001 and 2011 values were first logged-transformed and then first-differenced, yielding a proportional change-score between the two waves. The denominator value for total land area within each census tract was also derived from the NLCD.

Second, we collect the majority of the predictor variables from the LTDB. The LTDB is published by a group researchers at Brown University (Logan, Stults, and Xu 2016; Logan, Xu, and Stults 2014). Between each decennial Census, the U.S. federal government changes some (but not all) of the boundaries of census tracts (as well as other administrative units). The tracts that change can be split up into separate, smaller tracts or consolidated and merged into a single, larger tract. Ultimately, any change to the boundaries of census tracts complicates longitudinal analysis because the areal units are not comparable over time, hence the modifiable areal unit problem (Downey 2006). To address this, for the census tracts that change, the LTDB uses a series of statistical-geographic techniques to harmonize their boundaries and make them

Figure 1. Map of study area in continental United States.
Note. This figure is included simply to illustrate the scope of metropolitan tracts used in the study. The scale of the map obscures delineation of the boundaries of all the census tracts ($N = 52{,}473$) being analyzed.

comparable over time. The LTDB provides not only harmonized variables but also a harmonized shapefile to be used in ArcGIS (see Logan et al. 2016; Logan et al. 2014; for a complete description of the methodology used to harmonize tract boundaries). From the LTDB for 2000–2010, we collect information on three primary predictors for socioeconomic status and race as well seven control variables. For our primary predictors on socioeconomic status and race, we include the following three variables: (1) *median household income*, (2) *proportion of the population who are non-Hispanic white*, and (3) *proportion who have greater than a high school degree*. The following are the seven control variables we collected from the LTDB; these are included to control for demographic, economic, and infrastructure factors: (1) *total population size*, (2) *proportion employed in manufacturing*, (3) *proportion unemployed*, (4) *median home value*, (5) *proportion who are renters*, (6) *proportion of housing units aged 30 years or older*, and (7) *proportion of housing units that are vacant*.[8] These primary and control variables from the LTDB are time-variant, first-differenced, change scores, representing change between the years 2000 and 2010. To control for potential floor/ceiling effects in the initial level of development within a census tract, we also incorporate the starting values for the dependent variable measured in 2001 as well as all primary and control variables, which are measured in the year 2000. Like the dependent variable, all LTDB variables have been logged. For the time-variant change scores, the log transformation was done before calculating the first-differences. For *median household income* and *median home value*, the values were adjusted for inflation (using the consumer price index) before logging and calculating the first-difference. Last, a small constant of “1” was added to variables with any zero-values before logging.

Third, the WRLURI (Gyourko, Saiz, and Summers 2008) provides a cross-sectional snapshot of information on the regulatory environment of residential construction across the United States. To construct the WRLURI, the researchers, in 2005, conducted a nation-wide survey, asking local planning directors a series of questions to gauge how restrictive state and local regulatory

Table 1. Variables, Sources, and Descriptions ($N = 52{,}473$).

Variables	Source	Description
Dependent variable (Δ between 2001 and 2011)		
1. Developed land as a proportion of total land area	National Land Cover Database	Developed Land Area (in square meters) Divided by Total Land Area (in square meters)
Primary predictors (Δ between 2000 and 2010)		
2. Median household income	Longitudinal Tract Database	Median household income
3. Non-Hispanic white	Longitudinal Tract Database	Number of non-Hispanic white residents divided by total population
4. Greater than high school degree	Longitudinal Tract Database	Number of people who have more than a high school degree (i.e., have at least attended some college) divided by total population
Controls (Δ between 2000 and 2010)		
5. Total population size	Longitudinal Tract Database	Total number of residents
6. Employed in manufacturing	Longitudinal Tract Database	Persons employed in manufacturing divided by civilian labor force 16 years or older
7. Unemployed	Longitudinal Tract Database	Persons unemployed divided by civilian labor force 16 years or older
8. Median home value	Longitudinal Tract Database	Median home value
9. Renters	Longitudinal Tract Database	Rented housing units divided by occupied housing units
10. Housing units aged 30 years or older	Longitudinal Tract Database	Housing units aged 30 years or older divided by total housing units
11. Vacant housing units	Longitudinal Tract Database	Vacant housing units divided by total housing units
Controls (time invariant)		
12. State-Level Land Use Regulatory Index (2005)	Wharton Residential Land Use Regulation Index (WLRURI)	Measure was derived from Gyourko, Saiz, and Summers (2008), who conducted a nation-wide survey of local planning directors about how restrictive state and local regulatory processes of land use and land development are. We used the average WLRURI for each state from Gyourko et al. (2008).
13. Latitude	National Land Cover Database	Latitude of centroid of census tract (in degrees from equator)
14. Longitude	National Land Cover Database	Longitude of centroid of census tract (in degrees from prime meridian)
15. Total land area	National Land Cover Database	Total land area (in square meters)

