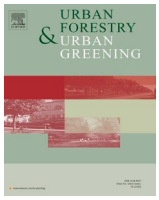
Urban Forestry & Urban Greening 101 (2024) 128376

Contents lists available at ScienceDirect

Urban Forestry & Urban Greening

journal homepage: www.elsevier.com/locate/ufug



Original article

Does greening generate exclusive residential real estate development? Contrasting experiences from North America and Europe

Isabelle Anguelovski [a,b,c,*,1,2], Emilia Oscilowicz [a,b,1], James J.T. Connolly [b,d], Melissa García-Lamarca [b,e,3], Carmen Perez-del-Pulgar [b,f], Helen V.S. Cole [a,b], Dan Immergluck [g], Margarita Triguero-Mas [b,h,i,4], Francesc Baró [j,5], Nicholas Martin [a,b], David Conesa [k,6], Galia Shokry [b,l,7], Lucia Argüelles Ramos [m], Austin Matheney [a,b,8], Elsa Gallez [j,9], Jésua López Máñez [k], Blanca Sarzo [k,10], Miguel Angel Beltrán [k], Joaquín Martínez-Minaya [n,11]

[a] Institute for Environmental Science and Technology (ICTA) and Universitat Autònoma de Barcelona, Bellatera, Spain
[b] Barcelona Lab for Urban Environmental Justice and Sustainability, Barcelona, Spain
[c] ICREA, ICREA-Institució Catalana de Recerca i Estudis Avançats, Barcelona, Spain
[d] School of Community and Regional Planning, University of British Columbia, Canada
[e] Lund University Centre for Sustainability Studies, Sweden
[f] Department Umweltpolitik, Helmholtz Center for Environmental Research UFZ, Leipzig, Germany
[g] Andrew Young School of Policy Studies, Georgia State University, Atlanta, Georgia
[h] Barcelona Interdisciplinary research group on planetary health (BITAL), Faculty of Health Sciences, Universitat Oberta de Catalunya (UOC), Spain
[i] ISGlobal, Barcelona, Spain
[j] Vrije Universiteit Brussel (VUB), Brussels, Belgium, Sociology and Geography Departments, Vrije Universiteit Brussel (VUB), Belgium
[k] Department of Statistics and Operations Research, University of Valencia, Spain
[l] School of Environmental and Sustainability Sciences, Kean University, USA
[m] Estudis d'Economía y Empresa and Internet Interdisciplinary Institute, Universitat Oberta de Catalunya, Barcelona
[n] Department of Applied Statistics and Operational Research and Quality, Universitat Politècnica de València, Spain

ARTICLE INFO

Keywords:
Real estate development
Green gentrification
Housing justice
Environmental justice
Urban greenspace

ABSTRACT

With the branding of a city as green increasingly serving to amplify attractiveness andinvestment while also contributing to patterns of green gentrification, the incentive to link real estate development and green space is growing. Yet, little is known about the extent to which this incentive has generated a spatial relationship between green space and newly constructed housing at the city-wide level and in ways that can be compared between cities. This gap in knowledge makes it difficult to precisely indicate the implications for housing rights, affordability, and broader goals of urban green justice. In response, this study explores quantitative trends in 26 mid-sized North American and European cities, utilizing greening and real estate data from the last three decades. Results show that greening becomes a more significant driver of development over time and operates to attract development in a growing number of cities, although more so in US cities. Next, in order to contextualize the quantitative results, we employ qualitative field data gathered through field work in Atlanta and Amsterdam.

* Corresponding author at: Institute for Environmental Science and Technology (ICTA) and Universitat Autònoma de Barcelona, Bellatera, Spain.
E-mail address: Isabelle.Anguelovski@uab.cat (I. Anguelovski).
[1] These authors contributed equally
[2] ORCID: 0000–0002-6409–5155
[3] ORCID 0000–0002-4813–3633
[4] ORCID:0000–0002-1580–2693
[5] ORCID: 0000–0002-0145–6320
[6] ORCID: 0000–0002-5442–5691
[7] Orcid: 0000–0002-2959–3677
[8] ORCID: 0000–0003-0739–3129
[9] ORCID: 0000–0002-2198–2504.
[10] ORCID: 0000–0001-7305–6564
[11] ORCID: 0000–0002-1016–8734.

https://doi.org/10.1016/j.ufug.2024.128376
Received 19 September 2023; Received in revised form 1 April 2024; Accepted 24 May 2024
Available online 13 August 2024
1618-8667/© 2024 The Authors. Published by Elsevier GmbH. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

We contrast the greening and development trajectories of these cities by examining implications for housing rights and social justice, accounting for the fact that those cities exhibit different green gentrification trends, as demonstrated in the literature. Green gentrification is indeed a proxy for understanding housing justice implications in the relationship between greening and development. We find that Amsterdam's legacy of housing rights and policies acts as a protection against growing inequities embedded in the relationship between urban greening, development, and gentrification. In contrast, Atlanta embodies patterns of historic racial segregation and continued gentrification of Black neighborhoods which urban greening has further intensified. This analysis shows that greening can attract real estate development across a city, but the implications need not always be harmful to social equity.

1. Introduction

While municipal urban greening strategies prioritize branding to attract investment (Garcia-Lamarca et al., 2021), their direct role in spurring new real estate development at the city-wide scale remains unclear (Robin, 2022). Greenspaces and associated Nature-based Solutions (NbS) provide publicly available environmental and social benefits and thus have become a priority in urban and environmental planning, particularly in those neighborhoods most underserved, infrastructurally underdeveloped and within or adjacent to post-industrial landscapes. Yet, urban greening is always underpinned by financial aspirations, as funding and support for urban greening is often justified by prospective economic growth and revenues through new real estate investments, jobs, and increases in property taxes (Teo et al., 2023).

As growing research demonstrates, developers themselves perceive new real estate investments around green spaces as anchors for financial benefits and act as "green grabbers" of rent and value, particularly so in gentrifying neighborhoods (García-Lamarca et al., 2022). Yet, broader city-wide and quantitative trends regarding whether residential real estate investment follows greening remain underexplored. Analyzing investors' development practices on the ground can thus offer a new understanding of the extent to which greening operates as a conscious or unconscious driver for attracting real estate. Moreover, research shedding light on the implications greening has on access to housing across social groups and classes, housing affordability and rights, and justice is much needed.

In this paper, we examine the relationship between greening and new residential development in 26 European and North American mid-sized cities (out of an original sample of 28 cities). We assess new development as the dependent variable and use greening as an independent variable to determine its influence on the locational trends we observe and when/if greening can predict development. Our analysis differs from the many recent large-scale analyses on green gentrification (e.g. Rigolon and Németh, 2020) since green gentrification can occur as greening attracts wealthier classes, but not necessarily via the creation of new housing or other investments (Anguelovski and Connolly, 2024).

First, we establish the quantitative extent to which development follows greening in 26 cities. In short, we find that, between 1990 and 2016, greening becomes a more relevant driver than other economic and landscape changes in a growing number of cities, even when accounting for other infrastructural and locational factors. Then, we follow with qualitative research focused on two cases which are both most similar and most different (Yin, 2018): Amsterdam and Atlanta. We aim to unpack data from both cities where the relationship between greening and development is similarly strong, but also where prior analyses found differing trends of green gentrification and housing justice concerns (Anguelovski et al. 2022). Here, we ask: When greening is found to predict development, and considering green gentrification is a proxy for understanding housing justice, what are the broader ramifications for housing rights and affordability? In Atlanta, what policy and planning strategies can help explain the transformation of real estate development into an exclusive green commodity for incoming educated, white, and high-income residents? What can further explain how housing affordability and security is jeopardized in newly greened neighborhoods? In Amsterdam, why are greening and development not as embedded in this green gentrification and exclusion dynamic despite the more recent and increasing trends towards the market-driven commodification of housing?

2. Exploring greening and residential real estate development dynamics

Urban greening includes the integration or (re)development of green or blue spaces and their associated ecosystem services into the urban form (Nesbitt et al., 2017; Pauleit et al., 2017). Such greening interventions can include park development, tree planting, urban gardening, waterfront redevelopment, and more. Through greening interventions, urban dwellers are able to benefit from positive health outcomes, social wellbeing, enhanced sense of place (Raymond et al., 2023), and heightened cultural and historical connection to place (Triguero Mas et al., 2021). As extreme climate-change related events become more frequent, the many forms of urban greening and their associated ecosystem benefits prove critical for how cities can respond to urban climate mitigation and adaptation.

Nevertheless, greening interventions and the delivered ecosystem services do also come alongside certain ecosystem disservices, including the spread of allergenic pollen, fear of violent animals, discomfort in unlit green spaces, or loss of social cohesion and threats to social equity (Rodgman et al. 2024). The negative impacts of urban greening are particularly visible when procedural (Rutt and Gulsrud, 2016) and distributive dimensions of planning and management are inadequately considered. Urban greening can manifest into 'disruptive green landscapes' (Triguero-Mas et al., 2021), which are most impactful to historically marginalized groups, including low-income, racialized, and minority residents (Du and Zhang, 2020) and can result in uneven access to urban greening co-benefits (Grabowski et al., 2023; Rigolon, 2016). Furthermore, considering temporal and socio-spatial impacts of greening over time as well as potential exacerbation of existing social inequalities, new greenspaces have also been found to physically, emotionally, socially, financially or culturally exclude, displace, and otherwise isolate those residents from their changing neighborhoods in a process of environmental or green gentrification (Anguelovski, 2022; Black and Richards, 2020; Blok, 2020; García-Lamarca and Ullström, 2020; Quinton et al., 2022). Green gentrification is the process by which the implementation of an environmental planning agenda, including urban greening and urban green spaces, can lead to increased perceptions of liveability and everyday cost-of-living, thus leading to the exclusion and displacement of politically disenfranchised residents. Green gentrification has been documented to result in harmful physical and mental health impacts on low-income, minority residents through loss of home, reduced effective access to green space, inadequate provision of public amenities, as well as increase of crime (Triguero-Mas et al., 2021). Green gentrification thus produces a highly volatile and complex riskscape for lower-income, racialized, and minority residents (Cole, 2021). This process, in turn, further perpetuates a legacy of exclusionary whiteness in greened neighborhoods (Angelo, 2021; Connolly, 2019; Connolly and Anguelovski, 2021).

