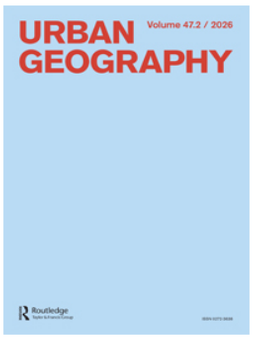

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Taming the green gentrification cycle? Evidence from street greening in Vienna

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ABSTRACT

Cities are increasingly vulnerable to climate change, prompting policymakers to implement urban greening. While extensive research has examined whether urban greening initiatives trigger gentrification, recent studies conceptualize a green gentrification cycle, where greening can both precede and follow gentrification. This study investigates both the occurrence of green gentrification and gentrified greening, as well as demand-, supply – and resource-side mechanisms shaping these processes. Using a mixed method approach, we quantitatively analyze the relationship between street tree planting, tenure commodification and social upgrading in Vienna between 1991 and 2021. Our qualitative analysis explores institutional arrangements and how actors frame mechanisms that influence these dynamics. Findings from quantitative analysis show no systematic evidence that green gentrification or gentrified greening is a significant trend related to street tree planting in Vienna. Interviews reveal that Vienna's institutional framework, including decentralized green space planning, strong housing regulation and social housing provisions, acts as a buffer that tames the green gentrification cycle. While Vienna's institutional framework currently tames the green gentrification cycle, its long-term resilience remains uncertain as climate change and real-estate pressures grow. These findings highlight the need for adaptive policy frameworks and further comparative research to better understand how institutional contexts shape green gentrification and gentrified greening globally.

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Green gentrification; gentrified greening; urban street green; social upgrading; tenure commodification; mixed-method analysis

Introduction

Urban areas are increasingly facing significant pressures. The combined effects of climate change and increasing urbanization have highlighted the particular vulnerability of cities towards climate hazards, such as floods or heat-waves (Dodman et al., 2022). Cities are

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forced to adapt to these extreme weather events (Thaler et al., 2022). The implementation of urban green is a highly attractive response to these challenges for cities (Lafortezza et al., 2018). However, greening cities can also create unintended trade-offs for citizens, such as green gentrification (Anguelovski et al., 2022; Anguelovski & Connolly, 2024).

Over the past decade, research on green gentrification has grown rapidly, concentrating on whether new or upgraded green amenities trigger gentrification processes tied to growth-oriented or sustainability-driven urban development agendas (Checker, 2011; Gould & Lewis, 2018; DuPuis & Greenberg, 2019; Anguelovski et al., 2022; García-Lamarca et al., 2022). Recent research questions the assumption that greening always precedes gentrification, showing that green amenities developed by local governments and developers may also follow social upgrading in already gentrifying areas (Sharifi et al., 2021). This research has led to the conceptualization of the green gentrification cycle, in which greening may both trigger and follow gentrification, driven by a mix of demand-, supply-, and resource-side mechanisms (Rigolon & Collins, 2023).

Despite substantial research on green gentrification itself, empirical studies explicitly examining both sides of the green gentrification cycle remain sparse. Moreover, the few existing studies in the Global North concentrate on North American cities (Reibel et al., 2023; Quinton et al., 2023; Rigolon et al., 2024). Although recent research has examined diverse greening measures, including different-sized parks (Reibel et al., 2023; Rigolon et al., 2024, 2025) and broader urban sustainability initiatives such as bike lanes (Quinton et al., 2023), implementation of urban trees remains largely understudied in relation to the full green gentrification cycle. Evidence whether trees trigger or follow gentrification remains mixed: in Portland, tree planting shows associations with gentrification only after long time lags (Donovan et al., 2021), whereas in Montreal, canopy expansion was strongest in already gentrifying neighborhoods (Kiani et al., 2023).

With our case study of Vienna, we aim to provide the first empirical insights into the green gentrification cycle in a European context, within a social-democratic city where neoliberal housing and planning policies have limited traction. Urban tree planting is a central strategy in densely built areas with limited space for larger-scale green infrastructure. Methodologically, we broaden the predominantly quantitative orientation of previous research using a mixed-methods approach. Using regression analysis and bivariate spatial analysis, our quantitative analysis addresses the following research questions: To what extent is greening associated with subsequent exclusionary displacement or tenure commodification in Vienna, and does social upgrading or tenure commodification, in turn, foster subsequent greening between 1991 and 2021? Complementing this, our qualitative content analysis addresses the following research question: How and why do institutional actors recognize and contextualize the demand , resource , and supply-side mechanisms operating at both ends of the green gentrification cycle?

The remainder of the paper is structured as follows: We will first outline the theoretical background and current state of the research on the green gentrification cycle, before providing the methodological background for our analysis. After giving an overview of our data, we examine the interplay between greening and gentrification. Second, we

aim to ground the quantitative analysis in expert interviews with local politicians, street-level bureaucrats, and administrative personnel about their perceptions of changing neighborhood socio-demographics and citizen demands for green spaces. Finally, we will discuss how our quantitative and qualitative results relate to one another and to the current state of research on the green gentrification cycle.

From green gentrification to gentrified greening (and back)

Green gentrification has been the subject of increasing debate over the last decade. From North America to various regions around the world, researchers increasingly addressed the question of whether urban greening initiatives trigger gentrification processes (Dooling, 2009; Checker, 2011; Shokry et al., 2020; Anguelovski et al., 2022; Cucca et al., 2023). While an increasing number of studies have started to look at which types and sizes of greenspace development trigger gentrification to different extents (Rigolon & Németh, 2020; Hawes et al., 2022; Melstrom et al., 2022), others have focused on identifying whether green plays a primary or a subsidiary role amongst other factors in gentrification processes over time, but also across a myriad of cities in Western Europe and North America (Anguelovski et al., 2022).

Various explanations are offered to understand the mechanisms behind green gentrification. The most important explanations are based on the notion of the "green growth machine" (DuPuis & Greenberg, 2019; Gould & Lewis, 2018). Building on Molotch's (1976) concept of the urban growth machine, this literature focuses on how elected officials and private real estate investors collaborate (e.g. in the form of public-private partnerships) to restore and revitalize neglected green spaces in order to maximize profits, economic growth and property tax revenues. In this context, greening operates within the general paradigm of neoliberal urban development, enabling capital accumulation and economic growth. This resonates with what other researchers have described as the "sustainability fix" (Quastel, 2017; Jonas, 2015; Neidig et al., 2022). Greening, or the implementation of NbS, often enables developers to appropriate and capitalize on the value of new green amenities (Quinton et al., 2022; DuPuis & Greenberg, 2019; García-Lamarca et al., 2022; Kronenberg et al., 2023). "Urban green grabbing", as labeled by García-Lamarca et al. (2022), involves developers and investors capturing a portion of the financial and social surplus value created by municipalities through the development of new or planned green amenities. Even without directly owning or altering these green spaces, developers strategically leverage their symbolic and discursive value to market properties to urban elites (García-Lamarca et al., 2022; Kronenberg et al., 2023). By capitalizing on green amenities, developers close the "green rent gap", enabling them to charge higher rents or demand premium real-estate prices for properties located nearby (Quinton et al., 2022; García-Lamarca et al., 2022; Kronenberg et al., 2023). These processes are particularly prevalent in contexts marked by welfare state retrenchment, absent housing regulations on the private (rental) market, and limited social or affordable housing policies (Anguelovski et al., 2022; García-Lamarca et al., 2022). The consequences include the development of gentrification processes based on higher rent prices.

A recent shift in the literature has moved beyond asking whether greening triggers gentrification. Rigolon and Collins (2023) initiated a debate about whether the

relationship between green space and gentrification is driven by the realization of new green spaces or whether pre-existing gentrification can itself encourage further greening. Building on Sharifi et al. (2021), who demonstrated that greening is predominantly realized in recently gentrified areas ("gentrified greening"), Rigolon and Collins (2023) propose that a spatio-temporal connection exists between new green spaces and gentrification processes in the form of a cycle. In this cycle, greening may both precede and follow gentrification in a given neighborhood, and both sides of the cycle can occur independently without being necessarily interconnected.

Rigolon and Collins (2023) highlight three main explanations for this spatio-temporal connection: demand-side, supply-side and resource-side explanations. First, demand-side explanations suggest that gentrifiers demand more green spaces because they belong to a socio-demographic group that places a higher value on them. They also tend to have knowledge and capacity to effectively voice their demands in participatory processes, unlike other groups (Checker, 2011). Second, supply-side explanations argue that the green growth machine is often more focused on targeting gentrifying rather than low-income, disinvested neighborhoods because real-estate developers can more easily close the "green rent gap" (García-Lamarca et al., 2022; Rigolon & Collins, 2023). As a result, existing gentrification trends tend to accelerate in these neighborhoods. Third, resource-side explanations emphasize that gentrification can facilitate greening by generating additional public and private resources, such as higher tax revenues, park fees and investments from property owners, which, in turn, provide the necessary funding for local green initiatives (Rigolon & Németh, 2020; Rigolon & Collins, 2023; Sharifi et al., 2021).

Quinton et al. (2023) examine different cities in Canada and investigate the association between gentrification and greening, either in the decade before, the same decade, or the decade after. They found that greening precedes, follows, or occurs simultaneously in most gentrifying census tracts (CTs) in all their case studies. However, they only looked at gentrifying CTs and did not compare them with non-gentrifying CTs. A second empirical study of the green gentrification cycle is that of Reibel et al. (2023), focusing on explaining gentrification from a resource-side perspective. They found that spending on new and existing parks goes disproportionately to gentrifying neighborhoods. Rigolon et al. (2024) examine changes in the sale price of single-family homes in Los Angeles and Chicago in relation to the period up to seven years before and seven years after the nearest new park opened to the public. They find an association between gentrification and subsequent greening in both cities. Rigolon et al. (2025) demonstrate that the green gentrification cycle depends on both the scale of greening and the concentration of power. They conclude that the cycle is likely to happen when the green growth machine and large-scale greening align in intentionally attracting wealthier residents, while initially small-scale and community-led greening projects delayed immediate follow-up gentrification.