Note. All variables are logged with the exception of State-Level Land Use Regulatory Index, Latitude, and Longitude. Time-variant predictors were logged before calculating first-differences.

processes were when it comes to land use and land development. The questions in the survey addressed a variety of factors, including, for instance, what levels of government participated in and what rules existed on land development as well as the cost of land. Ultimately, the responses to these questions were turned into the land-use regulation index (WRLURI), with higher, positive values representing a more restrictive regulatory process, and lower, negative values signaling a less restrictive environment. For our study, we include the (unlogged) state-level average for the WRLURI measured in 2005; for census tracts in different states, this gives us a sense of how restrictive the larger political context is when it comes to land development. Clearly, a more ideal of measure of local land-use regulations would be longitudinal and at a lower level of analysis, capturing potential changes in city politics across the United States; nevertheless, a cross-sectional snapshot of the state-level average regulatory environment serves the purpose of a control variable.

In addition to the other control variables mentioned above, we also incorporate variables (unlogged) for the latitude and longitude (of the centroid) for each census tract from ArcGIS. The latitude and longitude of each tract will help to control for its local climate.

Analysis

For the analysis, we employ spatial autoregressive models with autoregressive disturbances (SARAR). The SARAR model, otherwise known as a spatial autocorrelation model (SAC), controls for spatial autocorrelation in both the dependent variable and in the error term (Anselin and Florax 1995). In Models 1 to 2, we regress the dependent variable (change in developed land as a proportion of total land area) on the primary predictors and the control variables. With two waves of data, first-differencing both the dependent and independent variables yields a longitudinal regression model with unit and period fixed effects (Allison 2009). With parameter estimates for a spatially lagged dependent variable as well as a spatial error term, the generic equation for this model is written as follows:

$$\begin{aligned} y_{it} &= \alpha + \rho W y_{it} + x_{itk}\beta k + \upsilon_{it} \\ \upsilon_{it} &= \lambda W \upsilon_{it} + \varepsilon_{it} \end{aligned},$$

wherein, y_{it} indicates the values of the dependent variable for the ith census tract at time t; α represents the model intercept, or constant; and x_{itk} indicates the value of the kth predictor for the ith tract at time t, with β_k representing the effect of the kth predictor on the dependent variable. The spatial lag term ρ represents the effect of the average value of the dependent variable in neighboring census tracts on the values of the dependent variable in the ith tract, which is based on the spatial weights matrix W. In our study, because tract boundaries have been harmonized and do not change, W is the same for all t and is constructed using a row-standardized, first-order queen contiguity specification, where the weight equals "1/# of neighbors" for any tract that touches the ith case and "0" otherwise. Thus, for Models 1 to 2, the spatial lag for the ith tract at time t is equal to the weighted average of *developed land as a proportion of total land area* at time t for all of the tracts that immediately border the ith case. The error term υ_{it} is decomposed into two parts. The first part estimates the spatial error term λ, which is based on the same contiguity weights matrix W, and the second part ε_{it} represents all the leftover unobserved variation in the dependent variable.

Results and Discussion

Table 2 displays descriptive statistics and bivariate correlations. In this table, the mean values for the time-varying measures are interpreted as proportional change over time. Thus, positive values represent increases and negative values represent decreases between the two time periods. Looking at the dependent variable and three primary predictors, we highlight that the typical metropolitan census tract experienced increases in the relative amount of developed land and

Table 2. Univariate and Bivariate Statistics ($N = 52{,}473$).