In many mid-sized to large cities, these riskscapes have been shown

to be often produced by lifestyle and economic attraction of which greening is a part, with significant profit harnessed by financial investors and real estate development around a process of green grabbing and land speculation (García-Lamarca et al., 2022). Furthermore, the domination of economic growth through the lens of sustainability and a 'green is good' orthodoxy (Angelo, 2021; Connolly, 2019) is what has led many local governments to a speculative fervor of operationalized land value capture projects and financial strategies that assume and capture property appreciation (Weber, 2021). An abundance of literature using hedonic price modelling supports this fervor through estimations of the extent to which urban green spaces affect residential real estate prices. Early studies from the 1980s and 1990s across American cities quantitatively confirmed historic observations from early English parks that urban green spaces make a notable contribution to proximate property values (Crompton, 2001). During the 2000s and 2010s, more studies have verified these results (Conway et al., 2010), also considering different typologies like community gardens, greenways, and forests. However, most of this research remains case study specific, based on data from one single city (and at times neighborhoods), with market price variation fluctuating widely by location, type of green space, and study methodology (e.g. Kronenberg et al. 2023).

Scholarly theorization of the green growth machine (Gould and Lewis, 2016) as well as the utilization of green branding (Garcia-Lamarca et al., 2021; García-Lamarca and Ullström, 2020; Immergluck and Balan, 2018), green marketing (Gałecka-Drozda et al., 2021), and green gentrification reflective of strategic economic action remain ongoing critiques of the neoliberal and speculative dynamics embedded in urban green space planning and their impact on the housing rights of historically marginalized groups. As a result, researchers and activists alike are increasingly confronting municipalities and their economic growth agendas for their continued push of the 'green is good' agenda (Angelo, 2021; Oscilowicz et al., 2023) without operationalizing greening and NbS "towards more emancipatory and just socio-ecological futures" (Kotsila et al., 2020, p. 252). Their demands are centered on participatory and engaged planning processes for more inclusive, accessible green spaces while simultaneously protecting existing housing and its character as well as providing more affordable housing stock (Oscilowicz et al., 2022; Ranganathan and Bratman, 2021).

Many social justice-focused activists also actually oppose urban "pro-housing" movements such as YIMBY-driven[12] urbanism led by white, upper-middle class and tech industry-oriented millennials. These movements defend an affordable and inclusionary urban imaginary 'for all', despite utilization of tools such as upzoning, which changes the zoning code to allow for increased and denser development, also employed by exclusionary racial capitalism (Freemark, 2023). In the US, elected officials themselves often advocate for the construction of large amounts of private housing as a strategy to decrease housing prices and respond to increasing demand to what is seen as a housing shortage (Cole et al., 2021). Yet, few of those officials contend with the fact that a significant majority of new housing are high-income and luxury condos (Immergluck, 2022). Meanwhile, national housing policies have failed low-wage earners in securing affordable housing and public housing has been either continuously sold or entirely dismantled (Vale, 2018). Similarly, European cities and states have continued to undo social housing policies and privatize public housing (Byrne and Norris, 2022; Power, 2021), although they still have a stronger legacy of housing rights and safety nets in place (Anguelovski and Connolly, 2021; Oscilowicz et al., 2022) that limit the hyper-commodification of housing.

In calling for more housing construction, the dynamics of *rent gaps* are at the center of speculative development and unequal housing access: As Wyly (2022, p. 319) writes, "localized economic rent gaps become transnational, transhistorical moral rent gaps constituted through competing claims for inclusion into the inherent exclusivity of capitalizable property rights". All in all, rent grabbing risks as part of urban greening projects further compromise already precarious and insecure housing rights for working class and non-white residents in North America and Western Europe (Tretter and Heyman, 2022).

Building on existing research at the intersection of greenspace planning, real estate development and housing rights and affordability, this paper addresses questions raised regarding the specific links between greening and real estate development, the financial capture and commodification of greening identified in the green gentrification literature (Boanada-Fuchs and Boanada Fuchs, 2022), and broader investment behaviors in cities (Todes and Robinson, 2020). We ask the following questions: To what extent does real estate development happen after greening and where and when does this trend occur most acutely, separately from processes of green gentrification? When greening does happen after (and thus is a predictor of) development, what are the broader ramifications for housing rights and affordability?

3. Methods: unpacking the relationship between greening and residential development

3.1. Parent study and context

This study is a subset of a larger European Research Council-funded parent project whose objective was to assess the relationship between green space development and gentrification in 28 mid-sized (between 500.000 and 1.5 million residents) North American and Western European cities. The quantitative analysis included socio-demographic data (census data from each city at the census tract or similar level), green spatial data (the locations of green spaces in each city with dates of creation of each space), and residential real estate data (data indicating where new housing had been built or where permits had been issued). We sought to include four time points of these datasets for each city—baseline, baseline +10 years, baseline +20 years, and baseline +30 years – effectively dividing the longitudinal datasets into three time periods. The gentrification outcome variable was a composite indicator which accounted for socio-demographic change and changes in real estate prices in order to obtain a more nuanced understanding of gentrification trends. While details on the methodology and analysis developed can be found in (Anguelovski et al., 2022), results from the parent study show that *city-wide* green gentrification trends are present in 17 out of 28 cities, with greening being the leading factor in gentrification in nine cities, including Copenhagen, Nantes, Vancouver, Montreal, Seattle, Boston, Atlanta, Milwaukee, and Louisville.[13] The study also found that there are no clear green gentrification trends in cities such as Amsterdam, Dublin, or Baltimore, with, overall, negative trends more present in the European sample of cities. [For full research results, see Anguelovski et al., 2022].

3.2. Quantitative analysis of greening and development

This paper focuses on a two-phased subset of the parent study in 28 cities and sought to quantitatively examine the extent to which and where real estate development is driven by city-wide greening,

[12] "Yes In My Backyard" (YIMBY or YIMBYism) is a pro-housing development movement associated with densification and re-zoning planning processes with the aims to 'build baby build'. YIMBYism has come under scrutiny by tenants unions and academics for the support of market-rate development that utilizes a "deregulatory, trickle-down framework for housing policy that does more harm than good" (For more information, see https://www.housingisahumanright.org/trickle-down-housing-is-a-failure-heres-what-you-need-to-know/).

[13] Examining city-wide, aggregate trends allowed for a more robust analysis of green gentrification, in contrast with specific case study sites, because it required trends to be present on a large scale in order to be labeled as a "green gentrification" city.

independent of green gentrification trends (Fig. 1). In other words, when a city is physically greened, does residential real estate development happen after? From the original set of 28 cities, we removed Lyon and Dublin for this analysis as development data was not publicly available. Through publicly available sources, we identified and mapped all new greenspaces (parks, greenways, preserves, gardens) inaugurated between 1990 and 2016 as well as new real estate developments for each of the 26 cities (see Supplemental Data in Appendix). We gathered two types of real estate datasets[14]: 1) a dataset with the year of construction of specific residential properties; and 2) a dataset of new residential developments per spatial unit for each time period collected. We located the new development data by mapping X,Y coordinates or joining appropriate data columns to shapefiles of statistical area boundaries for each city. Ultimately, we aimed to assemble data for each census tract (or equivalent) for the total number of new residential developments in every year. In all cases the majority of new residential development from the 1990s onwards are market-price housing while social or public housing remains residual.

To test the relationship between greening and residential real estate development, we developed three spatial Bayesian Hierarchical models, one for each of the next time periods: 2000–2010 (time period 2), 2011–2020 (time period 3) and 2000–2020 (time period 2–3) (Fig. 2). In our quantitative Results, we use the word "relevant" rather than "significant" to account for the Bayesian frameworks and models we used to develop our quantitative analysis. Further details on the Bayesian approach can be found in the Supplemental Data in the Appendix.

4. Results

4.1. Quantitative analysis of 26 North American and European cities

In terms of the overall positive relationship between greening and new development, our quantitative analysis (Table 1) reveals that greening on the whole is effectively a driver for development, and becomes a more relevant driver over longer. We find this also to be true over prolonged time periods instead of shorter time periods. In other words, when conducting the statistical analysis across the studied cities, more cities show a positively relevant result in time period 2–3 (2000–2020) than in time period 2 (2000–2010) or time period 3 (2011–2020). However, in most of the cities this relationship is not fully conclusive (see Table 1). In presenting our quantitative findings, we use the Bayesian term "positive relevant" or "negative relevant" to refer to the relationships we find. All relationships discussed account for the role of greening in the presence of all other potential explanatory factors in the models. Values in parentheses reflect scores of where the final spatial effect model best predicts the relationship between greening and development.

Focusing more on the temporal aspects of the relationship, considering all greenspaces built in the 1990s and real estate development from the 2000s, we found a positive relevant relationship in four cities, mostly in the US (Atlanta, Milwaukee, Seattle and Amsterdam). For the next time period (greenspaces from the 2000s and development from the 2010s), we further identified a positive relevant relationship in five cities (Atlanta, Louisville, Milwaukee, and Montreal) and close to relevant in Portland. Regarding longer term temporal trends (period 2 and 3 together), results show a higher number of positive relevant relationships between greening and real estate development when considering development built over two decades after green space built in the 1990s, with six cities identified, mostly again in the US: Boston, Louisville, Milwaukee, Seattle, Washington, Amsterdam (with trends likely also taking place in Portland and Atlanta). In this sense, real estate development seems to make the most of green space construction over a period of several decades, not just in the years immediately after its construction.

In terms of the counter-trend, we found fewer negative relevant relationships between greening and development than positive relationships in studied cities. Negative relevant relationships – meaning greening is not a significant driver of development – are identified in Canada (Calgary, Montreal) and Europe (Barcelona, Valencia, Vienna) for greenspace from the 1990s and development built in the 2000s. In the US (Baltimore, Boston, and Washington DC), similar negatively relevant (and close to negatively relevant for Philadelphia) relationships are found for greenspace built in the 2000s and development in the 2010s, but not for the earlier period. There is also a clear negative relationship for green space from the 1990s and cumulative development from the 2000s and 2010s only in two cities in the EU (Barcelona) and Canada (Montreal), although in Montreal the relationship becomes strongly positive from the 2010s onwards.