Analytical approach, data and methods

We used a mixed-methods research design to complement the quantitative analysis of the green gentrification cycle with an analysis of how institutional actors perceive, interpret and frame the regulatory framework and policy strategies in relation to risks of green gentrification and gentrified greening. We applied a convergent parallel design (Creswell

& Plano Clark, 2018), in which quantitative and qualitative data collection (Step 1) and analysis (Step 2) were conducted in parallel, and their results were compared and integrated at the end (Step 3).

Quantitative data collection

We gathered and processed socio-demographic, tenure and greening data with the aim of performing a long-term quantitative analysis of the green gentrification cycle. Register and census data-based socio-demographic and tenure variables were obtained for the years 1991, 2001, 2011 and 2021 from the Statistical Department of the City of Vienna at the census tract (CT) level. While income is usually one of the key indicators in quantitative gentrification research (Rigolon & Nemeth, 2020), income data is not available for such a long-term analysis for Vienna. To capture the demand-side perspective, as conceptualized by Rigolon and Collins (2023), we use three socio-demographic variables to approximate displacement pressures and social upgrading: the share of residents with compulsory education or below, unemployment rates, and the share of residents with a university degree or similar.

While gentrification research typically relies on housing or rental price data (e.g. Rigolon et al., 2024), small-scale price data at the CT level is not publicly available for Vienna. We therefore approximate supply-side pressures through changes in the tenure composition of housing units, a strategy also used in other gentrification studies (Walks et al., 2021). Drawing on Bernt's (2023) concept of the commodification gap, and informed by existing knowledge of Vienna's housing market dynamics, we identify housing segments particularly susceptible to commodification using three variables: the share of ownership apartments, the share of unregulated private rental units, and the share of other legal entities (usually commercial developers) owning and renting out dwellings. These variables capture two defining features of Vienna's housing commodification: (a) the conversion of rent-regulated pre-war units into condominiums or unregulated rental units (Musil et al., 2022a), and (b) newly built free-market rental and ownership units provided by commercial providers that are typically priced far above the city average (Plank et al., 2022).

For greening, we focused on street trees maintained by the City of Vienna. First, greening streets and squares is the most important greening measure in Vienna (Friesenecker et al., 2024). Second, the publicly available tree registers include planting years, enabling a temporal reconstruction of greening (Stadt Wien, 2024). We aggregated tree data to CTs for the years 1980s, 1990s, 2000s and 2010 to match our gentrification indices and analyze preceding or subsequent greening per decade . Street area per CT was derived from Vienna's land-use dataset (Realnutzungskartierung, 2012), and tree density per hectare of street area was calculated to account for the varying CT sizes. Following existing studies on green gentrification (Anguelovski et al., 2022; Friesenecker et al., 2024), we collected available data on potential confounders influencing the spatio-temporal relationship between greening and gentrification. We included the distance to the city center (St. Stephen's Cathedral) as a measure of centrality, and the number of metro stations, the share of rent-controlled historic housing stock, and the share of municipal and limited-profit housing stock per decade and CT. We also included the number of changes in housing units representing new neighborhoods (usually with

new parks), as well as the change in metro stations to control for the effects of urban development.

Modeling of gentrification and street greening

In line with other green gentrification studies (Anguelovski et al., 2018, 2022; Quinton et al., 2023; Rigolon & Németh, 2019, 2020), we calculated three composite indicators to identify CTs at risk of gentrification relative to city-wide trends: (a) a social upgrading and exclusionary displacement index (UDI), (b) a tenure commodification index (TCI) and (c) a combined gentrification risk index (GRI). To identify change rates that deviate from city-wide trends, we performed a weighted modified shift-share analysis for each variable, following Holm and Schulz (2018). To maintain comparability with our gentrification calculations, we also performed a shift and share analysis for the street tree density. The shift-share analysis consisted of the following steps:

1. calculating city-wide and CT-level change rates.
2. addition of city-wide trends to the CT values at the beginning of the periods,
3. subtraction of this trend value from the actual value at the end of the period,
4. Weighting the values at the end of the periods involves multiplying the total number of residents or tenures in the CTs, divided by the sum of the latter for the whole city, to account for CTs with quantitatively more impactful changes.

Composite indicators of gentrification used z-standardised weighted values, whereas the UDI is calculated as the mean of weighted inverted changes in the share of people with compulsory education, the share of unemployed and the changes in the share of residents with a university degree (or similar). While upgrading and displacement are two distinct concepts in gentrification research, this calculation method enables us to analyse exclusionary displacement pressures by reflecting the above-average decline in people with compulsory education and unemployment in green gentrification processes. At the same time, it also allows claims to be made about social upgrading (the above-average increase in people with a university degree) in gentrified greening processes (as conceptualized by Rigolon & Collins, 2023). The TCI is calculated as the mean of the above-mentioned variables without any inversion.

Quantitative analysis of green gentrification and gentrified greening

We analyzed the interdependencies between greening and gentrification through city-wide multivariate ordinary least square (OLS) regressions and through local spatial correlation patterns using univariate and bivariate Local Indicators of Spatial Association (LISA) statistics.

First, in addition to descriptive statistics, a univariate local Moran's I was utilized to identify and highlight spatial concentrations of (a) street greening and (b) the GRI for each decade investigated. After performing robustness checks with different spatial weights, a spatial weights matrix with a second-order queen weight was used.

Second, for analyzing the GRI, the UDI, and TCI served as dependent variables, with the street greening index, controlled for potential confounding variables from the previous

decade, as the key predictor. We used one model for each of our three decades, starting with street greening between 1981 and 1991 and its impacts on potential gentrification from 1991 to 2001. For the gentrified greening part of the green gentrification cycle, we use the street greening index as a dependent variable, with the gentrification indices (GRI, UDI and TCI) as independent variables. Because socio-demographic and tenure data begin only in 1991, gentrified greening could only be analyzed for two decades (2001-2011 and 2011-2021). For the sake of simplicity, only the regression tables with the GRI are reported in the main text, while more detailed regression tables for the UDI and TCI are provided in the supplemental material. Since the studentized Breusch–Pagan test (Breusch & Pagan, 1979) reports heteroskedasticity for some models, we use the HC1 type for robust standard errors in those models (MacKinnon & White, 1985).

Third, we employed a bivariate local Moran's I correlation analysis to gain deeper insights into the spatiotemporal relationship between street greening and the risks of gentrification. Green gentrification has been analysed by correlating the street greening index of the previous period with the GRI values of the following period in the surrounding CTs, given the weight matrix specified above. For gentrified greening, we reversed this procedure and correlated the gentrification risk of the previous period with the street greening index for the following period.

All regression models and summary statistics were implemented in R (R Core Team, 2023), with tables generated using the stargazer package (Hlavac, 2022). LISA was done using GeoDa software package (Anselin et al., 2006).

Qualitative data collection and analysis

For qualitative data collection, we conducted 31 semi-structured expert interviews with local policymakers, housing market actors, interest groups, and independent experts between November 2023 and February 2024 (see Supplemental Table A2). Interviewees from the city authorities were selected based on their administrative responsibilities in housing, greening, and urban planning. District authorities were selected in a manner that ensures their districts represent a mix of non-upgraded and already upgraded districts. Housing market actors represent both private and social housing providers. Interest groups were selected in a similar way: they represent both private real estate actors and tenant representative groups. Independent experts were selected based on their knowledge of greening efforts in Vienna and their expertise in gentrification mechanisms. All interviews were held in person.

Ethical approval was granted by the Commission for Science Ethics (Austrian Academy of Sciences) on 17 June 2020. All research participants provided written informed consent. Interview themes were organized around the following main topics: (a) risks of social upgrading, tenure upgrading and increase of housing and rent prices in general and because of greening, (b) perceptions of displacement risks for different segments of the Viennese housing market including mechanisms and the role of social (housing) policies, (c) perceptions about whether socio-demographic upgrading relates to higher demands in greening, (d) governance arrangements and regulations related to the implementation of greening. The interviews lasted between 60 and 90 min and were anonymised, transcribed and coded using the qualitative software program MAXQDA.

The qualitative content analysis employed a combination of inductive and deductive coding. In a first step, the deductive codes were applied that follow the theoretical mechanisms of the green gentrification cycle: (1) housing price increase leading to demands for green, (2) social change leading to demands for green, and vice versa, (3) greening leads to a price increase, and (4) greening attracts certain groups (triggering social upgrading). In a second step, transcripts were inductively screened for empirical insights into housing and planning policies that prevent green gentrification. This deductive-inductive strategy was employed to maximise the effectiveness of the qualitative material (Kuckartz & Rädiker, 2023).

Case study description

Vienna represents an unusual case in gentrification research due to its resistance to neoliberal housing and planning policies. It is characterized by a high proportion of decommodified housing stock which is also reported to dampen private rents (Banabak, 2023). The private rental segment, in particular, has faced commodification trends in recent decades through reforms introducing market principles into a largely rent-regulated housing segment. According to Friesenecker and Kazepov (2021), the commodified housing stock consists of a high proportion of municipal housing (22%), Limited-Profit Housing Associations (LPHA) at 21%, and rent-regulated private flats (22%). Only about 11% of the rental market is allowed to freely set the rents and ownership rates are comparably low at 19%.