Variables	*M*	*SD*	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
Dependent variable (Δ between 2001 and 2011)																	
1. Developed land as a proportion of total land area	.090	.152	1.000														
Primary predictors (Δ between 2000 and 2010)																	
2. Median household income	–.052	.186	.078	1.000													
3. Non-Hispanic white	–.135	.286	–.060	.206	1.000												
4. Greater than high school degree	.080	.236	.110	.298	.164	1.000											
Controls (Δ between 2000 and 2010)																	
5. Total population size	.071	.268	.699	.149	–.098	–.180	1.000										
6. Employed in manufacturing	–.259	.523	–.020	.125	.017	.008	–.025	1.000									
7. Unemployed	.446	.669	.028	–.147	–.056	.052	.036	–.052	1.000								
8. Median home value	.304	.295	–.019	.377	.056	–.139	.045	.032	–.129	1.000							
9. Renters	.075	.305	.146	–.242	–.115	.080	.187	–.003	.116	–.126	1.000						
10. Housing units aged 30 years or older	.387	.651	–.040	–.155	–.113	.254	–.115	–.011	.082	–.076	.097	1.000					
11. Vacant housing units	.390	.476	–.118	–.129	–.098	.067	–.185	–.012	.112	–.007	–.002	.053	1.000				
Controls (time invariant)																	
12. State-Level Land Use Regulatory Index (2005)	.013	.613	–.119	.155	–.033	–.037	–.027	.007	–.001	.393	–.034	–.035	.045	1.000			
13. Latitude	37.678	4.911	–.157	–.021	.152	–.065	–.119	.000	.026	–.144	–.065	–.227	.067	.114	1.000		
14. Longitude	–91.623	16.182	–.037	–.028	.098	–.081	–.080	–.046	.069	–.112	–.052	–.157	–.047	–.069	.124	1.000	
15. Total land area	15.413	1.763	.257	.040	.082	.007	.225	.002	.088	–.203	.080	.030	–.157	–.156	–.039	.028	1.000

Note. All variables are logged with the exception of State-Level Land Use Regulatory Index, Latitude, and Longitude. Time-variant predictors were logged before calculating first-differences.

proportion with a high school degree and decreases in median household income and proportion of the population who are white. In other words, in addition to new land development, the typical metropolitan census tract became less affluent, less white, and more highly educated.

Table 3 reports the results from the SARAR models, which include estimates for the predictor variables and spatial parameters as well as a pseudo-R^2. The significant estimates for ρ and λ indicate that there is spatial autocorrelation (in the values of the dependent variable as well as the error term) that would otherwise bias the slope estimates. Or rather, the significant results for ρ and λ suggest that the inclusion of these parameters helps to minimize any spatially induced bias in the slope estimates of the predictor variables. As a reminder, the dependent variable is change in *developed land as a proportion of total land area* between 2001 and 2011. Looking at Models 1 to 2, the negative slope estimate for the dependent variable measured at $time_1$ indicates that tracts with more developed land in 2001 had lower rates of new land development between 2001 and 2011. In other words, because built-out census tracts were already relatively covered with human-constructed impervious surfaces they had lower rates of new land development.

In Model 1, we do not include the initial values of the primary and control variables measured in 2000; in Model 2, we include these initial values to control for potential floor/ceiling effects in the predictor variables. As tests for our hypotheses, turning to the results of the primary predictors for socioeconomic status and race in Models 1 to 2, we note that there is support for H1 and H3 and no support for H2. Looking at the slope estimates, both *median household income* and the *proportion of the population with more than a high school degree* are significantly and negatively related to land development; these results hold even after controlling for the initial values of the predictor variables at $time_1$. Thus, increasing affluence and educational attainment over time are negatively related to the rate of land development within a census tract. Or rather, tracts that experienced increases in affluence and educational attainment also experienced lower rates of land development. Even though the slope estimate for the race variable switches from positive to negative, it is not significant in either model. Based on the results of these models, as the proportion of the residents who are white in the census tract increases, there is no significant change in the rate of land development. Given that the affluence and educational attainment variables are significant, we speculate that the nonsignificant result for race is likely due to the rise of racially diverse "global neighborhoods" across metropolitan areas in the United States (e.g., Zhang and Logan 2016). While there is variation in the type of racial diversity, metropolitan neighborhoods across the United States have generally experienced a decline in the proportion neighborhoods with all-white populations. While segregation certainly persists, the unprecedented change in the racial composition of metropolitan neighborhoods likely contributes to the nonsignificant effect of the race variable in our models.