Finally, in terms of quantitative findings, the trends between greening and real estate development were not clear and appeared non relevant in Cleveland, Philadelphia, Austin, Denver, Detroit, San Francisco, as well as Edinburgh, Bristol and Sheffield (for the early time period). Data for greening in the 2000s and development in the 2010s was also insufficient for Valencia, Vienna, Edinburgh, Bristol, and Sheffield.

Moving to results interpretation, in some Canadian cities, the already wider access to large scale metropolitan greening might explain why green space is not a driver for urban developers and thus for residents (this is an important observation when considering the goals of greening in wider planning initiatives). Moreover, many Canadian cities are also undergoing a process of re-densification where centrally located empty lots and smaller green spaces are replaced by new buildings (Anguelovski and Connolly, 2021). Negative relevant trends in Barcelona and Valencia may be explained by the high density of the cities and the overall reduced provision of greenspace within city limits, with new buildings developing independently of greening on any land parcel found available. Unclear trends in our results for greening reveal that factors other than greening may also explain real estate construction, including proximity to the city center, or transit lines, or population growth (as a proxy for conditions like expanded room for allowable development), demonstrating that developers value an array of geographical and physical amenities when making strategic investment decisions.

In sum, overall, we find a greater number of cities with a positive relevant and a positive non-relevant relationship between greening and development than the opposite (that is that greening is not a predictor of development) (Fig. 3), and this positive relationship seems to become stronger over time. Based on these overall results in the next section we delve into two cases where we encountered a mostly positive relevant relationship: Atlanta and Amsterdam. We contrast these trajectories relative to housing and social justice implications by accounting for the fact that these cities exhibit different green gentrification trends, as demonstrated in the literature. In Atlanta, greening strongly predicts city-wide gentrification, and thus exclusion and displacement, while Amsterdam is a case where greening does not.

4.2. Qualitative analysis of greening, development, and housing justice

We aimed for a mixed-methodological framework in the second phase of this study. We drew the qualitative interview data from the database of interviews collected as part of the parent project of this study. The protocol for interviewing as part of this parent study used snowball sampling to conduct 25 and 35 interviews in 24 of 28 cities (as field study travel was disrupted due to COVID 19 to achieve all 28) between 2019 and 2020 for a total of 492 interviews on the social, racial, and economic impact of green redevelopment in neighborhood environments (See interview instrument in Supplementary Materials). We

[14] We assembled the data from cadastral or tax archives (a mix of American, Canadian, and European cities), building permit archives (only some American cities), or by new developments per spatial unit (only some European cities).

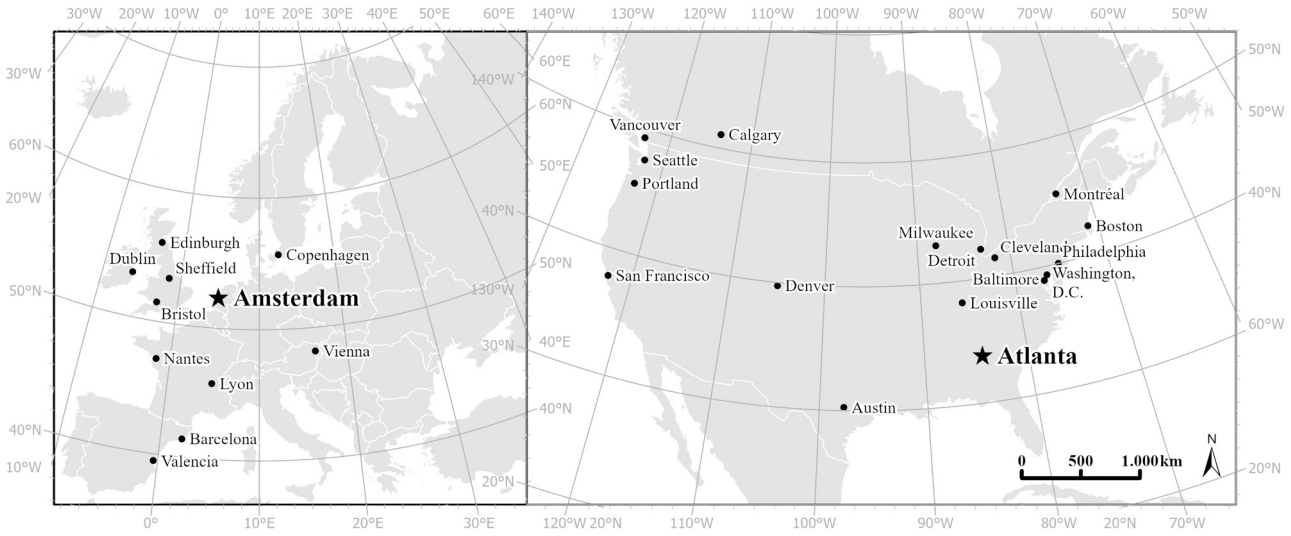


Fig. 1. 28 cities were selected for analysis of the parent project. Of those 28 cities, Atlanta and Amsterdam are selected in this study on greening and real estate development as case studies. Dublin and Lyon were removed from the study described in this paper.

1. DEV_TIME2 = CH_GSAB_PRE2 + NEW TRANSIT_B_PRE2 + POP_CHANGE2 + GDP_CHANGE2 + PRE_1990_GREEN + CENTER + REGION + CITY + SIZE + TRACT_DENSITY_2010 + TIMEFROM1990

2. DEV_TIME3 = CH_GSAB_PRE3 + NEW TRANSIT_B_PRE + POP_CHANGE3 + GDP_CHANGE3 + PRE_1990_GREEN + CENTER + REGION + CITY + SIZE + TRACT_DENSITY_2010 + TIMEFROM1990

3. DEV_TIME23 = CH_GSAB_PRE2 + NEW TRANSIT_B_PRE2 + POP_CHANGE23 + GDP_CHANGE23 + PRE_1990_GREEN + CENTER + REGION + CITY + SIZE + TRACT_DENSITY_2010 + TIMEFROM1990

Fig. 2. Bayesian hierarchical models developed for the study. Each model included eight explanatory variables, with greening being one, and real estate development (DEV_TIME) as dependent variable.2 In addition to greening, seven other explanatory variables were selected based on expert opinion to account for a diversity of factors that could explain development: 1) total green space area added to the census tract (CH_GSAB), 2) the number of public transit stops added to the tract immediately before and during the first two years of the time period (NEWTRANSITB), 3) green coverage prior to 1990 (PRE_1990_GREEN), 4) distance to city center from the centroid of the census tract (CENTER), 5) population change at the city level during the decade of the dependent variable (POP CHANGE), 6) change in GDP at the city level during the decade of the dependent variable (GDP CHANGE), 7) the years from 1990 to the dependent variable (TIMEFROM1990) and 8) the population per square kilometer in the census tract in the year 2010 (TRACTDENSITY_2010).

selected cities in order to maximize diversity of regions, city size, urban development dynamics, and growth patterns. We designed this field work to help us zoom in on emblematic neighborhoods where greening and urban residential redevelopment have been particularly intensive over the last three decades.

For the purpose of this paper, drawing from methodological literature on case study selection (Yin, 2018) and building upon the mixed-methodological framework utilized in Garcia-Lamarca et al. (2021) where a quantitative analysis to determine trends across a variety of cities is paired with a qualitative case study analysis of opposing and comparative city contexts, we selected Amsterdam and Atlanta. Those cities are most similar cases in the relationship between greening and development, as revealed by the present quantitative analysis, yet different in green gentrification and housing injustice trends. We first analyze Atlanta, where green gentrification is sustained throughout the study period and the local and national political economy has led to significant housing injustice and insecurity. We then examine, Amsterdam, where no clear indication of green gentrification is present and the local and national political economy has, until more recently, largely focused on social and economic equity.

Our analysis is based on 18 interviews in Atlanta and 24 in Amsterdam, which we updated through additional qualitative insights in 2023. Interviews focused on the expert accounts of local planners, elected officials, residential real estate developers, and members of civic groups fighting for green and housing justice – informants with a strong knowledge of greening, development, housing, and civic mobilization dynamics in each city. This data was complemented by and triangulated with a comprehensive identification of relevant local policy and planning reports, changes in local ordinances, zoning, and plans, and media reports. Using the Nvivo software, all data was systematically coded through both a deductive, more thematic coding scheme regularly reviewed by the coding team, together with a more open-ended, inductive coding scheme (See full coding matrix in Supplementary Data). To make best use of the data, qualitative analysis is reported in a narrative format and based on the variety of triangulated qualitative data. Selected interviewee quotes highlight some of the trends found in the analysis.

4.3. Qualitative analysis: greening, residential development and green gentrification trends in Atlanta and Amsterdam

4.3.1. Atlanta

Atlanta is a car-dominated city with concentrated urban poverty and institutionally designed redlining which have contributed to highly visible race and class divides (Immergluck and Balan, 2018). These are epitomized by the segregationist power of highways and public transit lines that continue to physically separate areas of opportunity and wealth, keeping them out of everyday reach for residents outside of their

Table 1
Results of 26 city Bayesian analysis.