Nevertheless, with more professional investors also being active in the Viennese housing market, conversions of rent-regulated units to apartment ownership units, the demolition and replacement of rent-regulated buildings with unregulated rental units, and unregulated attic extensions have contributed in particular to commodification trends in the private rental market (Kadi & Matznetter, 2022; Musil et al., 2022a, 2022b). Although a substantial amount of social housing has been produced, new developments are dominated by commodified housing tenures, such as free-market rental and ownership apartments that are way above the average price levels in Vienna (Plank et al., 2022).

More than half of the Viennese area is classified as green and blue space (Brenner et al., 2021). However, the green space is very unequally distributed, with most of those green areas concentrated in a few larger urban wilderness areas (Vienna Woods in the west, Wienerberg in the south, the central Prater and Lobau in the south east). Given the impact of climate change in Vienna and its increasingly hot days, greening central neighborhoods, which are characterized by a dense built environment and lack of (big) green spaces, has become more important. In particular, Vienna's central neighborhoods have received hardly any new parks in recent decades. Hence, street and square greening is of specific importance to Vienna, using tree planting, de-sealing and other green and blue features within central neighborhoods (Friesenecker et al., 2024).

Results

Historic changes in street greening

Historically, street greening in Vienna has fluctuated over time. Table 1 shows how street greening dropped from a moderate level with an average of 3.6 trees planted per hectare

Table 1. Summary statistics for trees planted per hectare road area.

Period	Min.	Median	Mean	Max.
1981–1991	0.000	1.784	3.566	95.073
1991–2001	0.000	0.952	1.933	27.723
2001–2011	0.000	1.679	2.971	41.585
2011–2021	0.000	3.918	5.691	41.579

of road areas and a census tract with the highest number of about 95 street trees per hectare in the 1980s to lower levels of street greening in the 1990s and 2000s. The 1990s exhibits the lowest average number of street trees per hectare road area planted, while the average amount of street trees being planted increased already in the 2000s, but most significantly during the 2010s (to an average of 5.7 trees per hectare of street surface area).

While street greening efforts are distributed all over the city, distinct local hotspots of street greening from the 1980s to the 2000s mainly appeared along existing parks and green neighborhoods (Prater in the 2nd district, Schlosspark Schönbrunn in the 13th district, Cottage-Viertel in the 18th/19th district). The increased number of CTs with 12 or more trees per hectare of street area between 2011 and 2020 (Figure 1, Map D) clearly highlights Vienna's increased efforts regarding adaptation to climate change. In previous decades, especially between 1991 and 2011 (Figure 1, Maps B and C), street greening has been less intensive, and the patterns suggest that tree planting focused rather on replacing trees in existing locations. Furthermore, while in the 1990s and 2000s the central districts (one through nine) were characterized as hotspots of below-average street greening, these areas turned to hotspots of street greening efforts in the 2010s, again emphasizing climate adaptation efforts.

Gentrification processes in Vienna

During the 1990s, the distribution of the Gentrification Risk Index (GRI) across Vienna was relatively even, but an increasing kurtosis of the GRI over time indicates that some neighborhoods began to deviate more strongly from city-wide trends. This trend is likely linked to the intensified construction of new neighborhoods between 2011 and 2021, where commodified housing became more dominant.

Our LISA cluster analysis summarizes how patterns of potential gentrification unfolded spatially. Between 1991 and 2001, CTs at elevated risk of gentrification were dispersed across the city (Figure 2(a), red CTs). These early hotspots reflect broad social upgrading, characterized by rising educational levels and the expansion of apartment ownership and private rental housing, driven by renewed population growth. Hotspots at risk of gentrification appeared both in central districts (1-9) and parts of the west, (north- east and east (21st and 22nd districts). At the same time, a notable cluster of CTs around the 10th district showed an opposite trend, marked by an increase in residents with compulsory education and little expansion of commodified (Figure 2(a), dark blue CTs).

Between 2001 and 2011, areas at risk of gentrification became more concentrated in central districts (Figure 2(b), red CTs in districts 2-9, 18 and 20). This decade was shaped primarily by socio-economic upgrading: disproportionate increases in residents

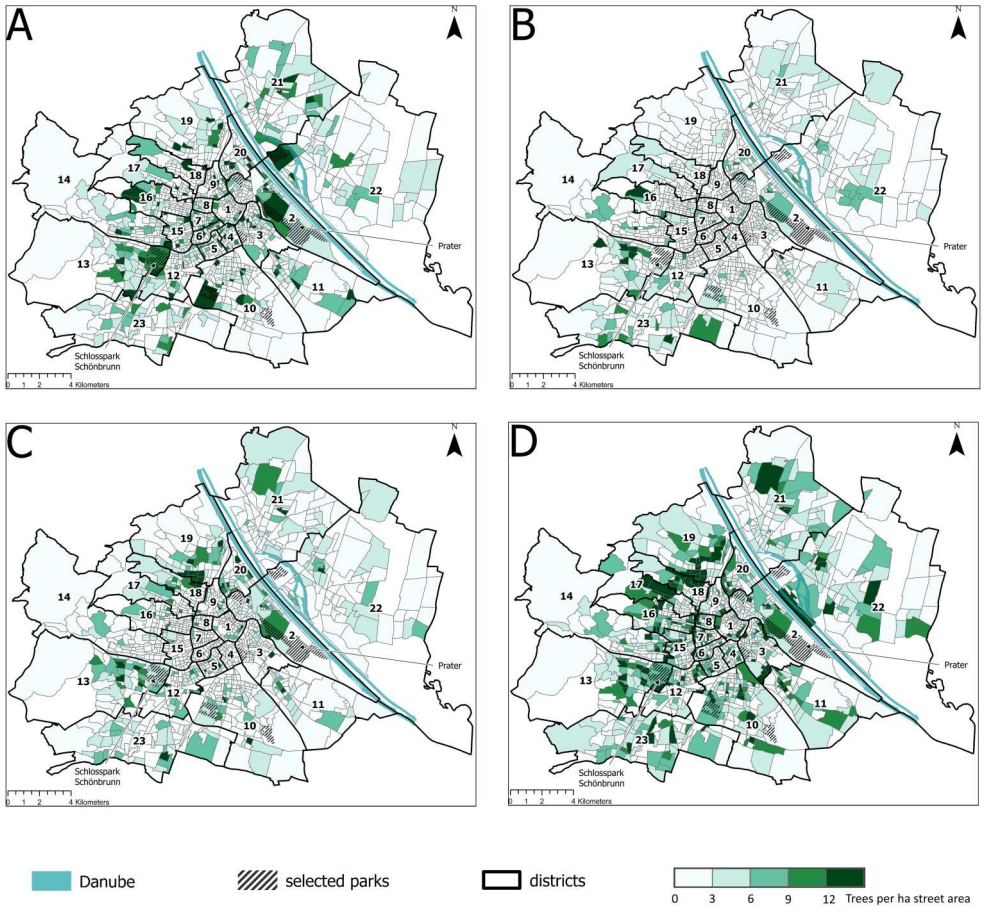

Figure 1. Number of newly planted street-trees per hectare of road area. (a): 1981–1991; (b): 1991–2001; (c): 2001–2011; (d): 2011–2021.

with university degrees and declines in those with compulsory education (see Supplemental Table A1). With slower population growth and less housing construction, the conversion of historic housing stock in central areas gained importance. Below-average development was concentrated in peripheral districts, particularly the 10th, 11th and 21st districts.

From 2011 to 2021, clusters at risk of gentrification remained concentrated in the 2nd district and expanded into the rapidly developing areas in the east and south (see Figure 2(c), red areas in the 22nd and 23rd districts). Following the global financial crisis and a renewed population growth, housing construction in Vienna accelerated considerably. As a result, privately owned apartments and unregulated rental units increased disproportionately, outpacing social housing provision in these areas. These shifts reflect processes of new-build gentrification, where limited accessibility for low-income residents leads to above-average increases in residents with a university degree. As in the previous decade(s), areas with lower-than-average risk of gentrification are still, in the south and northeast, associated with higher proportions of social housing.

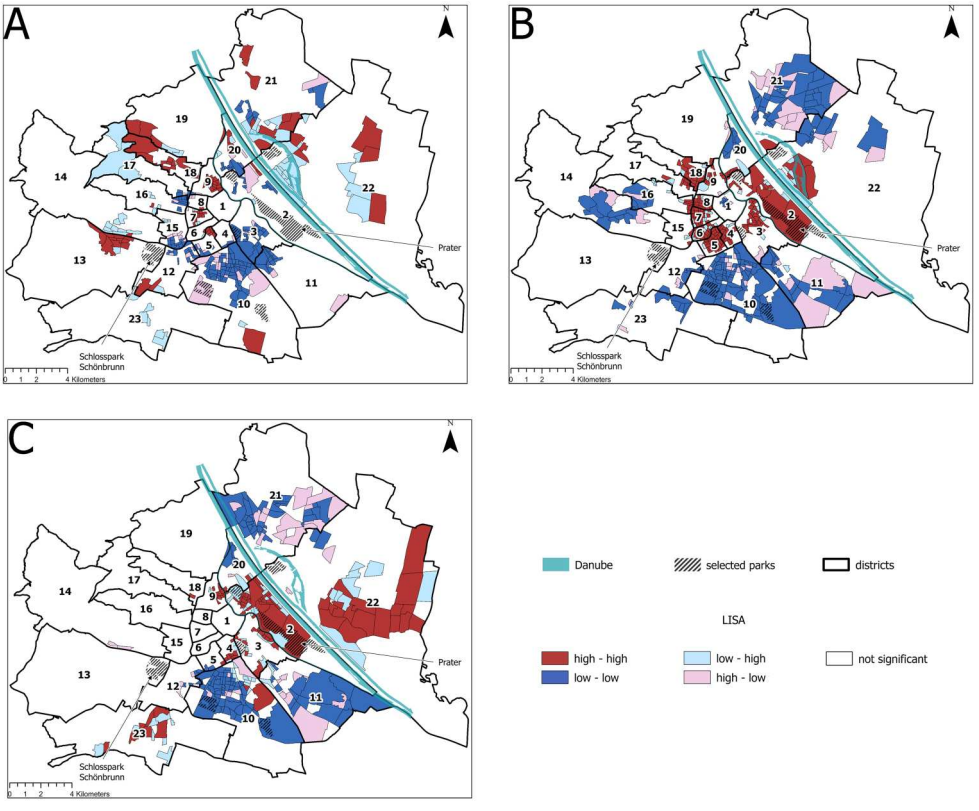

Figure 2. Univariate Moran's I of GRI between 1991 and 2021. Displayed are CTs that are significant on a $p <= 0.05$ level. A: 1991–2001; B: 2001–2011; C: 2011–2021. Source: own calculation.