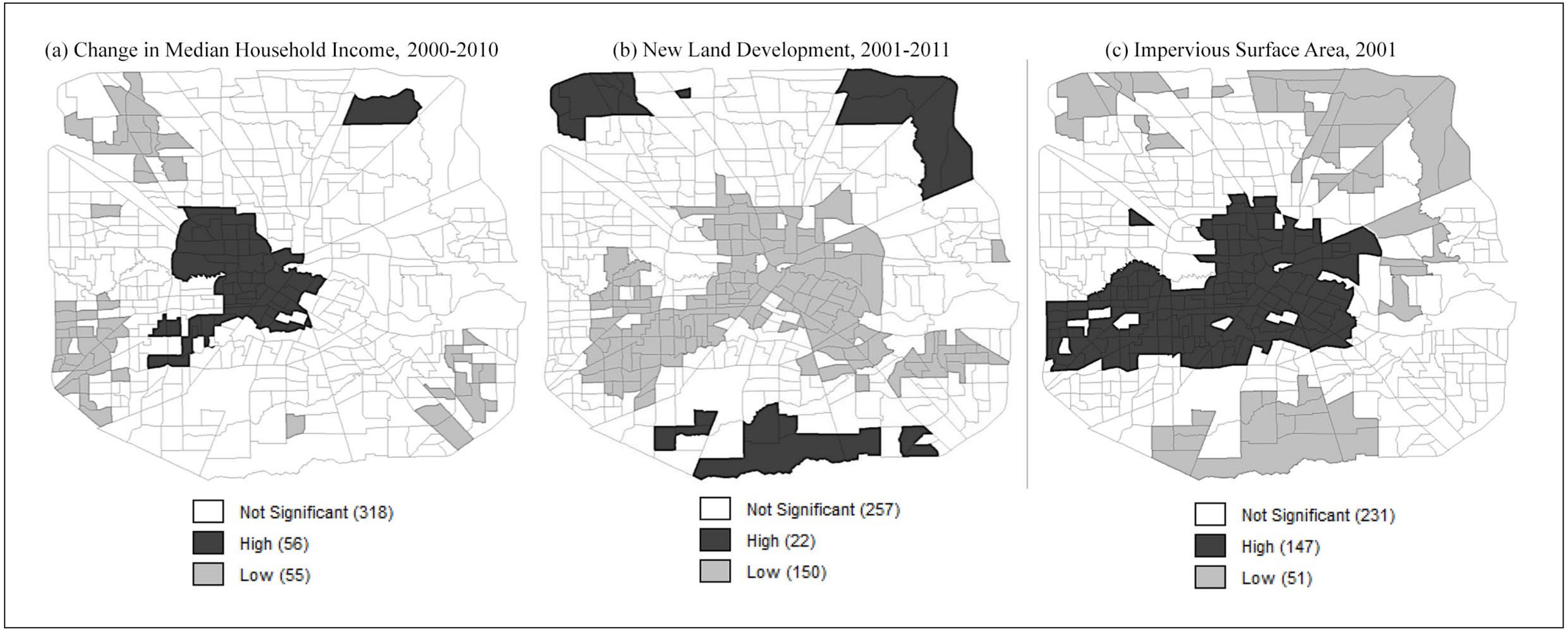
The results of the affluence and educational attainment variables are consistent with the two complementary frameworks discussed above: "aristocratic conservation"/"defensive environmentalism" and "back to the city"/"suburbanization of poverty." Here we briefly highlight the example of Houston, TX, to demonstrate that the results support the "back to the city" movement rather than "aristocratic conservation." In Houston, at the beginning of the twenty-first century, the "back to the city" movement brought affluent households into the urban core located inside the 610 Loop (Podagrosi, Vojnovic, and Pigozzi 2011). This spatial-demographic shift began a process of gentrification that continues to displace those demographic groups with less political-economic power from inner-city neighborhoods (Podagrosi and Vojnovic 2008). As evidence of this process and how it relates to land development, Figure 2 presents three maps of the Houston area utilizing the same data from the spatial regression models. These maps display the results from a spatial cluster analysis, showing where changes in affluence and land development are significantly clustered in the Houston area.[9] Generally speaking, the cluster results show that, compared to the suburban neighborhoods outside the 610 Loop, human-constructed impervious surface area in 2001 tended to significantly cluster in the inner-city neighborhoods within the 610

Table 3. SARAR Predicting Land Development, 2001–2011.