		Pre Period 2 Greenspace Area and Development Period 2 (greenspaces from the 1990s and development from the 2000s)	**Pre Period 3 Greenspace Area and Development Period 3** (greenspaces from the 2000s and development from the 2010s)	**Pre Period 2 Greenspace Area and Development Period 23** (greenspaces from the 1990s and 2000s and development from the 2000s and 2010s; period 2 and 3 together)
USA	Atlanta	POSITIVE (0.730)	POSITIVE (0.966)	NOT RELEVANT POSITIVE (0.698)
	Milwaukee	POSITIVE (0.976)	POSITIVE (0.765)	POSITIVE (0.995)
	Louisville	NOT RELEVANT POSITIVE (0.534)	POSITIVE (0.976)	POSITIVE (1.000)
	Seattle	POSITIVE (1.00)	NOT RELEVANT POSITIVE (0.633)	POSITIVE (0.999)
	Baltimore	NOT RELEVANT POSITIVE (0.523)	NEGATIVE (0.257)	NOT RELEVANT POSITIVE (0.512)
	Boston	NOT RELEVANT NEGATIVE (0.4956)	NEGATIVE (0.180)	POSITIVE (0.722)
	Washington	NOT RELEVANT NEGATIVE (0.312)	NEGATIVE (0.244)	POSITIVE (0.903)
	Cleveland	NOT RELEVANT POSITIVE (0.501)	NOT RELEVANT NEGATIVE (0.476)	NOT RELEVANT POSITIVE (0.503)
	Philadelphia	NOT RELEVANT POSITIVE (0.517)	NOT RELEVANT NEGATIVE (0.303)	NOT RELEVANT POSITIVE (0.524)
	Austin	NOT RELEVANT POSITIVE (0.508)	NOT RELEVANT POSITIVE (0.510)	NOT RELEVANT NEGATIVE (0.482)
	Denver	NOT RELEVANT POSITIVE (0.515)	NOT RELEVANT POSITIVE (0.532)	NOT RELEVANT POSITIVE (0.551)
	Detroit	NOT RELEVANT POSITIVE (0.499)	NOT RELEVANT POSITIVE (0.563)	NOT RELEVANT POSITIVE (0.500)
	Portland	NOT RELEVANT POSITIVE (0.639)	NOT RELEVANT POSITIVE (0.680)	NOT RELEVANT POSITIVE (0.681)
	San Francisco	NOT RELEVANT POSITIVE (0.509)	NOT RELEVANT POSITIVE (0.508)	NOT RELEVANT POSITIVE (0.514)
Canada	Calgary	NEGATIVE (0)	NOT RELEVANT POSITIVE (0.529)	NOT RELEVANT NEGATIVE (0.414)
	Montreal	NEGATIVE (0.189)	POSITIVE (0.897)	NEGATIVE (0.155)
	Vancouver	NOT RELEVANT NEGATIVE (0.420)	NOT RELEVANT NEGATIVE (0.480)	NOT RELEVANT NEGATIVE (0.403)
Europe	Amsterdam	POSITIVE (0.999)	NOT RELEVANT POSITIVE (0.552)	POSITIVE (1.000)
	Barcelona	NEGATIVE (0)	NOT RELEVANT NEGATIVE (0.466)	NEGATIVE (0)
	Copenhagen*	NA (No data or not enough data)	NOT RELEVANT POSITIVE (0.712)	NA (No data or not enough data)
	Valencia*	NEGATIVE (0.002)	NA (No data or not enough data)	NA (No data or not enough data)
	Vienna*	NEGATIVE (0.326)	NA (No data or not enough data)	NA (No data or not enough data)
	Edinburgh*	NOT RELEVANT POSITIVE (0.528)	NA (No data or not enough data)	NA (No data or not enough data)
	Nantes*	NA (No data or not enough data)	NOT RELEVANT POSITIVE (0.552)	NA (No data or not enough data)
	Bristol*	NOT RELEVANT NEGATIVE (0.472)	NA (No data or not enough data)	NA (No data or not enough data)
	Sheffield*	NOT RELEVANT NEGATIVE (0.476)	NA (No data or not enough data)	NA (No data or not enough data)

* indicates more than one period with no data

Legend
- Greening is a driver of development
- Greening is likely a driver of development
- Greening is not a driver of development
- Greening is likely not a driver of development
- No data or not enough data

The Bayesian posterior predictive distributions (values in parenteses) refer to the distributions of the power in predicting the development index (outcome variable) in each census tract (or equivalent) produced by the final model (model that includes spatial effect and selected independent variables). These probabilities are not to be interpreted as traditional *p*-values (the probability of obtaining the observed results, assuming that the tested null hypothesis is true). Value are rounded to the nearest 1/1000th.

Darker blue and yellow cells (and value) show where the final spatial effect model best predicts the relationship between greening and development, that is the relationship is considered relevant. Lighter blue and yellow cells show the areas where the final spatial effect least predicts that relationship, that is the relationship is considered not-relevant

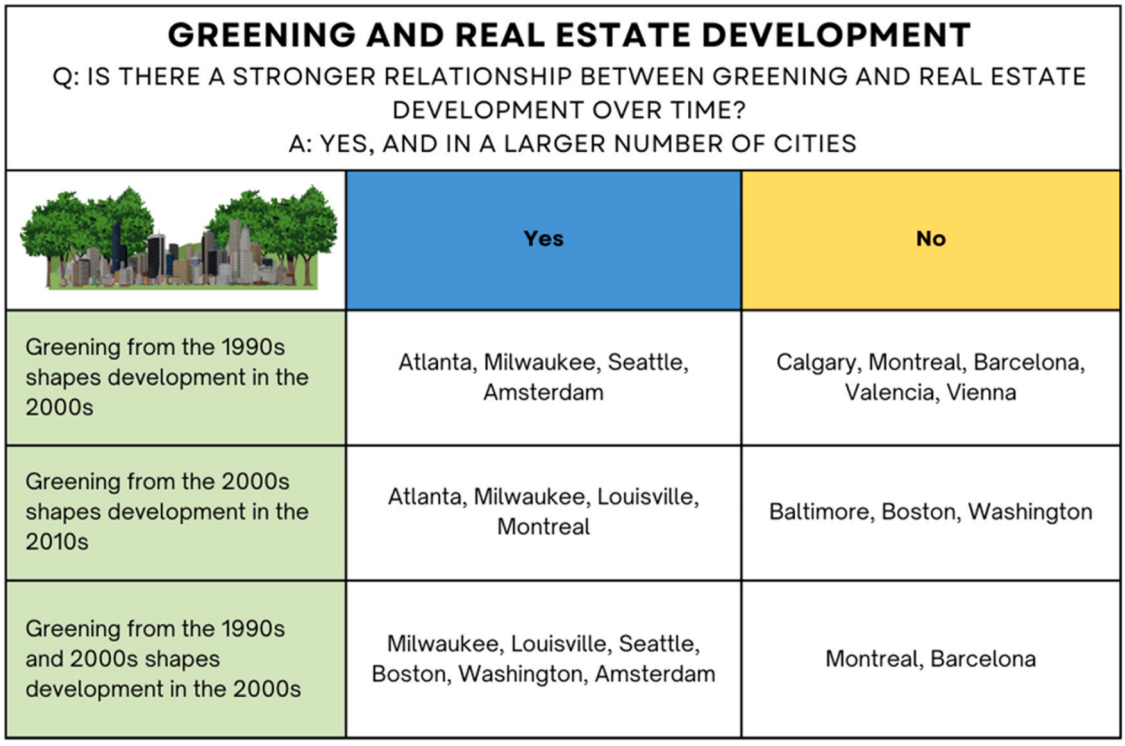


Fig. 3. Greening and real estate development in North American and Europe.

geo-political boundaries (Immergluck, 2022). Moreover, residents in these neighborhoods are exposed not only to noise and atmospheric pollution from highways and rail lines but also to severe climatic risk of flooding due to the low permeability profiles of these neighborhoods. These social and environmental riskscapes position Atlanta's southern, western, and south-western neighborhoods as lucrative potentials for real estate investors, particularly as few protective social services or institutionalized tenant/homeowners protections exist within the broader American national political landscape (Vale, 2018).

Within this context and as part of Atlanta's most visible and well-

known urban redevelopment and greening work, the Atlanta Beltline[15] is a 22-mile large-scale green rail-to-trail loop project surrounded by largely residential and commercial land uses (Fig. 4). Since its inception in 1999, it has been marketed as a holistic connectivity and livability solution to the historic and modern segregation, inequality, and injustice. The land procurement, planning, development, and design for the Beltline have largely been led and informed by private, non-profit groups which work closely with the city in a public-private partnership. These include Atlanta Beltline Inc. and Atlanta Beltline Partnership, among others, that focus on environmental sustainability and conservation. Although both entities work closely with the City of Atlanta, they are private, non-profit organizations. While the City took a backseat on new green projects, the non-residential development itself was planned in a staged approach, with construction for both the Eastside Beltline and nearby transit lines beginning in 2010, and has since incorporated a system of six interconnected parks. Significant commercial and residential change has occurred as a result of the parks construction, while speculative practices run rampant in the neighborhoods of planned Beltline redevelopment (Immergluck and Balan, 2018). This speculation was particularly aggravated as the Atlanta Beltline, Inc. focused the majority of its funding towards building trails and parks first, coming to consider land procurement for affordable housing too late.[16]

From a land use perspective, historical industrial buildings that line the new greenway have been redeveloped by high-profile investment companies to operate as non-residential real estate development, as with the example of the Ponce City Market built by the same developers as Chelsea Market on NYC's Highline (Fig. 5). Meanwhile, the once historically Black, working-class neighborhood has since hastily transformed into a "flipping" market of financial gain, displacing long-term residents through increases to property taxes ranging from 74 % (farthest from Beltline) to 160 % (closest to Beltline) (Immergluck, 2007). This process also has a downstream effect on rent increases as landlords are forced to keep up with increasing annual homeownership costs (Lartey, 2018). Moreover, the incipient fear of gentrification and pressure of displacement has had documented impact on the sleep quality of Black adults in Atlanta (Williams et al., 2021). The state of the recent housing market, as described by an activist representing the West Atlanta Watershed Alliance (WAWA), arises as an additional stressor following the great losses suffered following the 2008 Great Recession, where the Black, middle-class of Atlanta were most impacted:

> "Atlanta was ground zero for predatory lending… we did have a large population of Black middle class and so I would say in that market downturn a lot of Black wealth was lost because our wealth was in our homes. The market essentially flipped and people lost their houses, banks foreclosed on people and so that inventory of foreclosed houses… It's not serendipitous that the market does what it does… people choose what neighborhoods are ripe for development."

