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Resident Retention in Green Climate Adaptation: Ordinal Civic Evidence from Boston, Philadelphia, Amsterdam and Barcelona

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Abstract

Now that the greening of climate infrastructure is firmly established as part of urban adaptation, however, civic effectiveness is more complicated than hydrology, cooling capacity, plant cover or space design alone. Socially fragile adaptation occurs where greening brings local benefits to people who face displacement pressure, selective redevelopment, access restrictions and weakened local identity. In this study, Resident Retention Gate Analysis (RRGA) is introduced as an ordinal civic calculation of the likelihood that socio-environmental benefits are usable by marginalized residents. Applying the calculation involves mapping a civic record of each of four neighborhoods in Boston, Philadelphia, Amsterdam and Barcelona: their histories, their climate/environmental problems, their greening interventions, their redevelopment pressures, their distribution of civic interviews and the order magnitude of their benefits in terms of recognition, displacement experience, displacement threat, development, dissatisfaction, green gentrification fears, unequal access and social cohesion disruption. RRGA turns those order-magnitudes into civic gates based on three civic criteria: tenure stability, public development orientation and continuity of access/belonging. It calculates the retained benefit score by multiplying recognized benefit with the average of the two constraints and the dominant one. The retention deficits are worst in East Boston due to high tenure pressure and greening associated with the marketization of waterfront amenities, where only a small civic gate makes room for benefits that are already recognized to be moderate. The retained benefit score is highest in Hunting Park, whose high greening need has been coupled with low marketization pressure, despite green gentrification fears being very real there. The Amsterdam Noord case features a bottleneck situation caused by investment-led greening and creative redevelopment, as well as waterfront amenities. The most exclusionary and protection-focused tension between benefits and constraints emerges in Poblenou, where high need for greening is compounded by strong displacement and redevelopment pressures. Conclusion: Climate-adaptive greening should be evaluated in terms of resident retention – the crucial question here being whether the affected community will remain nearby, able to govern, access and take ownership of their environmental improvement.

Keywords: green climate infrastructure; climate adaptation; civic retention; displacement; environmental justice; green gentrification; ordinal analysis

1. Introduction

Climate adaptation planning has shifted from a niche focus to a municipal responsibility. Municipalities increasingly leverage parks, rain gardens, restored shorelines, bioswales, greenways, community gardens, street trees and traffic-calmed corridors to address heat, stormwater, flooding, pollution and everyday decline in ecological quality. It is easy to see why. Vegetated and porous infrastructures can manage runoff, regulate urban heat, improve air quality, increase recreational opportunity and produce public-health benefits unattainable through gray infrastructures alone [1, 3, 7, 10, 15, 28]. Moreover, research on urban climate adaptation recognizes that risk exposure is local, placing municipalities, neighborhoods and civil society organizations at the core of climate governance [8, 25, 27].

Yet green solutions also create an inherent civic dilemma. The same park, waterfront, linear parkway or tree-lined road that addresses an environmental burden can become an asset that increases the attractiveness of a disinvested area to real estate investors, more affluent residents and consumption-oriented redevelopment. Environmental justice research revealed that green space is unequally distributed and that access, size, quality and safety of public spaces are linked to race, class, income and historical disinvestment [20, 34, 45]. In subsequent years, the green-gentrification research literature demonstrated that green spaces may become catalysts for land-value transformation, resulting in exclusion, displacement and cultural loss among communities previously subject to pollution and neglect [9, 11, 12, 19]. The challenge with green infrastructure is not that green space is useless. Rather, the problem is that benefits can be alienated through housing precarity, selective redevelopment, symbolic exclusion and the privatization of public adaptive capacity.

The argument hinges on retention. A successfully adapted public space must not only exist, perform a regulatory task and receive positive recognition from residents. It must also keep its benefits accessible to communities who have suffered environmental burden. Consequently, retention entails the interaction of three separate criteria: residential proximity, redevelopment exclusivity and public-space recognition. Residency research has highlighted for decades that being “retained” is not simply about staying put but also about security, recognition, social ties and the ability to use community assets without feeling excluded [24, 29, 44].

The fundamental question posed is how much recognized climate adaptation benefit is civically retained under tenure insecurity, redevelopment exclusivity and disruption of access-belonging relationships. To answer this question, the study applies a Resident Retention Gate Analysis (RRGA), which is an ordinal scoring method designed for comparative analysis using rich qualitative evidence. RRGAs neither identifies causes of displacement based on housing-market microdata nor converts complex lived experiences into statistical conclusions. Instead, RRGAs interpret a set of ordered social effects as gate-like factors that either retain or block benefits. The analysis becomes useful when qualitative evidence is extensive enough to compare multiple cases but not organized into a longitudinal database of individual households.

The empirical study uses four neighborhoods with a varied civic history and comparable climate and environmental burden: East Boston in Boston, Hunting Park in Philadelphia, Amsterdam Noord in Amsterdam and Poblenou in Barcelona. These neighborhoods are selected due to diverse urban backgrounds, varying degrees of market pressure, different histories of community action and a wide range of civic challenges associated with green climate infrastructure adaptation. East Boston exemplifies a convergence of aviation, port and coastal burdens along with shoreline adaptation improvements and luxury real estate development. Hunting Park brings together heat exposure, greenspace poverty and public-health concerns with renewed park improvements, trees and stormwater adaptation plans. Amsterdam Noord illustrates industrial brownfields and waterfront risk management through the creation of creative districts, parks and expensive redevelopment in a European city context characterized by housing and neighborhood policies fostering social inclusion and exclusion alike [42, 43]. Finally, Poblenou highlights industrial restructuring and tourism pressures, technologically-oriented land use and visibly green public space adaptation initiatives. Differences among these cases make it possible to highlight a few pathways by which adaptation benefits can be retained or blocked.