	Developed land as a proportion of total land area (Δ between 2001 and 2011)			
	Model 1		Model 2	
Predictors	*b*	*SE*	*b*	*SE*
Primary variables (Δ between time$_2$ and time$_1$)				
Median household income	–0.014***	0.003	–0.009**	0.003
Non-Hispanic white	0.002	0.002	–0.001	0.002
Greater than high school degree	–0.005*	0.002	–0.010***	0.002
Controls (Δ between time$_2$ and time$_1$)				
Total population size	0.309***	0.007	0.275***	0.007
Manufacturing employment	0.002*	0.001	0.001	0.001
Unemployment	–0.003***	0.001	–0.004***	0.001
Median home value	0.007***	0.002	0.005*	0.002
Renters	–0.005*	0.002	–0.005	0.003
Housing units 30 years or older	–0.004***	0.001	–0.030***	0.002
Vacant units	0.013***	0.001	0.015***	0.002
Controls (starting values at time$_1$)				
Median household income			0.004	0.003
Non-Hispanic white			–0.007***	0.001
Greater than high school degree			–0.010***	0.001
Total population size			–0.015***	0.002
Manufacturing employment			–0.003**	0.001
Unemployment			–0.003**	0.001
Median home value			–0.017***	0.002
Renters			0.006***	0.001
Housing units 30 years or older			–0.026***	0.001
Vacant units			–0.004***	0.001
Controls (time-invariant)				
State-Level Land Use Regulatory Index (2005)	–0.013***	0.001	–0.009***	0.001
Latitude	–0.001***	0.000	0.000	0.000
Longitude	0.000	0.000	0.000**	0.000
Total land area	0.000***	0.000	0.000***	0.000
Dependent variable (measured at time$_1$)	–0.012***	0.001	–0.014***	0.001
	0.107***	0.007	0.308***	0.026
Constant	0.374***	0.016	0.318***	0.017
ρ	0.179***	0.022	0.229***	0.022
Λ	–0.014***	0.003	–0.009**	0.003
Pseudo R^2	.621		.626	
N	52,473		52,473	

Note. All variables are logged with the exception of State-Level Land Use Regulatory Index, Latitude, and Longitude. Time-variant predictors were logged before calculating first-differences. All models are estimated with a queen, first-order contiguity weights matrix; ρ represents the spatial lag parameter, and λ represents the spatial error parameter. We acknowledge that with a first-order contiguity matrix, nonadjacent spatial units are presumed to have no spatial influence on each other; for more information, see Chi Guangqing and Jun Zhu (2008). SARAR = spatial autoregressive models with autoregressive disturbances.

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$ (two-tailed test).



(a) Change in Median Household Income, 2000-2010

(b) New Land Development, 2001-2011

(c) Impervious Surface Area, 2001

Figure 2. Cluster maps of Houston area comparing changes in affluence and land development.
Note. The cluster maps are based on results from the local G statistic, using the same contiguity weights matrix as used in the spatial regression models. The darker colored “High” category indicates that high values of the variable are significantly clustered together; the more lightly colored “Low” category indicates that low values are significantly clustered together. The white “Not Significant” category indicates that there was no significant clustering in either direction. The level of significance is based on pseudo $p < .001$. The value in the parentheses indicates the number of census tracts in that category.

Loop. As the urban core was relatively more built-out in 2001, these neighborhoods also experienced lower rates of new land development, with significant clustering of high rates of new land development in suburban neighborhoods. In terms of median household income, even though there is variation in affluence within the 610 Loop, these inner-city neighborhoods, compared to the suburbs, were more likely to experience an increase in median household income between 2000 and 2010. Thus, at the beginning of the twenty-first century, given the movement of affluent households to Houston's urban core, with its lower rate of land development, the case of Houston exemplifies how the "back to the city" movement provides a specific historical context for the discussion about environmental privilege.