Moreover, the current, post-COVID 'red hot' real estate market has contributed to the alienation of long-term residents excluded from the character, culture, and services of the neighborhood (Immergluck, 2022). These trends have been exasperated as tech giants such as Google, Honeywell and Microsoft, which often situate their tech-campuses in opportunity areas for revitalization (McElroy and Werth, 2019), have since brought over 100,000 high-paying workers from 2011 to 2019 into Beltline neighborhoods (Immergluck, 2022).

While the two non-profits leading the Beltline development included the need for affordable housing in the plan proposal phase and the current development phase, too little has been built for this to be an effective anti-displacement effort. The affordability push came very late in the greening process, after land values had already greatly increased. One example of anti-displacement efforts is the Beltline's Legacy Resident Retention Program, which is designed to help long-term residents afford rising property taxes in certain neighborhoods adjacent to the Beltline. However, this program was not launched until late 2020, 15 years after the Beltline broke ground.

Despite implementing affordable housing targets for households with less than 80 % of the metropolitan median income, our analysis found that income limits are based on highly stratified data across the city whereby limits are outstandingly high when compared to median income levels of long-term residents, especially Black residents, living in periphery Beltline neighborhoods. Moreover, these affordable housing targets largely exclude residents in the 50 % area median income (AMI)[17] and especially residents below the 30 % AMI. In total, the Beltline agenda aims to provide 5600 units of 'affordable' homes by 2030, of which the majority are located in very low-income neighborhoods, including Peoplestown and Westin Heights, where long-term residents would still consider these far out of their financial scope. By 2030, at the current rate of price increases, many residents will likely already have been displaced. In another example, while the Beltline plans mandate inclusionary zoning practices of affordable housing units within a half mile of the periphery of the greenway, many developers are dodging these zoning obligations by building properties outside these boundaries. A housing community activist describes this trend of avoiding affordable housing construction:

> "The city has done things like inclusionary zoning along the BeltLine corridor but it's not enough and developers are just building outside of that half mile on either side of the BeltLine, to still get the BeltLine benefit without having to lose money by building affordable housing (Interview, 2019)."

Moreover, an investigative journalism piece by the Atlanta journal *Constitution* reports that many affordable homes were later re-sold to higher-income households, data not reported by the Atlanta Beltline, Inc..[18] Shortly after, the CEO of the Atlanta Beltline, Inc. resigned.[19]

In another reactive anti-displacement effort, the Atlanta Beltline Partnership offered a Legacy Resident Retention Program to provide tax relief to cover the cost of increase to property taxes for existing long-term residents until 2030. Yet, this tax relief program was only accessed by 96 homeowners since 2022, a fraction of the housing-cost-burdened homeowners in the surrounding neighborhoods.[20] Furthermore, this property tax break program does not directly support renters in neighborhoods where homeownership rates are under 40 % and sometimes as low as 20 % (Immergluck, 2022). As one local developer and landscape architect puts it:

> "A developer is a certain type of personality and that personality is somebody who likes to make a lot of money… It's capitalism… anything outside the norm in terms of reduced parking spaces or subsidized rents or efficiency units… most developers do not do that (Interview, 2019)."

[15] https://Beltline.org/the-project/project-goals/project-goal-transit/

[16] See https://phys.org/news/2023–01-atlanta-Beltline-urban-green-gentrification.html

[17] Area median income (AMI) refers to midpoint of a jurisdiction's income distribution where half of the households earn more than the median and half earn less than the median. A household's income is calculated by its gross income, which is the total income received before taxes and other payroll deductions. A 60 % AMI household is one where the gross income is 60 % or less of the areea median income. See more: https://www.huduser.gov/portal/datasets/il.html

[18] https://www.ajc.com/news/local/how-the-atlanta-Beltline-broke-its-promise-affordable-housing/0VXnu1BlYC0IbA9U4u2CEM/

[19] https://roughdraftatlanta.com/2017/08/23/atlanta-Beltline-ceo-stepping/

[20] Reporting from the 2022 Beltline Annual Report https://Beltline.org/2022-annual-report/

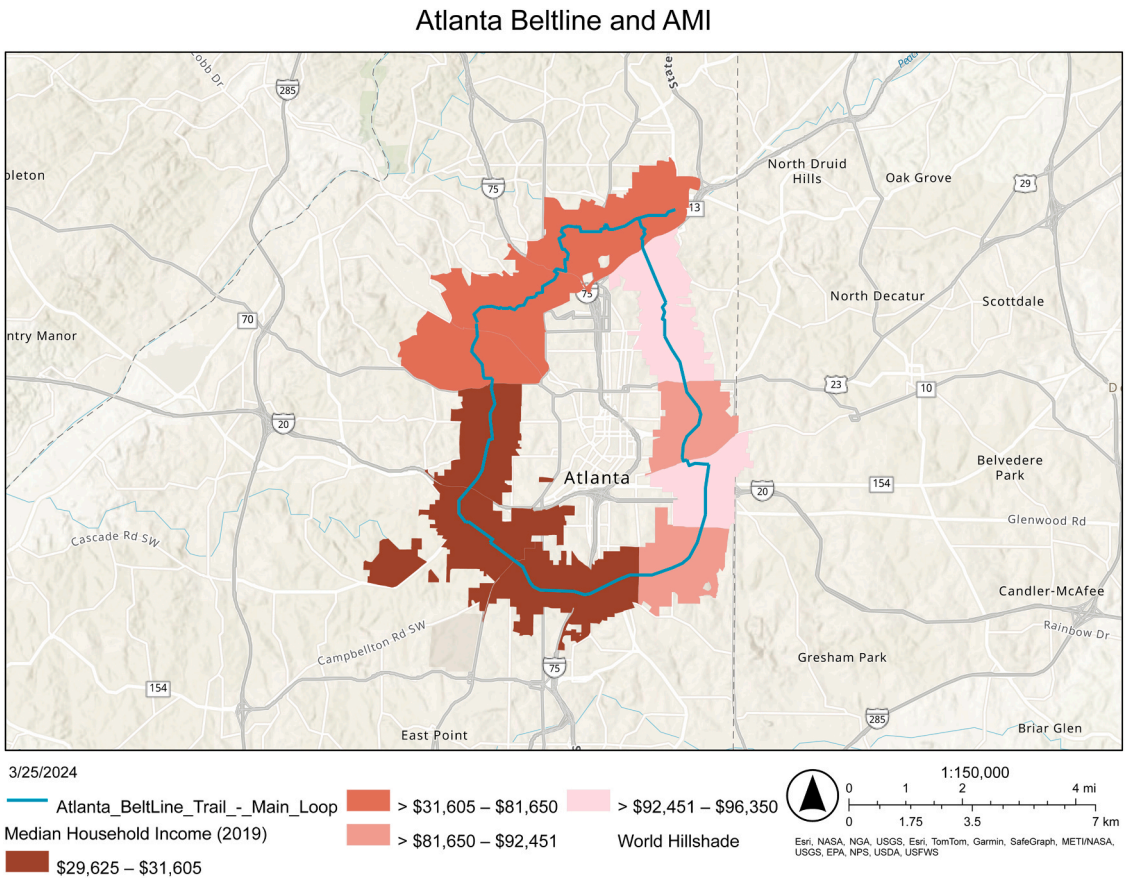


Fig. 4. Map of Beltline and Area Median Income (AMI) Distribution.

Fig. 5. New development including Ponce City Market along the East Atlanta Beltline (2019). Photographed by Helen V.S. Cole (co-author).

Meanwhile, institutionalized political conservatism in the city (and state) – and more broadly at the national level with a very split US Congress – only supports endured hardship and challenge in achieving any state-wide legislation that would offer housing rights and protections. As a housing rights activist shared, the political ecosystem of the state makes systemic wins near impossible to achieve:

> "We live in a state that's very red and Republican so we can't do things like renter's protection, renter's rights, we're in a state that doesn't allow those things, it's a landlord's rights state and not a renter's rights state (Interview, 2019)."

In sum, the Atlanta Beltline is an example of how a negative local and state political climate, de facto inexistent equity-driven planning of a green infrastructure, investors' green grabbing practices, and superficial intentions by the green infrastructure managers have come together to sacrifice the retention of affordable housing for green, exclusive, and mostly white profit. In Atlanta, real estate investors and speculators emerged with the upper-hand as they gained momentum in the announcement and development of the Beltline. At the same time, affordable housing planners were already at a disadvantage in providing housing units which was only magnified by the strategy and process of development for the Beltline, forcing hasty reactions as opposed to premeditated, pre-consulted, solutions. This haste is demonstrated through the poorly-accessed tax support programs and unrealistic affordable housing minimums – simply mild obstacles within a rather free, speculative green growth machine producing green gentrification through the marriage of greening and real estate development. Instead, extensive early investments in affordable housing through assembling and land banking *prior to* green announcement could have provided major anti-gentrification relief.

4.3.2. *Amsterdam*

Amsterdam is well-known for a historic commitment to urban sustainability and social planning. With a history of social planning through public green infrastructure development dating back to the 19th century, Amsterdam has demonstrated prioritization of public parks, gardens and social housing as part of its planning, with most recent goals aimed toward expansion of green infrastructure for achieving a sustainable and livable city (Balikçi et al., 2022). While most of the urban parks and larger green spaces in Amsterdam were created before the 1980s, a new strategy, dubbed the *green compact city,* transformed the urban planning paradigm beginning in the 1990s. Through this strategy, rationale for greening was increasingly *"argued from a competitiveness perspective"* to the point that greening *"became part and parcel of the city's economic strategy"* (Amsterdam municipal strategist; City of Amsterdam Chief Urban Planning, Interviews, 2019). The *green compact city* strategy combines two purposes: Conserving and developing green recreational

and natural landscapes in the urban fringes while developing 25 % more pocket parks and small green recreational areas in in the city center. As illustrative of these changes, since the 1990s, new high-density residential homes, museums, hospitality industry infrastructure, as well as green, walking and biking paths have dominated redevelopment on the East Amsterdam waterfront as well as Amsterdam's northwest (Fig. 6).