The paper makes two primary contributions. First, RRGAs represent a new application of gate-based ordinal logic for analyzing retention in relation to climate adaptation through green infrastructure. Unlike score aggregation procedures, RRGAs average social pressures and uses the worst one as a “bottleneck” of benefit recognition.

The rationale for this approach is straightforward. Social benefits cannot be retained if any one of the resident-retention social gates is nearly closed. Secondly, the findings reveal that similar greening narratives can be associated with dramatically different retention situations. Specifically, East Boston emerges as a strong retention deficit neighborhood, Hunting Park represents a guarded retention neighborhood, Amsterdam Noord becomes an investment-bottleneck neighborhood, and Poblenuo qualifies as a high-paradox neighborhood. Therefore, climate adaptation should not only evaluate its effectiveness in greening cities but consider social retention of benefits as a key equity criterion.

2. Conceptual background

A typical justification for green climate infrastructure is linked to the vocabulary of co-benefits. Parks and vegetated surfaces are meant to reduce heat, absorb runoff, increase biodiversity, improve air quality, encourage physical exercise, reduce stress, facilitate community gardening and create aesthetic public realm [1, 7, 26]. These benefits are not rhetorical arguments either because the urban environmental literature presents considerable evidence on the health, recreational and resilience-related advantages of green space and its infrastructural functions [20, 21, 35]. However, such co-benefits may lead to misunderstandings. While the neighborhood overall could receive significant improvements as the result of green climate adaptation projects, the citizens suffering the most from urban environmental risks might not get much.

In order to resolve this conceptual dilemma, the discussion needs to include environmental justice frameworks. Justice concerns equity, but also involves recognition, participation, procedure and the social conditions under which people can benefit from the environment [5, 13, 37]. In particular, the idea presented by Arnstein of participation by proxy continues to be meaningful because consultation without any actual power can leave residents with minimal capacity to influence land use decisions [6]. With regards to climate change adaptation, environmental justice implies protection of vulnerable communities against exclusion, displacement and indirect displacement [2, 30, 38]. As such, assessing the efficacy of adaptation measures should involve evaluating which communities get protected and which continue to be exposed to climate risks due to land-use politics.

This leads to the second framework used in the analysis: green gentrification. Research on ecological or environmental gentrification showed earlier how environmental and sustainable development initiatives, brownfield remediation and green amenities were associated with real estate speculation and exclusion of poorer residents [9, 12, 32]. The “just green enough” framework stressed that ecological repair and improvements must avoid signaling upscale redevelopment [11, 45]. Recent studies on green, climate and resilience gentrification illustrated that greening processes can lead to displacement and cultural exclusion, and climate protection can be unequal depending on economic opportunities [4, 18, 22, 39, 40]. None of these works called for abandoning green infrastructure projects altogether. Instead, they argued for combining climate protection with housing stabilization, public access and neighborhood control.

Residential displacement has been defined broadly to include physical movement and symbolic displacement through rising costs, retail changes, consumption norms, weakening networks, cultural othering, and discomfort in public spaces that are formally accessible but socially unwelcoming [16, 17, 24, 29, 31, 41]. Older, renting, poorer and racialized individuals perceive the risk of displacement through precarity and modify their routines accordingly before eventually leaving an area [44]. Such understanding of displacement becomes critical to evaluating green climate adaptation because the space can remain physically available to all residents yet symbolically accessible only to certain groups.

Four neighborhoods selected for the study represent an intersection of the above ideas. Greening and climate protection along waterfronts in East Boston and Amsterdam Noord demonstrates how environmental improvement can be integrated with post-industrial revitalization efforts. Greening in Hunting Park shows how neighborhoods urgently needing green and climate protection can be simultaneously concerned about attracting developers through improving the environmental quality. Finally, greening in Poblenuo highlights how technology offices, student dormitories and tourist services can become interwoven with the process of creating public spaces. The comparative

challenge is not how many residents welcome climate adaptation initiatives. It is about how much residents recognize benefits of adaptation when facing tenure insecurity, redevelopment and displacement risks.

RRGA aims to address precisely this gap in evaluating climate adaptation projects. It neither replaces nor diminishes the value of qualitative analysis and does not present ordered civic effects as quantitative measurements. On the contrary, RRGGA seeks to preserve interpretative meaning of qualitative evidence by translating it into a quantifiable form to assess benefit-retention challenges in a comparative manner. Specifically, RRGGA treats recognized benefit as a prerequisite of retention, and then determines whether the civic gates of benefit-retention remain open, narrow or closed. This represents a different analytical focus from the simple subtraction of benefit and burden because the worst social pressure cannot be compensated by the best one in another dimension.

3. Study area and analytical design

3.1. Neighborhood evidence base

The evidentiary basis includes the case material of four neighborhoods with documented climate adaptation through green infrastructure and civic recognition of related environmental benefits in Boston, Philadelphia, Amsterdam and Barcelona. There are four types of evidence that this paper preserves: environmental burden, greening, climate protection and redevelopment context, distribution of civic interviews, and ordered magnitude of effects. Published case material includes 62 civic interviews and a ranking of four social effect levels across the four neighborhoods [33].