Green gentrification

Regression analysis was used to examine the impact of the street greening index of the previous decade on the Gentrification Risk Index (GRI) of the following period. Table 2 reports the results of the regression analysis, while controlling for other variables known to influence gentrification. Overall, the results provide little evidence that street greening contributed to gentrification in Vienna between 1991 and 2021 (see also additional scatterplots in Supplemental Figure A1).

In all three decades, the coefficients for the street greening indexes from the previous period are very small and insignificant (−0.014 in the 1990s, 0.05 in the 2000s and −0.019 in the 2010s), indicating no measurable association with subsequent risks of gentrification, even when other confounders are taken into account. Additional regression models for our social upgrading and displacement index, as well as the tenure change index (see Supplemental Table A3), suggest a negligibly small but significant effect from the social upgrading and displacement component of our GRI in the 2000s.

Some control variables display significant effects, although their magnitude is also small. A higher share of public housing consistently reduces gentrification risk across all decades, with a 10% increase in public housing leading to a 0.04-0.08-standard-deviation decline in the GRI. Conversely, a higher share of private regulated rent increases the

Table 2. Linear regression for green gentrification between 1991 and 2021.

Results

	Dependent variable:		
	Gentrification Risk Index (GRI) (1991-2001) (Model 1)	Gentrification Risk Index (GRI) (2001-2011) (Model 2)	Gentrification Risk Index (GRI) (2011-2021) (Model 3)
Street greening index previous decade	−0.014	0.050	−0.019
	(0.023)	(0.027)	(0.030)
Number of metro stations (at the beginning of the decade)	0.059	−0.007	0.058*
	(0.047)	(0.038)	(0.030)
Share of private regulated rent (at the beginning of the decade)	0.002	0.006***	0.004***
	(0.001)	(0.002)	(0.001)
Share of public housing as a percentage of the housing stock (at the beginning of the decade)	−0.004***	−0.007**	−0.008***
	(0.001)	(0.002)	(0.001)
Share of LPHA of housing stock in % (at the beginning of the decade)	0.004	−0.000	−0.001
	(0.003)	(0.003)	(0.002)
Distance to city center in km	0.052***	0.014	0.045***
	(0.015)	(0.011)	(0.015)
Change in housing units compared to the previous decade		−0.001*	0.000
		(0.000)	(0.000)
Change in the number of metro stations compared to the previous decade		−0.102	0.088
		(0.079)	(0.112)
Constant	−0.404**	−0.145	−0.391***
	(0.154)	(0.146)	(0.150)
Observations (N)	1,119	1,144	1,144
R^2	0.027	0.096	0.045
Adjusted R^2	0.022	0.090	0.038
Residual Std. error	0.948	0.947	0.940
	(df = 1112)	(df = 1135)	(df = 1135)
F Statistic	5.231***	15.127***	6.627***
	(df = 6; 1112)	(df = 8; 1135)	(df = 8; 1135)

Notes: Model 1 and 2 display robust standard errors. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

risk of gentrification by a similar margin, but only significantly for the 2000s and 2010s. Taken together, the regression results suggest that street greening did not meaningfully drive gentrification in Vienna between 1991 and 2021, with broader urban development patterns and the city's housing policies playing a far more significant role.

As linear regressions can obscure underlying spatial relationships, we also examined local hotspots of green gentrification using bivariate local Moran's I. This method assesses whether a CT with a high street greening index in a previous decade correlates with the GRI of the surrounding CTs in the subsequent period. Our analysis reveals that street greening in the 1980s correlates with gentrification in the 1990s only in isolated hotspots. As shown in Figure 3(a), there are only very few neighboring CTs where both greening in the '80s and gentrification in the '90s were high (dark red CTs labeled as High-High). However, these hotspots appear to emerge in areas where gentrification in the 1990s was high despite relatively low levels of greening in the 1980s. This suggests that greening may not be the major driving force for gentrification in this period.

In the 2000s, our analysis revealed a ring of CTs where high street greening in the 1990s correlated with gentrifying CTs in the 2000s around the city center. Some of these CTs with high levels of street greening in the neighborhood in the '90s correlated with high GRI levels in the following decade (Figure 4(b), dark red CTs). However, more CTs experiencing gentrification in this ring did not correlate with higher levels of street

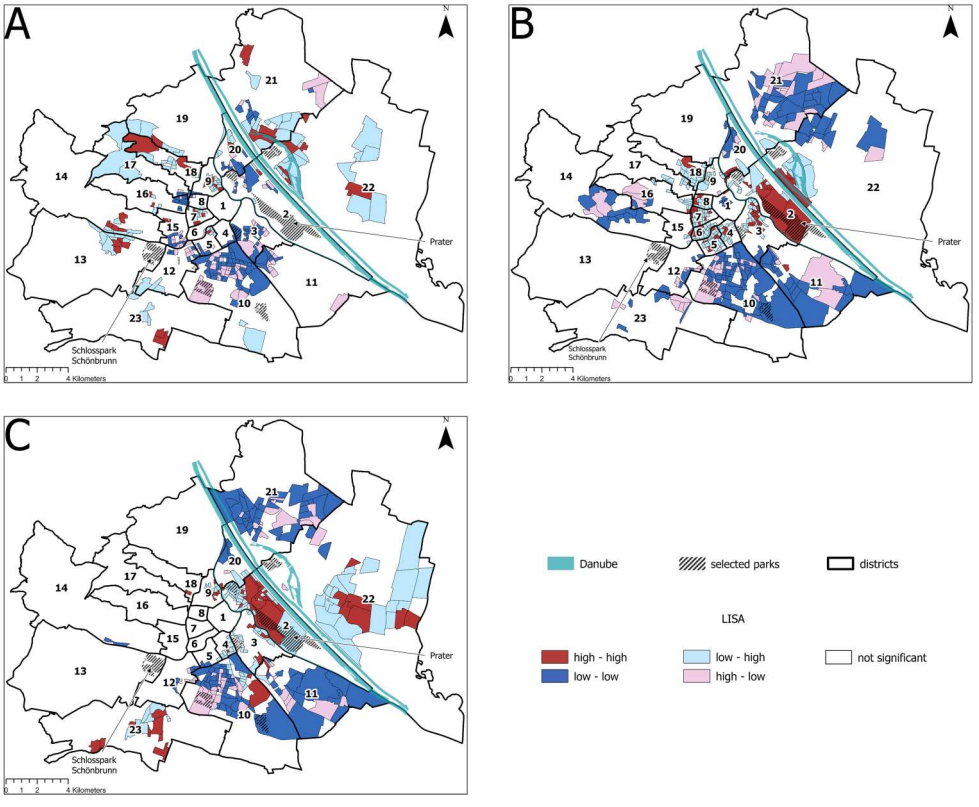

Figure 3. Bivariate local Moran´s I for green gentrification from 1981 to 2021. Displayed are CTs that are significant at a $p <= 0.05$ level. (a): Green space index 1981–1991 and GRI 1991–2011; (b): Green space index 1991–2001 and GRI 2001–2011; (c): Green space index 2001–2011 and GRI 2011–2021. Source: own calculation.

greening in the previous decade (Figure 3(b), light blue CTs indicating the correlation between low greening and high gentrification values). While spatially shifting towards the southern and eastern parts of the city, except for one continuing hotspot in the 2nd district, a similar pattern of correlation remains. While some green gentrification hotspots (Figure 4(c), dark red CTs) are found, CTs with high levels of gentrification exist without prior greening (light blue CTs in Figure 3(c)). Hence, our analysis suggests that while street greening can precede gentrification, the fact that CTs classified as gentrified also exist with low levels of greening in the previous decade underlines that there is no causal relation between greening and gentrification.

Gentrified greening

Table 3 presents the results of regressing the GRI of the preceding decade on the street greening index of the following decade, allowing us to assess whether gentrifying areas subsequently received more street trees. Overall, the results show no significant evidence that potential gentrification has an influence on the number of street trees planted (see Supplemental Figure A1 for additional scatterplots).

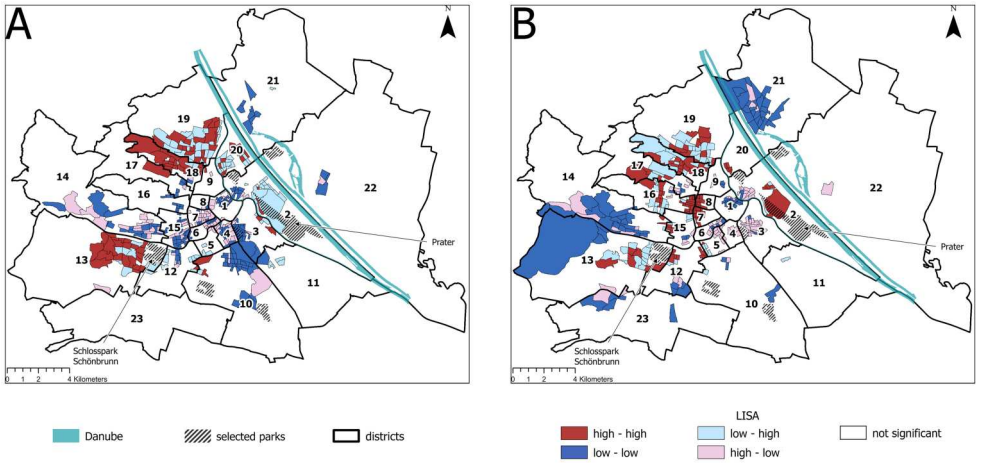

Figure 4. Bivariate local Moran's I for gentrified greening between 1991 and 2021. Displayed are CTs that are significant on a $p <= 0.05$ level. (a): GRI 1991–2001 and green space index 2001–2011; (b): GRI 2001–2011 and green space index 2011–2021.