Prioritization of investment toward quality green space is clearly demonstrated in the municipal budget which amounted to close to €20 million yearly in the 2015–2018 Green Agenda (Amsterdam Green Agenda 2015–2018, 2015). Through this funding, goals changed from being quantitative (e.g., 200 m2 of greenspace per 400 built households pre 2015), to becoming qualitative (considering specific characteristics of green space and its surroundings needed in new developed areas). As Amsterdam's Chief Urban Planner explains, greenspace and housing are perceived as a pairing match in the City's planning rhetoric:

> "If you want to have a successful park […] you don't have to do something in the park, but you have to do something around the park […]. If we [the city] invest in parks in areas that are too monotonous, too crowded with people who don't have enough money to support the amenities […]then you can't change the quality of the park use […] if you want to develop the use of green areas you should densify and, after you have done that, then you can go into the park […] so it's not the quantity of green it's the quality of green and its surroundings" (Interview, 2019).

Many of these green developments take place in the context of a legacy of national social planning policies that have tended to protect housing rights and thus, indirectly, green justice. The latter include housing laws supportive of the decommodification of housing and universal access to affordable housing, anchored in the historically persistent subsidy of a universally accessible social housing owned by housing associations, a share which remained at 42 % in 2022, despite a decrease from 58 % in 1995 (van der Veer and Kornatowski, 2023) – one of the highest in Europe. Other social planning policies include strict and comprehensive rent regulation laws reinforcing long-term and affordable leases (Pérez-del-Pulgar, 2021), and inclusionary zoning requirements – currently set at a 40 % social, 40 % housing and 20 % free-market housing (Wijburg, 2021; Van Gent et al., 2018). Underscoring this legacy and national policy framework is a high share of municipally owned land.

Yet these social planning policies that historically ensured housing access for all are slowly being dismantled through a neoliberal paradigm shift (Pérez del Pulgar, 2021). Emphasis is shifting to favor reducing national debt, producing a more competitive housing market, and eliminating the 'ghettoization' of low-income residents into densified areas (van Gent et al., 2018). While many long-standing protections have not yet completely been abolished or disappeared, a once robust system is now diminished in its capability of providing affordable and appropriate housing to lower-, working and middle-class residents.

It is in part the major green developments shift that took place since the 2000s in Amsterdam that have accompanied this restructuring of the housing system and the ambition to end the so-called ghettoization of lower income and ethnic minority residents in excluded neighborhoods (Pérez-del-Pulgar, 2021; van Gent et al., 2018). From a city where social housing constituted 57–64 % of the total housing stock up to the early 2010s or so (Jonkman, 2021; van Gent et al., 2018), that share has fallen to 42 %, as mentioned above (Jonkman, 2021). As high-earning tech- and knowledge-based capitalist industries have begun to move to new highly green, livable and walkable developments, demand for housing has increased for those groups (Fig. 7), jeopardizing housing accessibility for the working- and middle-classes whom seem neither able to access the public social housing provision nor private market high-end housing. Indeed, since 2008 the EU legislation on competition has forced housing associations to limit social housing only to economically vulnerable households, excluding middle income households (Interview, Renters Union Representative, 2019). Municipal leaders and planners have also laid blame for this limited access to affordable housing on the free market, and the imbalance between housing supply and demand, particularly when compounded with overly rigid zoning and regulatory frameworks (Interview, Social Housing Association, 2019; Interview, Real estate developer, 2019).

In response, under the hope that quickly built residential developments can and will drive down prices, the city has been developing and planning new urban expansions. However, to finance them and maximize returns, the municipality has declared greening as a long-term municipal strategy in order to attract investment and highly-qualified residents, thus prioritizing financial logics and green goals over social equity goals. As the Chief Urban Planner describes: "*if we see that [housing prices are] going up then we know there is gentrification, then we know we have to invest in the green*" (Interview, 2019).

In opposition with municipal views, housing activists and social housing developers argue that what incites the rapid growth of exclusive real estate development and the current housing accessibility crisis in Amsterdam is the coupling of development with the growing and complex role of the (global) financial sector, a coupling that leads to fewer affordable units built and contributes to skyrocketing housing prices benefiting high-income earners (Interview, Renters Union Representative, 2019). As an affordable housing developer in Amsterdam explains:

> "In 2013 only three parties joined the tenders [developers competitions] […] right now you would have 30 […] then it was possible to win a tender; right now it's just not possible because everyone wants to be in Amsterdam, because it's expanding so, the prices are going up, everyone wants to invest in housing here, especially if it's not

Fig. 6. Wonam Luxury Residential Apartments Development in Amsterdam Nieuw-West (2019). Photographed by Helen V.S. Cole (co-author).

Fig. 7. Mixed-use commercial and residential development in Pontkade neighborhood, Amsterdam (2019). Photographed by Carmen Pérez-del-Pulgar (co-author).

specifically written down that they need middle rent housing" (Interview, 2019).

Furthermore, the urgency of the housing crisis is paving the way to further deregulations that ultimately contribute to bypassing or dismantling historically robust social planning legacies. The recent inclusion of the 40 % 'affordable' housing segment in the inclusionary zoning regulations is one such example of a dismantling regulation. It ultimately operates as a chimera because affordable housing has no legal definition or regulation, and thus developers are not held responsible for retaining lower rents in this so-called affordable housing share. In addition, the City of Amsterdam keeps promoting 'affordable housing' developments as a solution to the housing crisis, further supporting developers who can in practice set higher rental prices. In return, it often provides developers with reductions in the regulated share of required 'social housing', in many cases from a 40 % minimum to a 20 % minimum (Wijburg, 2021) in exchange for increased shares of non-regulated 'affordable housing' (Interview, Affordable housing developer, 2019).

Other recent regulations that bypass or dismantle historic protection for lower-earners include the withdrawal of national public funding for social housing; a new landlord levy that demands a maximum of four months of dues equal to rental incomes of housing associations; and, strict restrictions of profitable economic activities. All these regulations leave housing associations in a precarious situation and with limited capabilities to continue providing social housing (Pérez-del-Pulgar, 2021). In addition, the introduction of temporary contracts, to which not only private but also social housing developers are subscribing (e.g. up to 93 % of the rental within new developments were temporary in 2019) are further jeopardizing affordable, long-term rentals. Overall, more that 50 % of new rental properties in Amsterdam are with a temporary contract (Interview, Renters Union, 2019).

In sum, Amsterdam illustrates how the remaining legacy of affordable housing provisions and planning instruments, in contrast with Atlanta, have until recently held at bay massive city-wide gentrification processes generated by twinned greening and residential development strategies. The analysis also underlines how national social planning policies ensuring access to green are being undermined by recent local hyper-segregation processes, whereby residents with top wages employed in creative industries are separated from middle- and working-class households who have lost access to the city center in what were once protected and robust housing associations that have since had to sell their housing stock in order to relocate to the periphery.

5. Discussion

This study renews and advances knowledge on the relationship between urban greening and real estate development both theoretically and methodologically. Findings provide a quantitative analysis of the relationship between greening and real estate development that supports much of the literature on hedonic pricing by showing that, in the majority of cases, development follows greening (Caprioli et al., 2023), in a growing number of cities and in a tighter relationship over time. Our analysis also offers a qualitative investigation of the role played by urban green branding in the perceptions and strategies of real estate developers and in the role played by urban planners in facilitating such concentrated, high-end investment (Garcia-Lamarca et al., 2021). Findings may also support recent calls for defining the green gentrification cycle, providing new evidence of the spatio-temporal scales of gentrification related to greening (Rigolon and Collins, 2023). Finally, our article is a key addition to the green gentrification literature as it points to how greening, as part of a continuum, is related to and influences real estate development and often gentrification, with a growing, stronger influence over time. These findings have been further supported in large, multi-scale, national and international studies which demonstrate the gentrification trends associated with greening across temporal scales (Anguelovski et al., 2022).

Moving to our two case examples, when contextualizing findings of Amsterdam and Atlanta, we saw that both have experienced strong economic growth, accelerating since the mid 2010s, where it is likely that greening and real estate development have co-occurred through a symbiotic relationship that contributed to this growing economy (Poe and Bellamy, 2020). In the case of Atlanta, a legacy of racialized housing segregation has been further amplified by a political local and state economy that supports private, luxury, de-regulated real estate development (Immergluck, 2022). In Amsterdam, in contrast, the legacy of national housing protections and regulations is disrupting the acceleration and intensification of the green gentrification "potential" (Pérez del Pulgar, 2021). These paradoxical trends, where greening drives development but still does not drive gentrification citywide in Amsterdam, is partly due to the resistance created by welfare and housing policies which increases the city's capacity to mitigate some of the equity and housing accessibility impacts for the most disadvantaged in the face of powerful global investment (Perez-del-Pulgar, 2021). Our quantitative findings for Amsterdam do not mean that gentrification did not (and continues to) take place in specific pockets of the city, as our qualitative analysis illustrates. Instead, our qualitative analysis demonstrated that other drivers to gentrification are at play and protective regulatory barriers are eroding (Jonkman, 2021; Planas-Carbonell et al., 2023). Thus, gentrification in Amsterdam disrupts and spatially reorders the very social safety net mechanisms that have served tenants and residents for generations by offering secure, stable, and affordable housing to the middle- and working-class in more centrally located areas of the city.

Constrained by irregularities in data accessibility and methods for housing data classification across international contexts, this cross-national and trans-continental type of study does face limitations. Quantitative data presented in this study required multiple scales of inquiry, including neighborhood, multi-neighborhood and city. Because of the multiple scales, it was difficult to locate, utilize, and make comparisons through varying city, regional, national, and cultural contexts. Each location utilizes a different format or prioritizes differing measurements of development and greening, thus making the co-location of such data across a variety of cities difficult. Moreover, publicly available data for European cities did not exist and instead data must be purchased at significant cost. Future research would further benefit from supplementation of uniform data types and units of analysis and may build upon our analysis in order to more definitively establish causality between greening, green gentrification, and real estate development (or vice versa). Furthermore, inclusion of Global South contexts would be welcome in a literature that is largely saturated by Global North real estate development trends and green gentrification dynamics.