Before turning to the conclusion, we will briefly highlight two notable and highly significant findings from the control variables reported in Table 3. First, in accord with previous environmental sociological research, the slope estimate for *total population size* in Models 1 and 2 is positive. As population size increases, there is more developed land, which is consistent with a large body of quantitative research showing population growth to be a statistically significant predictor of environmental change. If land development is seen as an environmental impact, then as the population size of a census tract increases, so too does its impact on the environment. Second, the *State-Level Land Use Regulatory Index (2005)* is consistently significant and negative across the four models. This finding indicates that the regulatory environment of land use (averaged for the entire state) matters significantly for land development at the neighborhood level. Indeed, the more restrictive the regulations, the slower the development of land. This finding encourages future quantitative scholarship to scrutinize more closely the relationship between land-use regulations and the construction of the built environment, while addressing the limitations of the land-use regulatory index we employed (Gyourko et al. 2008).

Conclusion

Environmental social scientists have focused much attention on the relationship between inequality and exposure to hazardous pollutants (Ard 2015; Ard and Fairbrother 2017; Liévanos 2017). Subsequent research on the theme of environmental privilege has suggested a connection between inequality and access to highly valued environmental amenities, such as parks and lakes (Gould and Lewis 2012; Winkler 2013). Localized case studies and cross-sectional quantitative research suggest that race and socioeconomic status operate as forms of privilege to preserve the unspoiled character of affluent, white, and educated communities (Rudel 2009; Schwarz et al. 2015). Nevertheless, this research has not examined whether this privilege operates as a generalizable force on the construction of the built environment at the neighborhood level over time. The present study aimed to fill this gap, looking at whether socioeconomic status and race have generalizable effects on land development across metropolitan census tracts within the United States (N = 52,473) between 2001 and 2011.

Compared to the noxious pollutants studied by many environmental justice scholars, land development is more ordinary and visibly recognizable across time and space; in other words, it is a mundane form of environmental change (see Footnote 2 for clarification). In framing the analysis, we presented an alternative yet complementary perspective to the conventional framework of environmental privilege. The conventional framework, based on the notions of "aristocratic conservation" and "defensive environmentalism," suggests that those groups with political-economic power will organize themselves to control local environmental change (e.g., Molotch 1976; Rudel 2012). In the case of land development, this power is said to be used to preserve undeveloped land and open space. Meanwhile, we consider how, in the early twenty-first century, across the United States, metropolitan areas "have drawn the affluent, educated, and white to the urban core" (Florida 2016). In terms of land development, the literature on the "urban revival" (Couture and Handbury 2016; Florida 2010, 2016; Kneebone and Garr 2010) presents novel questions about how inequality is related to environmental change. In this project, we asked: What implications do these spatial shifts have for our understanding of inequality and privilege as forces behind ordinary processes of environmental change, specifically in terms of land development?

Utilizing spatial regression models with fixed effects, we found significantly negative slope estimates for the affluence and educational attainment variables, suggesting that increasing affluence and educational attainment is associated with lower rates of land development. We speculate that the nonsignificant effect of the race variable is due to the proportionate decline of white-only neighborhoods and the rise of racially diverse "global neighborhoods" across metropolitan areas in the United States (e.g., Zhang and Logan 2016). To discuss the significant effect of affluence, as an example, we briefly focused on the case of Houston and its recent history of demographic change (Podagrosi and Vojnovic 2008; Podagrosi et al. 2011). Consistent with the "back to the city" literature, spatial analyses of the Houston area show that rising affluence was clustered in neighborhoods in the urban core, which was already relatively built-out and had lower rates of land development compared to the suburbs. Thus, the case of Houston exemplifies the general effects found in the spatial regression models: As affluent and educated communities move back into the inner city, communities with less political-economic power are being displaced from the urban core and into the suburbs, which have less impervious surface area and have higher rates of land development. Thus, in the twenty-first century, across metropolitan America, affluent and educated groups use their political-economic power not to preserve undeveloped land and open space in their home communities; rather, they are moving into the built-out urban core where the rate of land development is lower.