Across both time periods, the coefficients for the GRI controlled by other potential confounders remain small and statistically insignificant. The potential gentrification in the 1990s and street greening in the 2000s suggest that a one-standard-deviation increase in the GRI corresponds to only a 0.047 standard deviation increase in the greening index (Table 3, Model 1). For CTs at risk of gentrification in the 2000s and street greening in

Table 3. Linear regression models for gentrified greening.

	Dependent variable:	
	Street greening index (2001-2011) (Model 1)	Street greening index (2011-2021) (Model 2)
Gentrification Risk Index (GRI) (previous decade)	0.047	0.011
	(0.030)	(0.033)
Number of metro stations (at the beginning of the decade)	−0.077**	−0.018
	(0.033)	(0.032)
Share of private regulated rent of housing stock in % (at the beginning of the decade)	−0.001	0.001
	(0.001)	(0.001)
Share of public housing of housing stock in % (at the beginning of the decade)	0.003**	0.002
	(0.001)	(0.001)
Share of LPHA of housing stock in % at the beginning of the decade	0.001	−0.001
	(0.002)	(0.002)
Distance to city center in km	−0.009	−0.01
	(0.015)	(0.028)
Change in housing units compared to the previous decade	−0.000	0.000
	(0.000)	(0.000)
Change in number of metro stations compared to the previous decade	−0.033	0.004
	(0.081)	(0.119)
Constant	0.098	−0.008
	(0.146)	(0.161)
Observations	1,143	1,144
R^2	0.018	0.003
Adjusted R^2	0.011	−0.004
Residual Std. Error	0.917 (df = 1134)	1.006 (df = 1135)
F Statistic	2.537*** (df = 8; 1134)	0.436 (df = 8; 1135)

Note: *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

the 2010s (Model 2), the effect is even smaller and remains insignificant. Moreover, the model fit is very poor. The extended analysis for gentrified greening also included a separate analysis for our tenure change index and the social upgrading and displacement index (Supplemental Tables A4). The results underline the fact that our analysis shows no significant association between the gentrification indices and street greening.

Control variables display only limited and substantively small effects on street greening. In the 2000s, the number of metro stations and the share of municipal housing are statistically significant, but their effects are minimal. In the case of public housing, the influence may be explained by the fact that many of the housing estates also included extensive greenery, even in the surrounding streets. Overall, the regression results indicate that street tree planting in Vienna was largely independent of neighborhood-level gentrification dynamics and shaped instead by other planning and policy considerations.

As with green gentrification analysis, we used bivariate local Moran's I to identify spatial clusters where gentrification in one decade correlates with subsequent greening in surrounding CTs. For the relationship between the GRI in the 1990s and greening in the 2000s, larger clusters of high GRI values coincided with high subsequent street greening efforts in the 13th, 18th, and 19th districts (dark red CTs in Figure 4(a)). These areas are interspersed with CTs that showed below-average gentrification in the 1990s but had high amounts of urban greening in neighboring CTs in the following decades (light blue CTs in Figure 4(a)). A similar pattern of these clusters remained when comparing the GRI of the 2000s with greening in the 2010s. Additionally, the results also show a cluster of high GRI value CTs at the border between the 7th, 8th and 16th districts (dark red CTs in Figure 4(b)).

Similar to our analysis of green gentrification, these patterns indicate that while gentrification can spatially coincide with later greening, such hotspots are limited. Most CTs displaying high greening after a decade of high GRI values are located in areas that generally exhibit above-average street greening activities. Moreover, hotspot CTs often neighbor CTs with high greening levels despite little or no gentrification in the previous decade. Overall, the bivariate spatial analysis provides little evidence that gentrification systematically drives subsequent street-tree planting in Vienna.

In summary, our quantitative analysis of both green gentrification and gentrified greening provides little indication that street greening is a primary driver of gentrification or vice versa. Regression models for both phenomena show no significant relationships, with minimal coefficients and poor model fits. Bivariate spatial analyzes identify isolated hotspots but lack systematic correlation, suggesting that other factors predominantly shape gentrification and greening trends. These quantitative findings will be further examined in our qualitative analysis, which explores perceptions and the contextualization of mechanisms that foster or impede green gentrification and gentrified greening.

Mechanisms and policies: Taming and reinforcing the green gentrification cycle

Figure 5 summarizes the main mechanisms along the resource, demand, and supply sides of green gentrification and gentrified greening dynamics in Vienna.

From a resource-side perspective on gentrified greening, our qualitative analysis shows that district mayors and authorities are the key actors in either facilitating or impeding greening projects. In Vienna, the 23 district authorities are responsible for

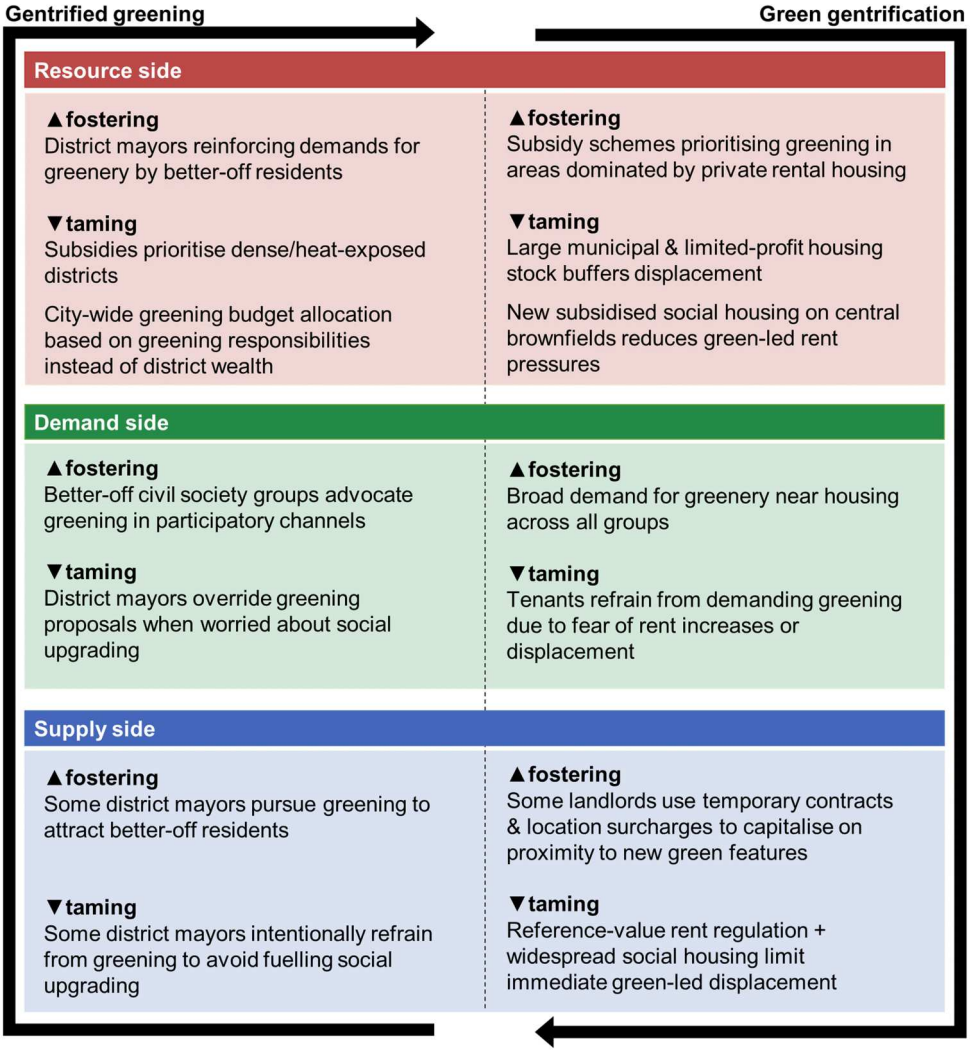

Figure 5. Mechanisms and policies fostering (▲) and taming (▼) the green gentrification cycle in Vienna. Source: Author's own compilation based on interview findings.

greening projects, including tree planting in public spaces. However, district budgets are not linked to higher tax revenues from wealthier residents. Instead, the district budget is distributed at the city level using an allocation key. The allocation key is based on factors such as population size, the street area, and the hours spent on the public maintenance of green spaces. In 2021, the allocation key was revised to accommodate the increased maintenance needs of green features, while also granting districts greater flexibility in investment decisions.

Besides, districts can apply for subsidies from city authorities to support climate-adaptive greening projects. An expert jury, composed of city officials from various departments, evaluates these projects and determines the funding rate, which ranges from 40% to 80%. The evaluation criteria include the number of green and blue features planned. Projects

located in densely built-up areas – often the hottest parts of Vienna – are eligible for higher funding rates. These institutional arrangements enable district heads to either reinforce or break with supply – and demand-side dynamics in shaping greening initiatives.