Table 1. Neighborhood record.

Neighborhood	Environmental and climate burden	Greening and adaptation assets	Redevelopment and protection context
East Boston	Airport, port, tunnel, highway and waterfront burdens; air and noise pollution; river, soil and industrial contamination; sea-level-rise and flood exposure.	Piers Park, East Boston Greenway, Bayswater Street Embankment, LoPresti Park, Eastie Farm, Bremen Street Community Garden and other gardens.	Luxury waterfront projects including The Eddy, Boston East, Clippership Wharf and The Mark; cooperative housing, community land-trust proposals, affordable housing advocacy and Green Walks.
Hunting Park	Former industrial district with air and noise pollution, toxic exposure, greenspace deprivation, respiratory-health concern and severe heat exposure.	Renewal of the 87-acre Hunting Park, 385 new trees, recreational spaces, tree planting and planned rain gardens for stormwater management.	Adjacent investment and citywide displacement pressure; attention to social and health services, affordability preservation and property-tax-freeze support for long-term residents.
Amsterdam Noord	Former heavy-industrial and port district with air and noise pollution, toxic brownfields and waterfront flood risk.	Noorderpark, Noordholland Canal landscape-park plans, neighborhood greening in Elzenhagen Zuid, Banne Noord and Molenwijk, and De Ceuveil.	Creative hubs, cultural venues, high-end buildings and luxury housing; rent controls and subsidies remain relevant, although rental and private housing costs have increased.
Poblenou	Former industrial district exposed to air and noise pollution, urban heat, flood risk, coastal erosion and shrinking beaches.	Parc del Poblenou, Parc del Centre del Poblenou, Pere IV tree planting, Poblenou Superblock, Cristobal de Moura green corridor and community gardens.	22@ offices, hotels, student accommodation and tourism pressure; short-term-rental regulation and neighborhood resistance to displacement and excessive touristification.

The case record shows that all four neighborhoods combine environmental need with land-market sensitivity, but the origin of pressure differs. East Boston and Amsterdam Noord are strongly shaped by waterfront redevelopment, while Hunting Park is more strongly defined by heat and park deprivation in a citywide geography of uneven investment. Poblenou occupies a different position because greening occurs within a broader transformation toward innovation-district land use, tourism and student accommodation. This variation is central to RRGGA because a retained adaptation benefit can be lost through several pathways, not only through direct rent increases.

The four-panel site context in Figure 1 places the case record in a visual sequence that follows the manuscript's comparative logic: waterfront adaptation and market pressure in East Boston, park-based heat relief in Hunting

Park, post-industrial waterfront transformation in Amsterdam Noord and corridor-based greening in Poblenou. Read with Table 1, the panels show why the same general category of green climate infrastructure has different retention implications in each neighborhood.



Figure 1. Civic setting.

Table 2. Civic interview base.

Neighborhood	Civic interviews	Share of total
East Boston	23	37.1%
Hunting Park	15	24.2%
Amsterdam Noord	11	17.7%
Poblenou	13	21.0%
Total	62	100.0%

The interview distribution supports comparative interpretation but not respondent-level inference. East Boston supplies the largest share of civic accounts, which is consistent with the richness of the case description and the prominence of waterfront redevelopment concerns. The European cases have fewer interviews, yet their inclusion is important because they show how exclusionary greening can appear even where social-welfare and housing-policy traditions differ from North American contexts. The method therefore treats the interview counts as an evidence-scale descriptor rather than as weights in the calculation.

3.2. Ordinal coding and score normalization

The case record uses four ordered classes to describe effect magnitude. A highly important effect corresponds to 25–60 coded references, an important effect corresponds to 16–24 coded references, a relevant effect corresponds to 6–15 coded references, and a less relevant effect corresponds to fewer than 6 coded references. RRGGA retains the ordering but avoids treating the classes as exact counts. The conversion is:

$$x_{ij} = \frac{s_{ij} - 1}{3}, \quad (1)$$

where s_{ij} is the ordinal score for effect i in neighborhood j . Highly important effects receive a normalized value of 1.000, important effects receive 0.667, relevant effects receive 0.333 and less relevant effects receive 0.000. The

transformation preserves relative salience and prevents the analysis from overstating precision. A value of 0.000 therefore means low salience in the comparative record, not the absence of the issue in everyday life.

Table 3. Ordinal civic effects.

Civic effect	East Boston	Hunting Park	Amsterdam N.	Poblenou
Perceived socio-environmental value and benefits of greening	R (2)	I (3)	I (3)	H (4)
Physical displacement and neighborhood unaffordability	H (4)	R (2)	H (4)	H (4)
Perceived threat of continued or future displacement	H (4)	I (3)	R (2)	R (2)
Exclusive new developments and resilient greening for others	H (4)	R (2)	H (4)	I (3)
Dissatisfaction with new developments	I (3)	L (1)	L (1)	I (3)
Explicit fear of green gentrification	L (1)	H (4)	L (1)	L (1)
Enduring unequal distribution or access to green spaces and benefits	R (2)	R (2)	L (1)	L (1)
Disruption of social cohesion around green spaces	R (2)	L (1)	L (1)	L (1)

The ordinal record already reveals why a benefit-only narrative would be misleading. Poblenou records the strongest benefit recognition, but it also records highly important physical displacement and important dissatisfaction with new development. East Boston records only relevant benefit recognition while all three major redevelopment and displacement categories are high or important. Hunting Park differs because fear of green gentrification is highly important even though physical displacement and exclusive development are lower than in the waterfront cases. Amsterdam Noord shows strong pressure in physical displacement and exclusive development but low salience for explicit green-gentrification language and access-belonging disruption.