6. Conclusion

As cities look to green agendas and initiatives to provide urban residents with cultural ecosystem services, environmental sustainability benefits and climate resiliency solutions (Kosanic and Petzold, 2020), it is critical for urban leaders to consider the broader, city-wide, socio-economic impacts that occur alongside greening and real estate development and impact marginalized communities at magnitude (Anguelovski, Cole, et al., 2021; Garboden and Jang-Trettien, 2020). Planning action must prioritize community-engaged anti-gentrification and anti-displacement policies while implementing inclusive greening and greenspace development for long-term and marginalized residents. This inherently includes protecting existing social and economic policies that have historically accomplished such goals (Oscilowicz et al., 2022). Ultimately, we believe that unpacking the relationship between greening and real estate development and examining the spatial dynamics occurring on the ground between those two drivers of current urban change is valuable in both planning practice and in supporting positive just, green housing outcomes. In this progressive scenario, new greening does not lead to more acute housing inequalities, but can

actually increase both access to green space and secure and affordable housing for all.

CRediT authorship contribution statement

Austin Matheney: Data curation, Formal analysis, Methodology, Software. **Elsa Gallez:** Data curation, Formal analysis, Methodology. **Melissa Garcia Lamarca:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Writing – original draft, Writing – review & editing. **Francesc Baró:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft. **Nicholas Martin:** Conceptualization, Data curation, Formal analysis, Investigation, Project administration, Supervision, Validation. **Conesa David:** Conceptualization, Formal analysis, Methodology, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Galia Shokry:** Conceptualization, Data curation, Investigation, Methodology. **Isabelle Anguelovski:** Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Validation, Writing – original draft, Writing – review & editing. **Jésua López Máñez:** Formal analysis, Software, Validation. **Carmen Pérez del Pulgar:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Writing – original draft. **Blanca Sarzo:** Formal analysis, Software, Validation. **Helen VS Cole:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Supervision, Writing – original draft. **Miguel Angel Beltrán:** Formal analysis, Software, Validation, Visualization. **Daniel Immergluck:** Formal analysis, Investigation, Writing – original draft. **Joaquin Martínez Minaya:** Formal analysis, Software, Validation. **Margarita Triguero-Mas:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft. **Lucia Arguelles Ramos:** Conceptualization, Data curation, Investigation, Methodology. **Emilia Oscilowicz:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **James JT Connolly:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

GreenLULUs project (GA 678034), European Research Council, Maria de Maeztu grant (CEX2019-000940-M), Ministerio de Ciencia, Innovación, y Universidades.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ufug.2024.128376.

References

Angelo, H., 2021. How green became good: urbanized nature and the making of cities and citizens. University of Chicago Press.
Anguelovski, I., Connolly, J.J.T., 2021. The green city and social injustice: 21 tales from North America and Europe. Routledge.
Anguelovski, I., Connolly, J.J.T., Cole, H., et al., 2022. Green gentrification in European and North American cities. Nat. Commun. *13* (1), 3816.
Anguelovski, I., Connolly, J.J.T., 2024. Segregating by greening: What do we mean by green gentrification? J. Plan. Lit., 08854122241227804
Balikçi, S., Giezen, M., Arundel, R., 2022. The paradox of planning the compact and green city: Analyzing land-use change in Amsterdam and Brussels. J Environ. Plann. Man. *65* (13), 2387–2411.
Black, K.J., Richards, M., 2020. Eco-gentrification and who benefits from urban green amenities: NYC's high Line. Landsc. Urban Plan. *204*, 103900.
Blok, A., 2020. Urban green gentrification in an unequal world of climate change. Urban Stud. *57* (14), 2803–2816.
Boanada-Fuchs, A., Boanada Fuchs, V., 2022. The role of real estate developers in urban development. Geoforum *134*, 173–177.
Byrne, M., Norris, M., 2022. Housing market financialization, neoliberalism and everyday retrenchment of social housing. Environ. Plan. A: Econ. Space *54* (1), 182–198.
Caprioli, C., Bottero, M., De Angelis, E., 2023. Combining an agent-based model, hedonic pricing and multicriteria analysis to model green gentrification dynamics. Comput. Environ. Urban Syst. *102*, 101955.
Cole, H.V.S., et al., 2021. Adapting the environmental risk transition theory for urban health inequities. Soc. Sci. Med. *277*, 113907.
Cole, H.V., Mehdipanah, R., Gullón, P., et al., 2021. Breaking down and building up: gentrification, its drivers, and urban health inequality. Curr. Environ. Health Rep. 8, 157–166.
Connolly, J.J.T., 2019. From jacobs to the just city: A foundation for challenging the green planning orthodoxy. Cities *91*, 64–70.
Connolly, J.J.T., Anguelovski, I., 2021. Three histories of greening and whiteness in American cities. Front. Ecol. Evol. *9*.
Conway, D., Li, C.Q., Wolch, J., Kahle, C., Jerrett, M., 2010. A spatial autocorrelation approach for examining the effects of urban greenspace on residential property values. J. Real. Estate Financ. Econ. *41* (2), 150–169.
Crompton, J.L., 2001. The impact of parks on property values: A review of the empirical evidence. J. Leis. Res. 33 (1), 1.
Du, M., Zhang, X., 2020. Urban greening: A new paradox of economic or social sustainability? Land Use Policy *92*, 104487.
Freemark, Y., 2023. Zoning change: upzonings, downzonings, and their impacts on residential construction, housing costs, and neighborhood demographics. J. Plan. Lit.
Gałecka-Drozda, A., Wilkaniec, A., Szczepańska, M., Świerk, D., 2021. Potential nature-based solutions and greenwashing to generate green spaces: Developers' claims versus reality in new housing offers. Urban For. Urban Green. *65*, 127345.
Garboden, P., Jang-Trettien, C., 2020. There's money to be made in community: Real estate developers, community organizing, and profit-making in a shrinking city. J. Urban Aff. *42* (3), 414–434.
Garcia-Lamarca, M., Anguelovski, I., et al., 2021. Urban green boosterism and city affordability: for whom is the 'branded' green city? (G). Urban Stud. *58* (1), 90–112. https://doi.org/10.1177/0042098019885330.
García-Lamarca, M., Anguelovski, I., et al., 2022. Urban green grabbing: residential real estate developers discourse and practice in gentrifying global North neighborhoods. Geoforum *128*, 1–10.
García-Lamarca, M., Ullström, S., 2020. Everyone wants this market to grow": The affective post-politics of municipal green bonds. Environ. Plan. E: Nat. Space, 2514848620973708.
Gould, K.A., Lewis, T.L., 2016. 7. Green gentrification and hurricane sandy: the resilience of the green growth machine around Brooklyn's gowanus canal. Rutgers University Press. https://doi.org/10.36019/9780813573793-009.
Grabowski, Z.J., McPhearson, T., Pickett, S.T.A., 2023. Transforming US urban green infrastructure planning to address equity. Landsc. Urban Plan. *229*, 104591 https://doi.org/10.1016/j.landurbplan.2022.104591.
Immergluck, D., 2007. Study for Georgia StandUp. The Beltline and Rising Home Prices: Residential Appreciation Near the Beltline Tax Allocation District and Policy Recommendations to Minimize Displacement.
Immergluck, D., 2022. Red hot city: housing, race, and exclusion in twenty-first-century Atlanta. Univ of California Press.
Immergluck, D., Balan, T., 2018. Sustainable for whom? Green urban development, environmental gentrification, and the Atlanta Beltline. Urban Geogr. *39* (4), 546–562.
Jonkman, A., 2021. Patterns of distributive justice: Social housing and the search for market dynamism in Amsterdam. Hous. Stud. *36* (7), 994–1025.
Kosanic, A., Petzold, J., 2020. A systematic review of cultural ecosystem services and human wellbeing. Ecosyst. Serv. *45*, 101168.
Kotsila, P., Anguelovski, I., Baró, F., Langemeyer, J., Sekulova, F., Jt Connolly, J., 2020. Nat. -Based Solut. discursive tools Contest Pract. Urban Nat. 'S. neoliberalisation Process. *4* (2), 252–274.
Kronenberg, J., Skuza, M., Łaszkiewicz, E., 2023. To what extent do developers capitalise on urban green assets? Urban For. Urban Green. 87.
Lartey, J., 2018. Nowhere for people to go: Who will survive the gentrification of Atlanta? October 23 Guardian. ⟨https://www.theguardian.com/cities/2018/oct/23/nowhere-for-people-to-go-who-will-survive-the-gentrification-of-atlanta⟩. October 23.
McElroy, E., Werth, A., 2019. Deracinated dispossessions: On the foreclosures of "gentrification" in Oakland, CA. Antipode *51* (3), 878–898.
Nesbitt, L., Hotte, N., Barron, S., Cowan, J., Sheppard, S.R.J., 2017. The social and economic value of cultural ecosystem services provided by urban forests in North America: a review and suggestions for future research. Urban For. Urban Green. *25*, 103–111.
Oscilowicz, E., et al., 2023. Grassroots mobilization for a just, green urban future: building community infrastructures against green gentrification and displacement. J. Urban Aff.