This decision-making power becomes particularly evident on the demand side, where concerns about social upgrading also shape how greening decisions are made. While the political orientation of district heads and authorities plays a critical role in allocating resources for green projects, these concerns also influence whether they choose to override or reinforce demands for greenery by (better-off) residents. In general, policymakers and planners have witnessed a growing demand, across all social groups irrespective of income, citizenship status or educational levels, for enhanced greenery, including more trees and water features. However, in neighborhoods experiencing social upgrading, better-off individuals – often described as the committed civil society or the vocal and articulate ones – are more likely to propose and initiate greening projects through participatory channels. According to one interviewee from the public administration, a former district mayor resisted the implementation of an urban renewal program focused on public greening in his neighborhood: "He [the district mayor] was worried that if the program upgraded the public space, the milieu in the district would change and the group of "Bobos' would be attracted" (I5).[1] Here, green gentrification is perceived indirectly as a risk to the districts' social dynamics.

At the same time, there are also views that greening should be encouraged and gentrification does not necessarily pose a major risk. As one district politician put it: "We should not be so afraid of gentrification. Of course, there is an influx of people into the district. That's a good thing, because it also mixes and changes things. That's obvious" (I19).

Nevertheless, the decision-making patterns are also shaped by a widely shared view that risks of gentrification associated with greening are relatively marginal. This is a recurring theme throughout our interviews, though it is expressed with different nuances associated with Vienna's complex legal framework in housing and planning. Displacement pressures resulting from greening existing streets are acknowledged by the local administration, but the effects are perceived as less severe due to Vienna's robust social housing market, consisting of municipal and limited-profit housing. As one public administrator explained, the high share of social housing "did not completely prevent gentrification, but it certainly contains it" (I5). This notion of "containing" gentrification reflects the resource-side mechanisms highlighted in Figure 5.

Interviews repeatedly highlighted Vienna's extensive municipal and limited-profit housing sector, noting that in historic housing areas the addition of new subsidized social housing on centrally located brownfield sites provides "a huge buffer against gentrification" (I14). Here, public administrators and politicians argue that social housing across the city serves as a safety net for private-sector tenants at risk of displacement due to gentrification, helping to tame green gentrification pressures.

Moreover, tenant interest groups emphasize that access to social housing is uneven, particularly for newly arrived lower-income residents who depend on the private rental sector. These more vulnerable groups, therefore, remain more exposed to green gentrification pressures, especially given the regulatory structure of the private rental market. Existing tenancy law stipulates reference rent values for the mostly centrally concentrated private buildings constructed before 1945, which is generally seen as further cushioning green gentrification. However, interest group organizations highlight that

the "system of reference value rents is harmless […], because tenants have to take their rights into their own hands" (I22). This statement emphasizes that tenants must independently initiate legal action if the rent is too high. In practice, this is rarely done, as there is no government unit proactively monitoring rent prices unless tenants seek assistance from tenant interest group associations. As a result, two significant mechanisms undermine the transparency of the reference-value system, enabling landlords to charge higher rents: the allowance of time-limited contracts and surcharges that can be added to the reference value based on location and quality.

This situation also exacerbates the risk of landlords capitalizing on new public greening projects in inner-city districts, fostering exclusionary displacement. Interviews with interest groups and housing market experts confirm this concern. For example, one interviewee highlighted that, while most private-sector tenants support neighborhood greening, "they also realize that their rental contract is temporary and will expire soon. Tenants are then afraid of being displaced. This is because the landlord can increase the rent between the expiration of one temporary contract and the issuance of the next. The tenants will not be able to afford this and may have to move out of their neighborhood in a central district" (I24). Furthermore, it was reported that, although "the reference value system defines exactly which kinds of surcharges are possible, landlords always ask for too much" (I25). While the Supreme Court requires case-by-case evaluations, it defined that locational surcharges are not justified when daily services, medical and educational facilities, and public transportation access are nearby; they are warranted when these features are accompanied by the absence of noise, cultural amenities, good car accessibility, and nearby green spaces. Nevertheless, interviewees reported that private landlords exploit these surcharges creatively, and consequently "proximity to green spaces is definitely a justification for the location surcharge – at least that's what landlords use it for" (I22).

Despite these tendencies that allow landlords to capitalize on neighborhood street greening, it is reported that market logics attribute only a minor role to public green. Interest groups from both tenants and real-estate developers agree that public greening has limited influence compared to other factors. As one interviewee noted, "The expansion of the metro has a much greater impact" (I24). Although our quantitative model does not identify an influence of metro expansion on gentrification , the statement highlights that private real-estate actors treat large-scale infrastructure investments as a key determinant when setting rents and sale prices. Another added: "The most important thing is the location. Location, image, transport connections. Then there are the floor plans, how nice the neighborhood is and only at last: Is it green or not?" (I3). These statements show that small-scale street greening projects are rarely a primary driver of private investment decisions. However, in the private housing market, green space, as a location improvement, plays a significant role in advertising, often referred to as the "green mascot" (I28). This influence is particularly pronounced in new, free-market building projects where proximity to large urban green can be a key selling point.

Scale effects in localized green gentrification cycles

Taken together, the LISA analysis and qualitative findings show that district heads can influence supply – and demand-side dynamics, but their capacity to do so is partly

constrained, as evidenced by the emergence of localized hotspots. Greening decisions are shaped not only by local priorities but also by institutional rules. For example, allocated funds must be used for the mandatory replanting of older trees under the Vienna Tree Protection Law. This helps to explain why some of the areas identified as hotspots of gentrified greening appear in neighborhoods that already have a high amount of street trees and a high, and still increasing, share of better-situated residents, such as the 13th, 18th, and 19th identified in Figure 4.

Scale effects become particularly salient in areas shaped by large-scale interventions. This helps explain the trajectory observed at the borders of the 6th, 7th and 16th districts: Following the large-scale revitalization project "*URBAN Wien Gürtel plus*' in the late 1990s (MA 27, 2002), including the upgrading of public streets and squares as well as the housing stock, the LISA analysis identified subsequent risks of gentrification in the 2001–2011 period. This, in turn, coincided with a renewed wave of greening efforts between 2011 and 2021. A similar pattern emerges in the central 2nd district (Figure 3(b) and 3(c)), where (new) social housing was insufficient to fully offset broader upgrading dynamics, including the renovation of historic housing, metro expansion, a new university campus, and proximity to Vienna's largest inner-city green space (the Prater). In this context, street greening appears to play a supplementary role, including elements of gentrified greening for 2011–2021 (Figure 4(b)).

By contrast, less central development areas (in the 10th, 22nd, and 23rd districts), where greening is typically integrated into new construction, tend to cater disproportionately to higher-educated and better-off residents, reflecting population growth and city-wide social upgrading trends rather than displacement-led dynamics. These trajectories, therefore, illustrate that even in regulated contexts, localized exclusionary pressures may emerge when street greening coincides with large-scale neighborhood upgrading projects.

Discussion and conclusions

This study set out to deepen the understanding of the green gentrification cycle by examining the extent of green gentrification, gentrified greening and its demand-, supply-, and resource-side mechanisms in the distinct context of Vienna. Vienna represents a particularly relevant and unique case for this inquiry due to its resistance to neoliberal housing and planning trends, given its long-standing social-democratic government. Using quantitative methods, our study investigates the extent to which greening drives social upgrading, exclusionary displacement or tenure commodification, and whether gentrification facilitates subsequent greening. Additionally, the study explored how policymakers perceive and understand the mechanisms in relation to the institutional and regulatory framework.

Most quantitative studies on green gentrification so far (Anguelovski et al., 2022), as well as all of the few quantitative studies that focused explicitly on the green gentrification cycle (Rigolon et al., 2024; Reibel et al., 2023; Quinton et al., 2023) have found associations between greening and gentrification and vice versa in their case studies. Our quantitative results nuance these findings by showing that street greening in Vienna does not operate as a straightforward driver of gentrification. While our analysis reveals the existence of locally bounded hotspots of green gentrification and gentrified greening, no

systematic relationship could be established by deploying regression models. Many local instances of above-average greening have not led to above-average social upgrading, exclusionary displacement or higher tenure commodification. This limited spatial relationship was also found for gentrified greening.

The main explanation lies in the institutional setting of the Viennese greening approach, the relatively small scale of tree planting and housing market regulation. The role of local district politicians is crucially tied to the resource-side explanation of gentrified greening, which posits that greening is targeted in gentrifying neighborhoods because of the increased availability of public and private financial resources. This is often the case in North American cities where more resources for greening are available in gentrifying neighborhoods due to higher property taxes and local income tax revenues (Sharifi et al., 2021; Rigolon & Collins, 2023). In Vienna, the situation is substantially different, since district governments are responsible for greening and their budgets are independent from property tax revenues. District authorities receive their resources through an allocation key that mainly relies on the needs for maintaining greenery, among other factors, granting them freedom to invest in greenery. Hence, there is no financial incentive for districts to compete for higher income groups by providing greener neighborhoods. This means that actively encouraging green gentrification through supply-side mechanisms is not built into Vienna's governance system per se.

Regarding the supply-side mechanism, the concept of the "green growth machine" (DuPuis & Greenberg, 2019; García-Lamarca et al., 2022; Kronenberg et al., 2023), which posits that private developers and public officials collaborate in order to capitalize on the value of green spaces, has been central. In Vienna, there is limited evidence of a green growth coalition between elected officials and private developers. This is primarily due to Vienna's highly regulated housing market, which helps curb gentrification tendencies. On the one hand, the large, publicly subsidised social housing segment in Vienna functions as a buffer for those facing exclusionary displacement pressures on the private rental segment. On the other hand, large parts of Vienna's private rental segment remain rent-controlled, despite regulatory loopholes. This means that some elements of the green growth machine are present in Vienna, such as developers using green spaces as a marketing tool, but exclusionary dynamics are less pronounced than in contexts marked by stronger neoliberal planning regimes.