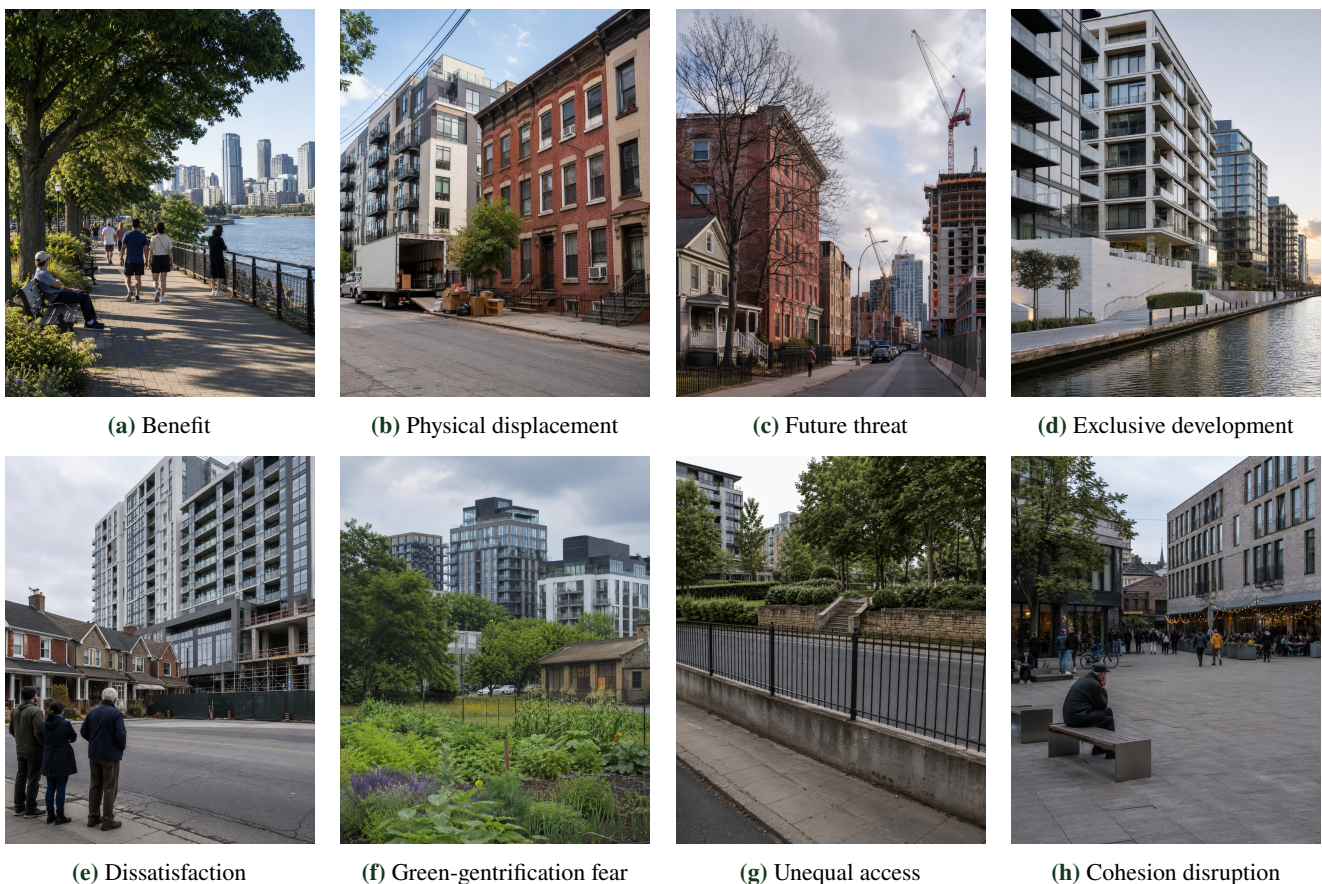


Figure 2. Civic effects.

The civic-effect sequence in Figure 2 translates the eight ordered variables in Table 3 into a visual record of benefit, displacement, development pressure, access and social cohesion. The panels do not replace the ordinal scores; instead, they clarify the social meaning of the coding by showing that RRGAs begin from lived urban conditions

rather than from an abstract numerical scale.

3.3. Resident Retention Gate Analysis

RRGA separates one positive dimension from seven pressure dimensions. The positive dimension is benefit recognition, denoted B_j . The pressure dimensions are arranged into three civic gates. The tenure gate captures whether residents can remain near the adaptation asset. The public-development gate captures whether greening is attached to exclusive development or public-oriented improvement. The access-belonging gate captures whether the space is socially usable, culturally legible and connected to neighborhood cohesion.

