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Nature, urban life and the deep structures of urban belonging: a retrospective on leverage points in Porto, Portugal

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Some images stay with us long after the fieldwork ends. An elderly man sitting alone beneath a plane tree in the Jardim da Corujeira; a homeless person sheltering in the bandstand of Arca d'Água; a couple silently reading in the shade of the Cordoaria. Four years after concluding doctoral research on urban green spaces (UGS) in Porto, Portugal, these scenes continue to inform how I understand the city. They speak of something that ecosystem service metrics and resilience indicators rarely capture: the quiet, embodied, and deeply human work that urban nature performs in sustaining the very possibility of inhabiting a city. Contemporary urban governance, dominated by the languages of optimization, smart infrastructure, and techno-managerial efficiency, tends to reduce nature to a functional instrument. This perspective article argues that such framings, however necessary, operate at the shallowest levels of systemic intervention. Drawing on the methodological triangulation of my doctoral work—an ecosystem services assessment grid, a user survey, and human behavior mapping of 979 users across four contrasting spaces—I revisit the empirical evidence of a "two-speed city" marked by profound environmental injustice. From this retrospective vantage point, I propose the concept of deep structures of urban belonging to argue that UGS are relational infrastructures that mediate coexistence, memory, and ecological consciousness. The deepest urban leverage point, I suggest, is neither technological nor infrastructural. It is the slow transformation of how we collectively imagine, inhabit, and share the city with the living world.

KEYWORDS
affordances, environmental justice, heterotopia, leverage points, relational ecology, urban green spaces, urban sociology

1 Introduction

It is a late spring afternoon in the Jardim da Cordoaria, in the historical centre of Porto, north of Portugal. A retired man feeds pigeons with the patience of someone who has nowhere urgent to be. A few benches away, a young woman closes her laptop and lifts her face toward the canopy of centennial trees, as if borrowing a breath from them. A tourist photographs the wrought-iron bandstand while, almost invisibly, a man sleeps curled against its base, his belongings carefully arranged around him. The city continues to roar beyond the garden's perimeter—buses, sirens, construction—but inside this fragile rectangle of green, a different temporality unfolds. Scenes like this one, witnessed countless times during my doctoral fieldwork (Vidal, 2022), do not appear in ecosystem service inventories. They do not register on

environmental performance dashboards. And yet, they are arguably where the urban ecological question becomes most legible.

Contemporary urban life is increasingly characterized by acceleration, fluidity, and a pervasive sense of socio-ecological precarity. Bauman (2000) diagnosis of "liquid modernity" remains painfully apt: the structural conditions of contemporary society dismantle enduring collective bonds and foster an individualization that progressively empties public space of its historic socializing functions. Simultaneously, the modern epistemological project, what Latour (1993) recognized as the artificial purification of "nature" from "society", has externalized the living world from urban experience, framing the city as an exclusively human artefact. Within this dominant paradigm, urban nature has been systematically instrumentalized, treated as aesthetic backdrop, real-estate amenity, or engineering solution to the metabolic excesses of the built environment (Čapek, 2010).

In recent years, the discourse on urban sustainability has come to be dominated by frameworks such as the "smart city" and "green infrastructure," which approach ecological crises through the lenses of efficiency, optimization, and data-driven management. While such approaches address indispensable metabolic challenges, they operate primarily at what Meadows (1999) identified as "shallow" leverage points, adjustments to parameters, buffer sizes, and material flows. They rarely touch the "deep" leverage points, which are the goals of the system, the rules that govern it, and, most crucially, the worldview from which the system itself arises. When urban green spaces (UGS) are reduced to mere providers of ecosystem services, such as carbon sinks, stormwater buffers, and air purifiers, we leave intact the deeper existential rupture at the heart of the urban ecological crisis (Rosa, 2021).