On that note, while we emphasize the novelty of this research topic, we also discuss some limitations of the present analysis. Indeed, environmental sociologists, in a very restricted manner, have only begun to explore the possibility that the "urban revival" is modifying the conventional dynamics of environmental inequality (e.g., Ard 2015; Downey 2005; Elliott and Frickel 2015; Pais, Crowder, and Downey 2014). For instance, using tract-level population density as a proxy measure for suburbanization, Jeremy Pais, Kyle Crowder, and Liam Downey (2014) find that suburbanization moderates but does not eliminate the effect of race on pollution exposure. Their focus is on the racial dimensions of environmental inequality, not affluence; also, they use population density as a proxy measure suburbanization. Clearly, for longitudinal studies, the challenge of categorizing census tracts as urban versus suburban across multiple metropolitan areas within the United States, especially when tract boundaries change and need to be harmonized, lends itself to proxy measures like population density, which is problematic.[10] While we provided the case of Houston as an example of how the "urban revival" is related to environmental inequality, future research can also focus on a single or a few metropolitan areas, where designation of inner city and suburb is not confounded by historical, geographical, climate, and other factors that vary between metropolitan areas.

Similarly, we examined inequality as a generalizable force and found that affluence and educational attainment have significant effects on land development across metropolitan areas within the United States. However, our models yield an average effect across space (i.e., metropolitan America) and do not test the possibility that the slope estimate for these variables might exhibit spatial heterogeneity, that is, whether the effect of the predictor varies across space (Fotheringham and Brunsdon 1999). As with the city–suburb issue, future scholarship, perhaps by moving back to more localized quantitative studies, will be able to address whether the relationship between inequality and land development is spatially variable. Indeed, by focusing on a single metropolitan area, researchers would not only be in a better position to incorporate direct and more robust measures of suburbanization but also be able to consider lower level data on the land-use regulation index (Gyourko et al. 2008), which we used as a control variable in our analysis.

Last, while the land cover data have been utilized in numerous social science publications (e.g., Chi and Ho 2018; Liévanos 2015; Wilson and Brown 2015), here we highlight some of their limitations. Based on the NLCD satellite imagery, land development, or the construction of the built environment, refers to increasing the amount of land area covered by human-constructed impervious surfaces. As discussed in the data and methods section, this includes not only the construction of impervious surfaces on undeveloped land but also adding more impervious surface area to already developed land. These data capture whether the areal footprint of a building expands, representing a loss of undeveloped land and an increase in human-constructed impervious surface area, which was adequate information for our dependent variable. Nevertheless, the NLCD does not measure the height of human-constructed impervious surfaces or buildings. Furthermore, the satellite imagery from the NLCD does not distinguish between the specific land uses that are captured in the developed land categories (e.g., roads, housing, commercial centers, industrial facilities, etc.). If research resources are available, future scholarship can utilize more costly geoprocessing methods to differentiate between the specific land uses. The information gained from distinguishing between the different land uses can be combined with additional waves of land cover data, as they become available from the NLCD. Meanwhile, based on the results of our study, we emphasize that environmental privilege has historically specific dynamics, at least with respect to land development. Future research, taking advantage of advanced geoprocessing methods and newly available data, can evaluate to what extent the "urban revival" is transforming and how inequality structures exposure to both noxious and ordinary forms of environmental change.

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Notes

1. For the purpose of this project, developed land refers to human-constructed impervious surfaces (e.g., roads, housing, commercial centers, industrial facilities, etc.). We use the following terms interchangeably: construction of the built environment and land development as well as developed land, human-constructed impervious surfaces, and built-up land area.
2. Of course, the built environment can have negative impacts on human health. For instance, the impervious surfaces that cover urban areas absorb solar radiation, which increases local ambient temperatures and exacerbates the formation of ground-level ozone, or smog, a harmful air pollutant. Also, especially in the Southwestern United States, as land development churns up dust from the dry soil, it contributes to air-borne health hazards, such as valley fever.
3. While Thomas K. Rudel (2012) differentiates between "defensive environmentalism" and "defensive environmentalist" practices, in the interest of brevity, we use the term "defensive environmentalism" to represent the social dimensions of environmental privilege in the context of land development.
4. Here we make a comment on the analytical sample of this project. Our research question asks (and our models test) whether demographic change has generalizable effects on land development across metropolitan America. Quantitative sociological research often tests whether social forces are generalizable across different metropolitan areas; this is the case not only with environmental research (e.g., Crowder and Downey 2010) but also with the literature on city–suburb residential mobility (e.g., South