The tenure pressure score T_j combines physical displacement and perceived future displacement:

$$T_j = 0.60x_{\text{physical},j} + 0.40x_{\text{future},j}. \quad (2)$$

The public-development pressure score M_j combines exclusive development and dissatisfaction with new development:

$$M_j = 0.55x_{\text{exclusive},j} + 0.45x_{\text{dissatisfaction},j}. \quad (3)$$

The access-belonging pressure score L_j combines explicit fear of green gentrification, unequal access and social-cohesion disruption:

$$L_j = \frac{x_{\text{fear},j} + x_{\text{unequal},j} + x_{\text{cohesion},j}}{3}. \quad (4)$$

The weights reflect the civic-retention meaning of each domain. Existing physical displacement receives more weight than future displacement because already experienced unaffordability closes the retention gate most directly. Exclusive development receives slightly more weight than dissatisfaction because privately oriented, high-end or consumption-coded greening can shape who feels entitled to use the new landscape. The access-belonging gate is averaged because fear, unequal access and cohesion disruption represent distinct but mutually reinforcing forms of social narrowing. This arrangement keeps the method readable while ensuring that the most direct route to loss of retention, the inability to remain nearby, is not diluted.

A composite constraint score C_j is calculated as:

$$C_j = 0.45T_j + 0.35M_j + 0.20L_j. \quad (5)$$

The dominant bottleneck Q_j is then defined as:

$$Q_j = \max(T_j, M_j, L_j). \quad (6)$$

The retention gate G_j combines average pressure and the strongest bottleneck:

$$G_j = 1 - (0.65C_j + 0.35Q_j). \quad (7)$$

The retained civic benefit R_j is the recognized benefit that passes through the gate:

$$R_j = B_jG_j. \quad (8)$$

The exclusionary-protection tension E_j identifies cases where valued greening and strong civic pressure coincide:

$$E_j = B_j C_j (0.5 + 0.5 Q_j) . \quad (9)$$

The equations are deliberately compact, but their purpose is interpretive rather than merely numerical. G_j measures how open the civic gate remains after social pressure is considered. R_j measures how much recognized benefit remains locally retainable. E_j measures paradox: a case becomes more paradoxical when benefit recognition is high and the civic gate is narrowed by average pressure and a dominant bottleneck. The use of Q_j prevents a severe tenure or marketization pressure from being masked by a low score in another domain.



(a) Recognized benefit



(b) Tenure pressure



(c) Development pressure



(d) Access-belonging



(e) Retained use

Figure 3. Retention components.

The component boxes in Figure 3 display the practical steps behind the calculations. Greening recognized value is considered just one condition, after which retention is constrained further by tenure pressure, selective development and access-belonging limitations to arrive at an ultimately useful benefit. The graphic portrayal corresponds to the equations since R_j can only be understood as a function of social barriers that will ensure the residents' ability to live nearby, interact with, and feel a sense of belonging to the newly-created space.

3.4. Robustness analysis and validity parameters

The proposed method is suitable for comparative analyses in which qualitative variables have been classified in a way that allows us to consider ordinal scales. According to expectations for qualitative research, issues such as transparency, saturation and triangulation must remain clear even when using a formal approach to interpretation [14, 36]. This measure is not supposed to replace the collection of information through household relocations, housing rents, investments made to each parcel or park usage observations conducted by residents themselves.

Scores are not to be understood as probabilities; they are comparative measures of civic salience. They allow us to make our method of interpretation visible and transparent for the reader who wishes to comprehend its logic.

One of the ways to assess the robustness of conclusions is a sensitivity analysis where the composite constraint is calculated with equal weights for all three gates:

$$C_j^{eq} = \frac{T_j + M_j + L_j}{3}. \quad (10)$$

Applying the same bottleneck equation results in the calculation of the retained benefit under the assumption of equal influence of each of the three gates.

4. Results

4.1. Gate configuration per neighborhood

First of all, we note that East Boston has a fully closed tenure pressure score of 1.000 and a very high public development pressure score of 0.850. The access-belonging score for the neighborhood in question is considerably lower, at 0.222. At the same time, the method gives significant weight to the two aspects that directly contribute to the residents' ability to use the water front as a civic asset for climate adaptation purposes. In the case of Hunting Park, there is a moderate score for tenure pressure at 0.467, a low score for public development pressure at 0.183 and an elevated access-belonging pressure of 0.444. Amsterdam Noord has a very high tenure pressure score of 0.733 and a rather high public development score of 0.550. Poblenu has identical scores with respect to tenure pressure, but a higher score with respect to public development pressure, which makes up 0.667.

Table 4. Retention-gate scores.

Neighborhood	B_j	T_j	M_j	L_j	C_j	Q_j
East Boston	0.333	1.000	0.850	0.222	0.792	1.000
Hunting Park	0.667	0.467	0.183	0.444	0.363	0.467
Amsterdam Noord	0.667	0.733	0.550	0.000	0.522	0.733
Poblenu	1.000	0.733	0.667	0.000	0.563	0.733

The gate scores show that civic fragility is not identical across the cases. East Boston is not mainly an access-programming problem; it is a tenure and waterfront-development problem. Hunting Park is not yet dominated by luxury greening in the same way, but distrust is already strong enough to narrow the access-belonging gate. Amsterdam Noord and Poblenu share a high tenure score, yet Poblenu's higher development pressure and higher benefit recognition produce a stronger paradox. This distinction matters because policy responses aimed only at park design would miss the most consequential pressures in East Boston, Amsterdam Noord and Poblenu.

The case panels in Figure 4 support the gate-score reading in Table 4. East Boston is visually defined by old housing beside new high-rise redevelopment, Hunting Park by residential public-space use under a large tree canopy, Amsterdam Noord by a canal-edge redevelopment field and Poblenu by a polished green corridor attached to high-intensity urban change. These contrasts explain why the same greening language produces different combinations of T_j , M_j and L_j .