Oscilowicz, E., Anguelovski, I., Triguero-Mas, M., García-Lamarca, M., Baró, F., Cole, H. V.S., 2022. Green justice through policy and practice: a call for further research into tools that foster healthy green cities for all. Cities Health.
Pauleit, S., Zölch, T., Hansen, R., Randrup, T.B., Konijnendijk van den Bosch, C., 2017. Nature-based solutions and climate change–four shades of green. Nature-based solutions to climate change adaptation in urban areas: Linkages between science, policy and practice 29–49.
Perez del Pulgar, C., 2021. In: Anguelovski, I., Connolly, J.J. (Eds.), Dismantling the Just City: The Unevenness of Green Experiences in Amsterdam-Noord. Routledge, New York; London.
Planas-Carbonell, A., Anguelovski, I., Oscilowicz, E., Pérez-del-Pulgar, C., Shokry, G., 2023. From greening the climate-adaptive city to green climate gentrification? Civic perceptions of short-lived benefits and exclusionary protection in Boston, Philadelphia. Amst. Barc. *Urban Clim. 48*, 101295.
Poe, J., Bellamy, J., 2020. Plantation urbanism. Radic. Hous. J. *2* (2), 143–164.
Power, A., 2021. Hovels to high rise: state housing in europe since 1850. Routledge.
Quinton, J., Nesbitt, L., Sax, D., 2022. How well do we know green gentrification? a systematic review of the methods. Prog. Hum. Geogr.
Ranganathan, M., Bratman, E., 2021. From urban resilience to abolitionist climate justice in Washington, DC. Antipode *53* (1), 115–137.
Raymond, C.M., Stedman, R., Frantzeskaki, N., 2023. The role of nature-based solutions and senses of place in enabling just city transitions. Environ. Sci. Policy *144*, 10–19.
Rigolon, A., 2016. A complex landscape of inequity in access to urban parks: A literature review. Landsc. Urban Plan. *153*, 160–169.
Rigolon, A., Collins, T., 2023. The green gentrification cycle. Urban Stud. *60* (4), 770–785. https://doi.org/10.1177/00420980221114952.
Rigolon, A., Németh, J., 2020. Green gentrification or 'just green enough': Do park location, size and function affect whether a place gentrifies or not? Urban Stud.
Robin, E., 2022. Performing real estate value(s): Real estate developers, systems of expertise and the production of space. Geoforum *134*, 205–215.
Rodgman, M., et al., 2024. Perceived urban ecosystem services and disservices in gentrifying neighborhoods: contrasting views between community members and state informants. Ecosyst. Serv. 65, 101571.
Rutt, R.L., Gulsrud, N.M., 2016. Green justice in the city: a new agenda for urban green space research in Europe. Urban For. Urban Green. *19*, 123–127.
Teo, H.C., Fung, T.K., Song, X.P., Belcher, R.N., Siman, K., Chan, I.Z.W., Koh, L.P., 2023. Increasing contribution of urban greenery to residential real estate valuation over time. Sustain. Cities Soc. *96*, 104689.
Todes, A., Robinson, J., 2020. Re-directing developers: new models of rental housing development to re-shape the post-apartheid city? Environ. Plan. A: Econ. Space *52* (2), 297–317.
Tretter, E., Heyman, R., 2022. Yimbyism and the housing crisis in canada and the united states: a critical reflection. Int. J. Urban Reg. Res. *46* (2), 287–295.
Triguero-Mas, M., Anguelovski, I., García-Lamarca, M., Argüelles, L., et al., 2021. Natural outdoor environments' health effects in gentrifying neighborhoods. Soc. Sci. Med. *279*, 113964.
Vale, L.J., 2018. After the projects: public housing redevelopment and the governance of the poorest Americans. Oxford University Press.
van der Veer, J., Kornatowski, G., 2023. Housing policy and the role of housing associations: urban renewal in the bijlmermeer, Amsterdam. In: Mizuuchi, T., Kornatowski, G., Fukumoto, T. (Eds.), Diversity of Urban Inclusivity: Perspectives Beyond Gentrification in Advanced City-Regions. Springer Nature, pp. 251–272.
van Gent, W., Hochstenbach, C., Uitermark, J., 2018. Exclusion as urban policy: the Dutch 'Act on Extraordinary Measures for Urban Problems.'. Urban Stud. *55* (11), 2337–2353.
Weber, R., 2021. Embedding futurity in urban governance: redevelopment schemes and the time value of money. Environ. Plan. A: Econ. Space *53* (3), 503–524.
Wijburg, G., 2021. The governance of affordable housing in post-crisis Amsterdam and Miami. Geoforum *119*, 30–42.
Williams, P.C., Krafty, R., et al., 2021. Greenspace redevelopment, pressure of displacement, and sleep quality among Black adults in Southwest Atlanta. J. Expo. Sci. Environ. Epidemiol. *31* (3), 412–426.
Wyly, E., 2022. YIMBY: the latest frontier of gentrification. Int. J. Urban Reg. Res. *46* (2), 319–330.
Yin, R.K., 2018. Case study research and applications, Vol. 6. Sage, Thousand Oaks, CA.

Isabelle Anguelovski is a Research Professor at the Catalan Institution for Research and Advanced Studies (ICREA), Barcelona Laboratory for Urban Environmental Justice and Sustainability (BCNUEJ), Institute for Environmental Science and Technology (ICTA), Universitat Autònoma de Barcelona (UAB). Her research for this paper was funded by the GreenLULUs ERC project (GA 678034) and the Maria de Maeztu (CEX2019-000-940-M) grant.

Emilia Oscilowicz is a dual doctoral student at the Barcelona Laboratory for Urban Environmental Justice and Sustainability (BCNUEJ), Institute for Environmental Science and Technology (ICTA), Universitat Autònoma de Barcelona (UAB), Barcelona, Spain and at the School of Architecture and Planning, University of Colorado Denver, Denver, Colorado.

James J.T. Connolly is an Associate Professor, School of Community and Regional Planning, University of British Columbia (Vancouver, Canada), and former co-director of the Barcelona Laboratory for Urban Environmental Justice and Sustainability, Institute for Environmental Science and Technology, Universitat Autònoma de Barcelona, Barcelona, Spain.

Melissa García-Lamarca is an Associate Senior Lecturer, Lund University Centre for Sustainability Studies, Sweden and an affiliated researcher at the Barcelona Laboratory for Urban Environmental Justice and Sustainability, Institute for Environmental Science and Technology, Universitat Autònoma de Barcelona, Barcelona, Spain.

Carmen Perez Del Pulgar is a Postdoctoral Fellow at the Helmholtz-Centre for Environmental Research (UFZ) and an affiliated researcher at the Barcelona Laboratory for Urban Environmental Justice and Sustainability, Institute for Environmental Science and Technology, Universitat Autònoma de Barcelona, Barcelona, Spain.

Helen V.S. Cole is a Senior Researcher at the Barcelona Laboratory for Urban Environmental Justice and Sustainability (BCNUEJ), Institute for Environmental Science and Technology (ICTA), Universitat Autònoma de Barcelona (UAB). She is supported by the UAB-Banco Santander Talent Fellowship program.

Dan Immergluck is a Professor of Urban Studies at the Andrew Young School of Policy Studies, Georgia State University, Atlanta, Georgia.

Margarita Triguero-Mas is a Research Professor at the Barcelona Interdisciplinary research group on planetary health (BITAL), Faculty of Health Sciences, Universitat Oberta de Catalunya (UOC) and ISGlobal, Barcelona, Spain. She is an affiliated researcher at the Barcelona Laboratory for Urban Environmental Justice and Sustainability (BCNUEJ), Institute for Environmental Science and Technology (ICTA), Universitat Autònoma de Barcelona (UAB). Margarita is funded by GreenLULUS (GA678034), Maria de Maeztu (CEX2019-000940-M) and Ramon y Cajal fellowship RYC2021-034215-I, Spanish Ministry of Science and Innovation

Francesc Baró is a Research Professor of Geography at Vrije Universiteit Brussel (VUB), Brussels, Belgium, Sociology Department, Vrije Universiteit Brussel (VUB), Brussels, Belgium. He is an affiliated researcher at the Barcelona Laboratory for Urban Environmental Justice and Sustainability (BCNUEJ), Institute for Environmental Science and Technology (ICTA), Universitat Autònoma de Barcelona (UAB).

Nicholas Martin is an affiliated researcher at the Barcelona Laboratory for Urban Environmental Justice and Sustainability (BCNUEJ), Institute for Environmental Science and Technology (ICTA), Universitat Autònoma de Barcelona (UAB), Barcelona, Spain.

David Conesa is a Researcher at the Department of Statistics and Operations Research, University of Valencia, Spain. He is funded by Grant PID2022-136455NB-I00, funded by Ministerio awdebhvyyyw2de Ciencia, Innovación y Universidades of Spain (MCIN/AEI/10.13039/501100011033/FEDER, UE) and the European Regional Development Fund. Grant CIAICO/2022/165 funded by Generalitat Valenciana.

Galia Shokry is an Assistant Professor in the Department of Environmental and Sustainability Sciences, Kean University, USA; Research Affiliate, BCNUEJ (ICTA-UAB), Barcelona Spain.Acknowledgements: National Science Foundation Build and Broaden Grant, Kean University Center for Data Analytics and Visualization in Urban Research, Award #2315235

Lucia Argüelles is a Postdoctoral Researcher at the Estudis d'Economia i Empresa and the Internet Interdisciplinary Institute (IN3), Universitat Oberta de Catalunya (UOC). Acknowledgments: Juan de la Cierva fellowship (IJC2020-045101-I) awarded by the Spanish Ministry of Science and Innovation.

Austin Matheney is a doctoral student at the Barcelona Laboratory for Urban Environmental Justice and Sustainability (BCNUEJ), Institute for Environmental Science and Technology (ICTA), Universitat Autònoma de Barcelona (UAB). Acknowledgements: Secretary of University and Research from Generalitat de Catalunya and European Social Fund through AGAUR-FI grant no. 2022 FI_B2 00131; GreenLULUS (GA678034); Maria de Maeztu (CEX2019-000940-M).

Elsa Gallez is a doctoral student in the Geography Department, Vrije Universiteit Brussel (VUB), Brussels, Belgium. Sociology Department, Vrije Universiteit Brussel (VUB), Brussels, Belgium.

Jésua López Máñez is a Researcher in the Department of Statistics and Operations Research, Univrsity of Valencia, Valencia Spain.

Blanca Sarzo is a postdoctoral fellow part of the Foundation for the Promotion of Health and Biomedical Research of the Valencian Region (FISABIO). Acknowledgments: ISCIII and European Union (CD23/00090).

Miguel Angel Beltrán is a Researcher in the Department of Statistics and Operations Research, Univrsity of Valencia, Valencia Spain.

Joaquín Martínez-Minaya is a Researcher in the Department of Applied Statistics and Operational Research and Quality, Universitat Politècnica de València, Camí de Vera, s/n, València, Spain.