Our study confirms and expands existing evidence that street greening alone appears to have a more limited impact on the housing market, which either affects housing markets with a time lag (Donovan et al., 2021) or is the strongest in already gentrifying neighborhoods (Kiani et al., 2023). In Vienna, street greening can play a supplementary role in gentrification when it occurs within the context of longer and larger-scale transformation processes in central areas or in conjunction with new development projects, where parks and street greening are integrated. While less central developments in Vienna cater more to better-off residents, notions of new-build gentrification (cf. Davidson & Lees, 2010) appear to be only partially applicable, as they usually include a baseline provision of new social housing in Vienna. Nevertheless, especially over the last decade, new construction dynamics in the form of free-market rental and ownership units characterizes these areas, leading to a growing share of commodified housing in Vienna (Plank et al., 2022), reinforcing exclusionary pressures.

To conclude, our mixed-methods approach highlights critical insights into taming the green gentrification cycle by unpacking the interplay between demand-, supply-, and

resource-side mechanisms. Our findings show that Vienna's historic and current institutional and regulatory framework has mitigated green gentrification and gentrified greening trends by decoupling resource allocation for greening from market-driven pressures so far. Allocation schemes that distribute greening budgets based on population and public needs, rather than property tax revenues, reduce financial incentives to attract affluent residents. While this does not directly limit the influence of gentrifiers in participatory processes, district politicians can override or redirect greening priorities. Additionally, Vienna's robust housing policies, including rent controls and extensive social housing, buffer against displacement pressures and limit the ability of private landlords to capitalize on greening efforts, which are often associated with gentrification dynamics in other contexts. By weakening market-driven dynamics, Vienna's political orientation demonstrates how aligning resource-side mechanisms with equity-focused housing policies can tame the green gentrification cycle, offering a model for more socially inclusive urban greening strategies globally. The supply-side dynamic, however, might shift as neighborhood greening efforts expand in response to climate change.

While our quantitative research design was carefully constructed to align with the local context of Vienna, certain data limitations must be acknowledged. First, our gentrification data is only available in decade-wide intervals, potentially misaligning the timing of greening and gentrification developments. This limitation may muddy the temporal relationships between trends in greening, social upgrading, exclusionary displacement, and tenure commodification. While this misalignment may explain the absence of evidence for the green gentrification cycle, other studies being subject to similar limitations have observed temporal associations between greening and gentrification (Quinton et al., 2023). A second limitation of our study is the focus on street greening as the sole measure of greening. Other studies on the green gentrification cycle have employed a broader range of urban greening initiatives (Reibel et al., 2023; Rigolon et al., 2024). This narrower operationalization may have contributed to the lack of observable effects in our findings, despite street trees being well-documented examples that policymakers demand.

To counterbalance these limitations, we complemented our quantitative analysis with a qualitative approach. Engaging with Rigolon and Collins' (2023) conceptualization of demand-, supply – and resources-side mechanisms, our study examined how these mechanisms operate in Vienna to explain why greening might precede gentrification or vice versa. The demand-side argument posits that gentrifiers demand more urban greening due to their socio-economic and cultural preferences as well as their ability to influence participatory processes in their favor (Rigolon & Collins, 2023; Gould & Lewis, 2018; Checker, 2011). Findings from our qualitative analysis reveal that in Vienna, the demand for urban greening is not exclusive to middle and upper-class gentrifiers but spans all social groups. While our study confirms that better-off residents often dominate participatory processes, the role of district heads and governments in steering urban greening emerges as a significant factor. These political actors possess the power either to override or reinforce gentrifiers' demands, depending on their priorities and political orientations, while their power to steer appears limited in relation to large-scale transformations of neighborhoods. These findings support recent evidence by Rigolon et al. (2025) that the centralization of power in the form of the green growth machine, combined with the scale of greening initiatives, plays a decisive role in relation to both ends of the green gentrification cycle.

In our study, we highlighted the importance of the institutional and regulatory context in how mechanisms foster or impede the green gentrification cycle. Even for Vienna, the future durability of these mechanisms is uncertain. As climate change exacerbates heat stress and urban greening becomes increasingly critical for liveability, the value of green spaces in the private real estate market is likely to rise, especially where existing regulatory loopholes remain open. This shift may also weaken Vienna's ability to resist green gentrification, especially if pressure grows for private-sector-driven development. In general, this highlights the need to continually adapt policy frameworks to changing environmental and market dynamics.

Since research on the green gentrification cycle is still emerging, significant gaps remain to be addressed. This study provides a crucial empirical case from a context outside North America, focusing on Vienna's unique anti-gentrification policies and decommodified housing stock. While we found no clear evidence of green gentrification or gentrified greening in Vienna, these findings underscore the importance of comparative research in understanding how diverse institutional, cultural and economic contexts shape the green gentrification cycle. In particular, evidence from outside North America is sparse, especially for the gentrified greening part of the cycle. Future research should also incorporate qualitative methods to deepen our understanding of the contextual conditions under which green gentrification or gentrified greening occurs, and to refine the parameters to be considered in our quantitative studies. By broadening the scope of inquiry, we can better identify the pathways to equitable and sustainable urban greening strategies. The main political implications supported by our study highlight the importance of aligning social and environmental policies to avoid reinforcing green gentrification dynamics. Planning systems that treat greening as a public service provision rather than a tool for tax maximization are as important as social housing provision and housing regulation in buffering greening-related upgrading, provided that greening strategies are explicitly coordinated with social policy goals.

Note

1. The term "Bobos" (bourgeois-bohemians) is colloquially used in the Viennese gentrification discourse when referring to gentrifiers.

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Research ethics

Ethical approval was granted by the Commission for Science Ethics (Austrian Academy of Sciences) on 17 June 2020. All research participants provided written informed consent. We sincerely thank all interviewees for their valuable contribution to this study.

Data availability statement

The raw population and dwelling stock data provided by Statistical Department of the City of Vienna and the Austrian Statistical Office are protected and not available. The data on trees from the tree cadaster of Vienna are available at Stadt Wien – data.gv.at: https://www.data.gv.at/katalog/de/dataset/stadt-wien_baumkatasterderstadtwien

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References

Anguelovski, I., & Connolly, J. J. (2024). Segregating by greening: What do we mean by green gentrification? *Journal of Planning Literature*, 08854122241227804. https://doi.org/10.1177/08854122241227804

Anguelovski, I., Connolly, J. J. T., Cole, H., Garcia-Lamarca, M., Triguero-Mas, M., Baró, F., Martin, N., Conesa, D., Shokry, G., del Pulgar, C. P., Ramos, L. A., Matheney, A., Gallez, E., Oscilowicz, E., Máñez, J. L., Sarzo, B., Beltrán, M. A., & Minaya, J. M. (2022). Green gentrification in European and North American cities. *Nature Communications*, *13*(1), 3816. https://doi.org/10.1038/s41467-022-31572-1

Anguelovski, I., Connolly, J. J. T., Masip, L., & Pearsall, H. (2018). Assessing green gentrification in historically disenfranchised neighborhoods: A longitudinal and spatial analysis of Barcelona. *Urban Geography*, *39*(3), 458–491. https://doi.org/10.1080/02723638.2017.1349987

Anselin, L., Syabri, I., & Kho, Y. (2006). GeoDa: An introduction to spatial data analysis. *Geographical Analysis*, *38*(1), 5–22. https://doi.org/10.1111/j.0016-7363.2005.00671.x

Banabak, S. (2023). Neighbourhood rental market integration and private rent trajectories – Evidence from the city of Vienna. *International Journal of Urban Sciences*, *27*(2), 239–259. https://doi.org/10.1080/12265934.2022.2110144

Bernt, M. (2023). *The commodification gap: Gentrification and public policy in London*. John Wiley & Sons.

Brenner, A.-K., Mocca, E., & Friesenecker, M. (2021). Vienna's urban green space planning: Great stability amid global change. In Y. Kazepov, & R. Verwiebe (Eds.), *Vienna: Still a just city* (pp. 117–130). Routledge.

Breusch, T. S., & Pagan, A. R. (1979). A simple test for heteroscedasticity and random coefficient variation. *Econometrica*, *47*(5), 1287–1294. https://doi.org/10.2307/1911963

Checker, M. (2011). Wiped out by the "Greenwave": Environmental gentrification and the paradoxical politics of urban sustainability. *City & Society*, *23*(2), 210–229. https://doi.org/10.1111/j.1548-744X.2011.01063.x

Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed., international student ed.). Sage.

Cucca, R., Friesenecker, M., & Thaler, T. (2023). Green gentrification, social justice, and climate change in the literature: Conceptual origins and future directions. *Urban Planning*, *8*(1), 283–295. https://doi.org/10.17645/up.v8i1.6129

Davidson, M., & Lees, L. (2010). New-build gentrification: Its histories, trajectories, and critical geographies. *Population, Space and Place*, *16*(5), 395–411. doi:10.1002/psp.584

Dodman, D., Hayward, B. Pelling, M. Castan Broto, V. Chow, W. Chu, E. Dawson, R. Khirfan, L. McPhearson, T. Prakash,A. Zheng, & Y. Ziervogel, G. (2022). Cities, settlements and key infrastructure. In H.-O. Portner, D. C. Roberts, M. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegria, M. Craig, S. Langsdorf, S. Loschke, V. Moller, A. Okem, & B. Rama, *Climate change 2022: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 907–1040). Cambridge University Press.