4.2. Retained benefit and exclusionary protection

The retained civic benefit score changes the ranking of the cases. Poblenu has the highest benefit recognition, but its retained score falls to 0.377 after the gate is applied. Hunting Park has a lower benefit recognition value than Poblenu but the highest retained civic benefit score, 0.400, because the public-development gate remains more

open. Amsterdam Noord records a retained score of 0.269. East Boston is the lowest at 0.045 because moderate benefit recognition is combined with the strongest bottleneck in the case record (Table 5).



(a) East Boston



(b) Hunting Park



(c) Amsterdam Noord



(d) Poblenu

Figure 4. Gate conditions by case.

Table 5. Retained benefit results.

Neighborhood	G_j	R_j	E_j	Primary diagnosis
East Boston	0.135	0.045	0.264	Retention deficit
Hunting Park	0.601	0.400	0.177	Guarded retention
Amsterdam Noord	0.404	0.269	0.302	Investment bottleneck
Poblenu	0.377	0.377	0.488	High paradox

The retained-benefit results offer a sharper answer than a benefit-only ranking of greening value. Hunting Park emerges as the strongest retained-benefit case not because it is free from injustice but because the greening benefit is less strongly tied to high-end development in the present ordinal panel. Its high fear score should not be dismissed; rather, it indicates that retention remains conditional on credible anti-displacement protections. Poblenu, by

contrast, illustrates how high benefit recognition can coexist with a strong exclusionary-protection tension. Residents may value the Superblock, green corridors and public-space improvements while also seeing them as part of a broader redevelopment landscape that changes who the neighborhood is for.



(a) Recognized greening



(b) Everyday use



(c) Retained access



(d) Exclusion tension

Figure 5. Benefit retention.

Visual representations of retained benefits appear in Figure 5. Attractive, open, and ecologically sustainable spaces do not equate to a fair adaptation process if the retained benefit of these areas is low. The views from the waterfront and along the path reveal the fundamental empirical question of the study: greening and resilience may exist and be appreciated, but their locally retained benefit may be reduced due to pressures related to residential development, exclusivity, and changes in the identity of the public realm.

4.3. Interpretation of case

East Boston shows the largest deficit in terms of retaining the existing benefit of the area. Its socially relevant benefits are evident; however, in terms of the ordinal data, physical displacement, potential displacement, and exclusive development rank the highest. RRGAs, therefore, sees East Boston as a scenario where benefit recognition is present, but retaining this benefit is unlikely to occur unless housing needs and waterfront access are made integral elements of adaptation planning. The RRGAs score in no way implies that there is no value in Piers Park, East Boston Greenway, LoPresti Park, and Eastie Farms. This score implies that the socially produced value of these assets is at risk because of the likelihood that shore protection and waterfront amenity would eventually become part of a wealthier and more exclusive residential landscape. Hence, the risk is that the green asset becomes visible, but it does not remain a durable benefit.

Hunting Park shows the greatest retention gate openness out of all four sites. However, this case is by no means a success story because, given its extreme heat and greenspace deficits, as well as its negative public health impact,

greening is essential. The very high fear of gentrification reveals how the residents interpret their environment and their needs in the context of the past experiences with uneven urban development. Therefore, RRGAs considers Hunting Park as a case of guarded retention of the current benefit. Greeneries will remain beneficial as long as they are coupled with explicit anti-displacement policies and commitments to maintaining the asset, local hire opportunities, clear communication, and proof that public health, not profit-making potential, justifies these investments.

Amsterdam Noord is an investment-bottleneck case. Benefit recognition plays an important role here, and the greenspaces are a logical response to the environmental challenges of the area. The narrowing of the public development gate is indicated by such factors as cultural venues, branding efforts, expensive housing, and waterfront market pressure. Although the access-belonging score is low, it cannot mean that there is no social exclusion in the area. Rather, the relative importance of such ordinal categories as fear of exclusion, unequal access, and cohesion breakdown ranks lower compared to that of physical displacement and exclusivity. Therefore, the problem faced by Amsterdam Noord is not necessarily how to increase greenspace use; it is how to ensure that greening does not create infrastructure for reinforcing the idea of an exclusive identity of the new district while pushing out lower-income, minority communities.



(a) East Boston



(b) Hunting Park



(c) Amsterdam Noord



(d) Poble Nou

Figure 6. Benefit attenuation.

Poblenou shows the largest exclusivity-protection paradox. The greening benefit of this area is recognized. This is consistent with the positive reaction towards Superblocks, the Cristobal de Moura green corridor, greenspaces, and gardens. On the other hand, physical displacement is very important, and dissatisfaction with development plays a notable role. RRGAs, therefore, considers Poblenou a high-paradox scenario, not a low-benefit scenario. The paradox consists of residents' appreciation of the environmental benefits coupled with their dissatisfaction with the development trajectory. Traditional adaptation assessments might praise the visual and design appeal of greening efforts in Poblenou. A retention assessment asks whether long-term residents, small business owners, and community gardens will keep shaping the neighborhood with the increase in office space, hotels, student residences, and tourists.

The attenuation panels in Figure 6 reflect the case interpretations as a move away from greening toward benefit retention. In East Boston, there is perhaps the most obvious contrast between public amenities for the waterfront area and high-value property development elsewhere. In Hunting Park, there is a good example of how retained benefits are maximized when public health concerns and community uses prevail. Amsterdam Noord represents an instance of greening taking place in a redeveloped post-industrial landscape, while Poblenou is a site of high public amenity development where benefit recognition and tenure-develop pressures are high and therefore must be addressed through additional retention strategies.