and Crowder 1997). Furthermore, the literature on the “back to the city” movement and the “suburbanization of poverty” also highlights how these spatial-demographic shifts are not simply happening in a few isolated spots but generally across metropolitan America (Couture and Handbury 2016; Florida 2016; Kneebone and Garr 2010). Last, as we cite Harvey Molotch’s (1976) notion of “aristocratic conservation,” we highlight the growth machine legacy in urban sociology which underscores commonality in the U.S. settlement system. As Harvey Molotch (1976) argued, “the political and economic essence of virtually any given locality, in the present American context, is growth” (pp. 308–309). Relevant to our project, he wrote that this growth takes the form of “more far-flung and increasingly intensive land development” (p. 309).

5. When Scott J. South and Kyle D. Crowder (1997) refer to “back to the city” residential mobility, they are using this term in the context of analyzing the factors that hinder affluent, educated, and white households from leaving the suburbs and moving back to the city.
6. Thomas K. Rudel (2009) made a similar argument about how the increasing scarcity of developable land contributes to a slowing rate of landscape transformation (pp. 148–149).
7. Here we provide more detail about the method used to obtain the measure of total land development, or area covered with human-constructed impervious surfaces. For each time point, we calculate a weighted sum of the four categories of developed land. Weights are derived from the midpoint of each, respective “developed” category, with all other (nondeveloped) categories set to zero. For example, parcels designated as “developed, open-space parcels” receive a weight of 0.1, or 10 percent, which is the midpoint between 0 and 20 percent. For low-, medium-, and high-intensity parcels, the weights are set to 0.345, 0.645, and 0.9, respectively. To aggregate data from parcels to counties, we multiply each parcel in a tract by its respective weight and then sum, yielding a measure of total impervious surface area. These values are then divided by the total land area in each census tract, which yields the proportion of total land area covered by human-constructed impervious surfaces. To merge the raster layer on land development from the NLCD with the tract-level shapefile, we use the “Tabulate Area” tool in ArcGIS. Social and natural scientists studying land cover commonly use this tool to count the number of raster values (i.e., cells or pixels) belonging to a given vector spatial unit. For recent examples, see David Hondula et al. (2015), Mario R. Moura et al. (2016), Locke and Grove (2016), and Luca Salvati (2016).
8. Here, we provide more information and justification about the seven time-variant control variables. Total population size controls for the direct effect of population growth/decline on land development. Proportion involved in manufacturing controls for the type of economic activity happening in the census tract; an increase in manufacturing likely increases the built environment in the form of more industrial facilities. Proportion who are unemployed controls for the job status of those living in the tract; greater unemployment may mean fewer opportunities for real estate investment, thereby reducing the pressure on land development. Median home value controls for the positive correlation between rising home values in neighborhoods with more intensive land development. Proportion who are renters, proportion of housing older than 30 years, and proportion of vacant housing control for the type, quality, and quantity of housing stock available to residents.
9. In Houston, there are two highways (Beltway 8 and the 610 Loop) that form two concentric rings around the city. Because these highways also tend to follow and create the boundaries for several of the city’s census tracts, these concentric rings are visible in the maps, with the outermost extent of the map representing the route of Beltway 8 and the inner ring generally following the 610 Loop, with the latter also representing roughly the boundary between the suburbs and the urban core (Podagrosi, Vojnovic, and Pigozzi 2011).
10. With areal units, there is also an analytical problem using population density in longitudinal models with fixed effects. Given that the boundaries of areal units must be harmonized, it becomes difficult to isolate the independent effects of changes in total population size versus population density. In other words, the area of the census tract is the denominator for density; if the area does not change, but the tract’s population size increases, then so too does its density and at the same rate. This is a challenge for quantitative research across multiple metropolitan areas.

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