Donovan, G. H., Prestemon, J. P., Butry, D. T., Kaminski, A. R., & Monleon, V. J. (2021). The politics of urban trees: Tree planting is associated with gentrification in Portland, Oregon. *Forest Policy and Economics*, *124*, 102387. https://doi.org/10.1016/j.forpol.2020.102387

Dooling, S. (2009). Ecological gentrification: A research agenda exploring justice in the City. *International Journal of Urban and Regional Research*, *33*(3), 621–639. https://doi.org/10.1111/j.1468-2427.2009.00860.x

DuPuis, E. M., & Greenberg, M. (2019). The right to the resilient city: Progressive politics and the green growth machine in New York City. *Journal of Environmental Studies and Sciences*, *9*(3), 352–363. https://doi.org/10.1007/s13412-019-0538-5

Friesenecker, M., & Kazepov, Y. (2021). Housing Vienna: The socio-spatial effects of inclusionary and exclusionary mechanisms of housing provision. *Social Inclusion*, *9*(2), 77–90. https://doi.org/10.17645/si.v9i2.3837

Friesenecker, M., Thaler, T., & Clar, C. (2024). Green gentrification and changing planning policies in Vienna? *Urban Research & Practice*, *17*(3), 393–415. https://doi.org/10.1080/17535069.2023.2228275

García-Lamarca, M., Anguelovski, I., Cole, H. V., Connolly, J. J., Pérez-del-Pulgar, C., Shokry, G., & Triguero-Mas, M. (2022). Urban green grabbing: Residential real estate developers discourse and practice in gentrifying Global North neighborhoods. *Geoforum; Journal of Physical, Human, and Regional Geosciences*, *128*, 1–10. doi:10.1016/j.geoforum.2021.11.016

Gould, K. A., & Lewis, T. L. (2018). From green gentrification to resilience gentrification: An example from Brooklyn. *City & Community*, *17*(1), 12–15. https://doi.org/10.1111/cico.12283

Hawes, J. K., Gounaridis, D., & Newell, J. P. (2022). Does urban agriculture lead to gentrification? *Landscape and Urban Planning*, *225*, 104447. https://doi.org/10.1016/j.landurbplan.2022.104447

Hlavac, M. (2022). *stargazer: well-formatted regression and summary statistics tables.* R package version 5.2.3. https://CRAN.R-project.org/package=stargazer.

Holm, A., & Schulz, G. (2018). GentriMap: A model for measuring gentrification and displacement. In I. Helbrecht (Ed.), *Gentrification and resistance: Researching displacement processes and adaption strategies* (pp. 251–277). Springer Fachmedien.

Jonas, A. E. (2015). Beyond the urban 'sustainability fix': Looking for new spaces and discourses of sustainability in the city. In D. Wilson (Ed.), *The politics of the urban sustainability concept* (pp.117–135). Common Ground Publishing.

Kadi, J., & Matznetter, W. (2022). The long history of gentrification in Vienna, 1890–2020. *City*, *26*(2-3), 450–472. https://doi.org/10.1080/13604813.2022.2054221

Kiani, B., Thierry, B., Fuller, D., Firth, C., Winters, M., & Kestens, Y. (2023). Gentrification, neighborhood socioeconomic factors and urban vegetation inequities: A study of greenspace and tree canopy increases in Montreal, Canada. *Landscape and Urban Planning*, *240*, 104871. doi:10.1016/j.landurbplan.2023.104871

Kronenberg, J., Skuza, M., & Łaszkiewicz, E. (2023). To what extent do developers capitalise on urban green assets? *Urban Forestry & Urban Greening*, *87*, 128063. https://doi.org/10.1016/j.ufug.2023.128063

Kuckartz, U., & Rädiker, S. (2023). *Qualitative content analysis: Methods, practice and software*. Sage.

Lafortezza, R., Chen, J., van den Bosch, C. K., & Randrup, T. B. (2018). Nature-based solutions for resilient landscapes and cities. *Environmental Research*, *165*, 431–441. https://doi.org/10.1016/j.envres.2017.11.038

MA27. (2002). *Schlussbericht Über das programm URBAN WIEN Gürtel Plus Im Zeitraum 1995–1999*. https://www.oerok.gv.at/fileadmin/user_upload/Bilder/3.Reiter-Regionalpolitik/4.EU-SF_in_OE_95-99/URBAN/1995-1999_URBAN_W_Schlussbericht.pdf.

MacKinnon, J. G., & White, H. (1985). Some heteroskedasticity-consistent covariance matrix estimators with improved finite sample properties. *Journal of Econometrics*, *29*(3), 305–325. doi:10.1016/0304-4076(85)90158-7

Melstrom, R. T., Mohammadi, R., Schusler, T., & Krings, A. (2022). Who benefits from brownfield cleanup and gentrification? Evidence From Chicago. *Urban Affairs Review*, *58*(6), 1622–1651. https://doi.org/10.1177/10780874211041537

Molotch, H. (1976). Varieties of growth strategy: Some comments on logan. *American Journal of Sociology*, *82*(2), 352–355. https://doi.org/10.1086/226314

Musil, R., Brand, F., Huemer, H., & Wonaschütz, M. (2022a). The Zinshaus market and gentrification dynamics: The transformation of the historic housing stock in Vienna, 2007–2019. *Urban Studies*, *59*(5), 974–994. https://doi.org/10.1177/00420980211051906

Musil, R., Brand, F., & Punz, S. (2022b). The commodification of a rent-regulated housing market. Actors and strategies in Viennese neighbourhoods. *Housing Studies*, *39*(8), 1930–1950. https://doi.org/10.1080/02673037.2022.2149707

Neidig, J., Anguelovski, I., Albaina, A., & Pascual, U. (2022). "We are the Green Capital": Navigating the political and sustainability fix narratives of urban greening. *Cities*, *131*, 103999. https://doi.org/10.1016/j.cities.2022.103999

Plank, L., Schneider, A., & Kadi, J. (with Kammer für Arbeiter und Angestellte für Wien & Technische Universität Wien). (2022). *Wohnbauboom in Wien 2018-2021. Band 1: Preise, Käufer:innen und Leerstände in der Wohnbauproduktion; im Auftrag der Kammer für Arbeiter und Angestellte für Wien* (Stand Juni 2022). Kammer für Arbeiter und Angestellte für Wien. https://wien.arbeiterkammer.at/interessenvertretung/meinestadt/wohnen/Studie_Wohnbauboom_Wien_2018-2021.pdf

Quastel, N. (2017). Fixing sustainability: Social contestation and re-regulation in Vancouver's housing system. In Curran, W. & Hamilton, T. (Eds.), *Just green enough: Urban development and environmental gentrification*. Routledge.

Quinton, J., Nesbitt, L., Connolly, J. J., & Wyly, E. (2023). How common is greening in gentrifying areas? *Urban Geography*, *0*(0), 1–23. https://doi.org/10.1080/02723638.2023.2258687

Quinton, J., Nesbitt, L., & Sax, D. (2022). How well do we know green gentrification? A systematic review of the methods. *Progress in Human Geography*, *46*(4), 960–987. https://doi.org/10.1177/03091325221104478

R Core Team. (2023). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. https://www.R-project.org/.

Realnutzungskartierung. (2012). *Realnutzungskartierung ab 2007 Wien*. https://www.data.gv.at/katalog/dataset/2f5baa1f-208c-42c2-8d04-9ea74aa1b229.

Reibel, M., Rigolon, A., & Rocha, A. (2023). Follow the money: Do gentrifying and at-risk neighborhoods attract more park spending? *Journal of Urban Affairs*, *45*(5), 923–941. https://doi.org/10.1080/07352166.2021.1886857

Rigolon, A., & Collins, T. (2023). The green gentrification cycle. *Urban Studies*, *60*(4), 770–785. https://doi.org/10.1177/00420980221114952

Rigolon, A., Collins, T., Kim, J., Stuhlmacher, M., & Christensen, J. (2024). Does gentrification precede and follow greening? Evidence about the green gentrification cycle in Los Angeles and Chicago. *Landscape and Urban Planning*, *248*, 105095. https://doi.org/10.1016/j.landurbplan.2024.105095

Rigolon, A., & Németh, J. (2019). Toward a socioecological model of gentrification: How people, place, and policy shape neighborhood change. *Journal of Urban Affairs*, *41*(7), 887–909. https://doi.org/10.1080/07352166.2018.1562846

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 Studies*, *57*(2), 402–420. https://doi.org/10.1177/0042098019849380

Rigolon, A., Stuhlmacher, M., Christensen, J., Collins, T. W., & Kim, J. (2025). Different pathways to greening in gentrifying communities: Power, transformative projects, and the green gentrification cycle. *Cities*, *166*, 106268. https://doi.org/10.1016/j.cities.2025.106268

Sharifi, F., Nygaard, A., Stone, W. M., & Levin, I. (2021). Green gentrification or gentrified greening: Metropolitan Melbourne. *Land Use Policy*, *108*, 105577. https://doi.org/10.1016/j.landusepol.2021.105577

Shokry, G., Connolly, J. J., & Anguelovski, I. (2020). Understanding climate gentrification and shifting landscapes of protection and vulnerability in green resilient Philadelphia. *Urban Climate*, *31*, 100539. https://doi.org/10.1016/j.uclim.2019.100539

Stadt Wien. (2024). *Baumkataster bzw. Bäume Standorte Wien*. https://www.data.gv.at/katalog/en/dataset/c91a4635-8b7d-43fe-9b27-d95dec8392a7.

Thaler, T., Hartmann, T., Slavíková, L., & Tempels, B., eds. (2022). *Homeowners and the resilient city: Climate-driven natural hazards and private land*. Springer International Publishing.

Walks, A., Hawes, E., & Simone, D. (2021). Gentrification in large Canadian cities: Tenure, age, and exclusionary displacement 1991-2011. *Urban Geography*, *42*(5), 603–633. https://doi.org/10.1080/02723638.2020.1832376