4.4. Equal-gate robustness

The robustness check reweighs the composite constraint by equalizing the weights assigned to tenure, public development, and access-belonging gate pressures. In doing so, the ranking pattern still demonstrates some stability and insight. East Boston stays the same because of its retained-benefit weakness, which does not depend upon a particular choice of weights. Hunting Park continues to rank similarly to its main score because its three gate scores are relatively balanced. Amsterdam Noord performs better in equal weights because it gets to rely more on its lower access-belonging score to decrease its composite constraint.

Table 6. Equal-gate sensitivity.

Neighborhood	C_j^{eq}	G_j^{eq}	R_j^{eq}	Shift from main score
East Boston	0.691	0.201	0.067	Slight increase
Hunting Park	0.365	0.600	0.400	No material change
Amsterdam Noord	0.428	0.465	0.310	Moderate increase
Poblenou	0.467	0.440	0.440	Moderate increase

The equal-gate result strengthens the interpretation rather than weakening it. East Boston's score remains low because the bottleneck itself is severe. Hunting Park's stability indicates that the diagnosis is not an artifact of the weight structure. Amsterdam Noord and Poblenou improve when access-belonging is given equal weight, but the improvement is not enough to erase their development and tenure pressures. This confirms the central claim that climate-adaptive greening must be assessed through both benefit recognition and the specific gate that constrains retention.

The sensitivity context panels in Figure 7 provide another perspective on the equal gates check presented in Table 6. The ranking pattern is not merely a mathematical convenience: East Boston continues to face its most severe bottleneck constraint, Hunting Park continues to maintain stability relative to the other case studies, and Amsterdam Noord and Poblenou are still found to be in need of tenure development, even when all gate weights are equally allocated.



(a) East Boston



(b) Hunting Park



(c) Amsterdam Noord



(d) Poblenou

Figure 7. Sensitivity context.

4.5. Planning diagnosis

The RRGAs results are interpreted as planning diagnosis by RRGAs. If there is a retention-deficit condition in a place, the planning diagnosis would be to ensure housing stabilization and public access before assessing the design quality of the green asset as being adequate. In case of guarded retention, the diagnosis will include building trust and anti-displacement measures so that environmental improvement can be trusted by local communities. For the investment bottleneck, the diagnosis includes land use controls and public benefit requirements in addition to anti-consumption branding of the district.

Table 7. Governance diagnosis.

Neighborhood	Dominant civic gate	Required adaptation condition
East Boston	Tenure stability and public waterfront orientation	Link resilient shoreline and park investment to anti-displacement housing, enforceable public access, community land control and protections against waterfront amenity capture.
Hunting Park	Access-belonging trust under anticipatory displacement concern	Pair tree planting, park renewal and stormwater work with affordability preservation, maintenance agreements, neighborhood hiring and transparent safeguards against speculative signaling.
Amsterdam Noord	Public-development orientation under selective reinvestment	Condition waterfront and green redevelopment on affordable housing, non-commercial public space, protection for lower-income residents and civic oversight of creative-district branding.
Poblenou	Tenure stability and development dissatisfaction under high benefit recognition	Integrate green corridors and superblock planning with small-business protection, community-garden security, short-term-rental control, affordable housing and resident authority over public-space change.

Thus, in both East Boston and Poblenou there is a great need to invest in housing and land use. However, in the former case, the planning diagnosis shows that the civic structure of green climate gentrification is shaped by the retention gate; in the latter case, the diagnostic structure shows that the conflict occurs due to the contradiction

between highly appreciated greening and the strong redevelopment pressure. Hunting Park's diagnostic reveals that distrust is the critical condition of adaptation in the neighborhood. For Amsterdam Noord, the retention diagnosis calls for public interest limitations on greening in relation to redevelopment.

5. Discussion

5.1. Civic retention as an adaptation outcome

These results suggest that retention-centered evaluation of climate adaptation should be used as the alternative to traditional delivery-centered assessment. The latter implies that a researcher checks whether there is a green infrastructure project in place, whether it helps with managing water, whether it is cooling the urban surface and whether it creates additional public spaces. This set of criteria is certainly essential but insufficient for conducting climate justice research. What else can we say about retention? The civic retention of greening becomes particularly important in marginalized districts where the most needy in terms of environmental repair are also at high risk of displacement due to land market pressure.

As the East Boston case demonstrates, if adaptation is realized in association with luxury housing projects, then it might benefit the landowners but fail to contribute to the wellbeing of long-term residents. Exclusionary protection is the opposite scenario of retention; a landscape becomes safer or more comfortable for its current inhabitants but does not guarantee that they will be able to use it in the future since its value goes up. Thus, RRGGA shows the lowest civic retention in the case when a project is environmentally efficient but socially ineffective.

Hunting Park presents another civic challenge associated with climate change adaptation. While this neighborhood clearly requires investment in greening, the fear of green gentrification raises a very important issue about how people interpret the necessity of investment. In this regard, the question of trust becomes particularly relevant. How can we make sure that people will not become displaced in connection with the introduction of new green infrastructure? Thus, it is the issue of maintenance, affordability, and recognition of the benefits.

The Amsterdam Noord and Poblenou cases show that even in the European setting the phenomenon of green climate gentrification remains actual and poses problems related to adaptation equity. Rent control, financial subsidies, and other characteristics of welfare states mitigate the risk of displacement, but not always. The case of Amsterdam Noord shows the interaction between greening, redevelopment, and reinvestment. As for Poblenou, it demonstrates the link between public-space improvements and innovation/tourism/student housing development, something common for many places in Barcelona [23]. Civic retention becomes impossible when urban spaces are designed primarily for certain groups of residents.

5.2. Added value of the gate-based reading

The gate-based approach introduces several advantages over traditional research on green climate gentrification. First, it distinguishes between the recognition and retention of benefit, which is important for understanding the dynamics of the adaptation process. If the residents value greening and still view it as insecure, it means that they lack confidence in the authorities' ability to prevent displacement. Poblenou is a case in point as it shows the highest benefits score while the exclusionary-protection tension also reaches the highest value, which means that greening should be discussed critically rather than celebrated.

Second, RRGGA allows us to define the dominant closure point. In East Boston, the retention gate reflects the tenure and waterfront marketization processes; in Hunting Park, the closure point is associated with distrust and access-belonging concerns. For Amsterdam Noord, the dominant gate is redevelopment; in the case of Poblenou, it is greening coupled with the overall land use transformations. This characteristic feature makes it possible to propose targeted interventions since each of these cases requires a particular type of planning policies.

Third, the gate-based method eliminates compensation as a possible option. Additive approaches to analysis often treat the lack of salience in a pressure dimension as an advantage in another dimension, but this is not quite true

in the real-life situation. In other words, greening cannot become a source of displacement even if it is officially considered as such. For example, people who rent an apartment are not able to retain greening benefits if they pay higher rent in the process.

5.3. Planning and environmental-justice implications

Several key lessons can be learned from these cases. First, anti-displacement policies should be a mandatory component of green climate infrastructure. Tenancy and rent stability programs, cooperative housing and land trusts, property tax reduction, and small business protection are the necessary conditions for ensuring that climate-related benefits are retained. In the case when the community lacks these protections, green climate gentrification is likely to occur.

The second key lesson is that access to green spaces should be guaranteed in a broader sense than mere formal legality. Public parks can become exclusive regardless of whether they belong to the city. In addition to the issue of design, a range of additional factors, including the presence of commercial activities, poor maintenance, programming, and policing, can affect the perception of the space by the residents and prevent them from enjoying green spaces.

The third lesson is that fear of gentrification is not an obstacle but evidence that should be considered seriously. People's concern about the potential negative impact of green climate adaptation is not necessarily unjustified since urban histories include numerous examples of environmental projects which have been implemented in a context of poor protection of the most needy population. Thus, rather than asking residents to trust the project, city agencies should prove that they are capable of preventing the undesired outcome.

Finally, it is necessary to include civic retention as an indicator of adaptation effectiveness. Physical characteristics, including cooling or water management, should not be separated from the social conditions, namely risk of displacement, access quality, and resident participation in decision-making. RRGGA presents one way of generating a retention index out of ordinal data. However, there are many others including resident co-scoring and geospatial access estimation.

5.4. Strengths and limitations

The main strength of the paper is that it defines civic retention as an adaptation outcome and introduces a tool that allows assessing its level using ordinal data. The paper demonstrates that retention differs from recognition in the sense that a project can be viewed positively but still fail to bring the promised benefits. It also proves that there is a number of civic structures in which climate gentrification takes place.

The method also has limitations. For instance, it does not imply exact calculation since the categories and normalized values represent estimates made on the basis of interviews. The theoretical weight scheme can be questioned from a statistician's perspective. In order to reduce it, the sensitivity test was included, which proves the robustness of the results regardless of the weight scheme. Another limitation is that RRGGA cannot establish causality because of its design and type of data used.

It should also be mentioned that low salience in a dimension cannot be interpreted as the lack of adverse effects. Low scores in the access-belonging dimension in Amsterdam Noord and Poblenou do not mean that these aspects should be omitted from the planning agenda. Rather, they reflect the fact that there is a more important issue in the retained panel. More research is needed here, involving ethnography, public space use studies, mapping and analysis of displacement. Co-designing the scoring system might help to address this issue.

Nonetheless, the RRGGA can become a useful instrument for studying green climate gentrification. There are numerous cases in which researchers collect rich qualitative information that cannot be used in statistical analyses because of its categorical and comparative character. However, leaving it in narratives is undesirable as well. In addition, cities keep introducing nature-based adaptation measures while competing for investment and residents. Therefore, tools to distinguish improvement from protection are necessary.

6. Conclusion

This analysis proves that there is a great gap between the benefit recognition and retention of civic value when evaluating the efficiency of climate adaptation. It also confirms that retention is a complex issue, reflecting different civic structures across cases. The lowest score is achieved by East Boston, which is characterized by relatively strong tenure and waterfront market pressures in conjunction with weak benefit recognition. Hunting Park has the highest score, yet its residents' fear of green gentrification shows that retaining benefits is a challenging task. In Amsterdam Noord, the civic structure is represented by the investment bottleneck since green and waterfront improvements are accompanied by selective redevelopment. Poblenou has the highest exclusionary-protection tension since the residents value greening highly but are faced with significant pressures.

In summary, one can say that green climate adaptation will not benefit communities in the event that it improves the environment without helping people to stay in place. In other words, resilience of a shoreline, renewal of a park, creation of a green corridor, and construction of a superblock become meaningless when they increase the value of the place but deprive its inhabitants of the possibility to stay, govern, access, and identify with the new place. This problem can be solved through the design of anti-displacement and retention-oriented planning policies.

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