This perspective article is a critical reflection on my 2022 doctoral thesis, which investigated the socio-environmental dynamics of UGS in the city of Porto, Portugal. Six years removed from the initial fieldwork, this is not a summary of findings, but an exercise in analytical maturation, an attempt to move from the descriptive inventory of urban nature toward a systemic, relational, and existential interpretation of the city. Re-engaging with the empirical evidence through the lens of Meadows' systems thinking, I propose the concept of deep structures of urban belonging. By deep structures of urban belonging, I refer to the enduring socio-ecological foundations through which individuals and communities come to experience themselves as meaningfully situated within a particular urban environment. These structures are constituted through the cumulative interaction of memory, everyday practices, embodied experience, social relations, and encounters with the more-than-human world. Unlike place attachment, which primarily concerns affective bonds between people and specific places, or ecological identity, which focuses on the incorporation of nature into the self-concept, deep structures of urban belonging describe the broader relational architecture through which urban life becomes intelligible, shared, and ecologically grounded. They operate at the level of paradigms and worldviews, shaping not only how urban residents feel about places, but how they understand their relationship with the city, with one another, and with the living systems upon which urban existence depends. Three analytical dimensions constitute the concept and help clarify its distinctiveness. The first is the temporal dimension: deep structures are not momentary affects but sedimentary formations built through repetitive, habitual engagement with specific urban natures over time, what Rosa (2021) would recognise as the slow, resonant accumulation of world-relations. The second is the relational dimension: these structures emerge not within isolated individuals but in the intersubjective space between people, between social groups, and between human and non-human inhabitants of the city. They are co-produced in the shared appropriation of benches, canopies, and water features, in the silent negotiations of space that daily life in a public garden demands. The third is the paradigmatic dimension: unlike place attachment, which remains largely affective and biographical, or ecological identity, which operates at the level of individual self-concept, deep structures of urban belonging are worldview-generative. They do not merely tell us how people feel about a garden; they shape how those people understand the city as a socio-ecological whole, how they apportion moral consideration between human and non-human inhabitants, and what forms of urban governance they are likely to find legitimate or alienating. It is this third dimension that places the concept firmly within the register of Meadows' deep leverage points: the paradigms and goals of the system itself. I argue that UGS function as relational infrastructures whose true transformative potential lies in their capacity to operate as deep leverage points, quietly altering the paradigm through which urban inhabitants experience, value, and ultimately belong to the socio-ecological fabric of the city.

2 Revisiting Porto six years later: from inventory to insight

The original investigation sought to understand how UGS in Porto were responding to contemporary socio-environmental challenges. The empirical architecture of the thesis relied on methodological triangulation to capture the multidimensionality of urban nature. Out of 95 UGS identified across the municipal territory, a representative sample of 25 spaces was selected for in-depth assessment. The methodology combined an ecosystem services assessment grid (based on the Common International Classification of Ecosystem Services—CICES), a survey of 131 UGS users, and systematic Human Behaviour Mapping (HBM) capturing the activities of 979 users across four diverse spaces: Arca d'Água, Corujeira, João Chagas (Cordoaria), and Mouzinho de Albuquerque.

The initial inventory revealed a stark paradox in urban planning metrics. At a macro level, Porto appeared highly sustainable, boasting a gross 54.8 m^2 of green area per inhabitant. However, when parsing the data to include only directly accessible public green spaces, the spaces where everyday urban life actually unfolds, the metric plummeted to a mere 7.8 m^2 per inhabitant, falling noticeably below the World Health Organization's recommended threshold of 9 m^2. This discrepancy highlighted how abstract territorial parameters often obscure the lived reality of the urban populace.

Six years later, it is necessary to acknowledge both the robust insights and the inherent limitations of that study. The survey relied on convenience sampling, yielding a user profile skewed toward a highly educated (84.7% with higher education), employed (81.7%), and predominantly female (68.7%) demographic, with a mean age of 42. Furthermore, 53.8% of respondents accessed these spaces by car, and 58.3% lived more than a 30-minute walk away. Fieldwork was also heavily conditioned by the COVID-19 pandemic, restricting spatial interactions and dictating daytime-only observations, thereby leaving the nocturnal temporalities of the

city completely unexamined. Yet, these very limitations propelled a theoretical shift. The realization that highly educated, mobile citizens were driving across the city to access quality green spaces pointed to a severe malfunction in the equitable distribution of local, walkable urban nature. The thesis inventory was merely the diagnostic surface since the underlying pathology was profoundly structural. It is worth making explicit the analytical pathway through which this shift from inventory to concept was traversed. The juxtaposition of three distinct data streams—the ecosystem services grid revealing spatial disparities in ecological quality; the survey evidence of selective, mobile, and highly educated usage patterns; and the behavioral mapping exposing emergent, unscripted appropriations of space—created an interpretive tension that descriptive categories alone could not resolve. Taken together, they pointed toward something that the ecosystem services framework structurally cannot capture, which is the differential capacity of urban spaces to generate, for differently positioned social actors, a felt sense of belonging to the living city. It is precisely this gap between the measurable and the relational that the concept of deep structures of urban belonging is designed to address.

2.1 The two-speed city: environmental injustice as a structural leverage point

Perhaps the most alarming empirical finding of the research was the crystallization of Porto as a "two-speed city," defined by a severe East–West socio-spatial asymmetry. Applying the Socio-economic and Environmental Deprivation Index (IPSA), the data demonstrated that the eastern parishes, characterized by higher socio-economic deprivation, housed green spaces of significantly lower quality and ecosystem service potential. In stark contrast, the western, wealthier waterfront areas benefited from heavily invested, highly equipped recreational parks. This inequality materialized visibly: 71.5% of all recorded vandalism signals were concentrated in UGS located in "High Deprivation" areas.

In the original thesis, this was described as a "two-speed response" to socio-environmental challenges. Today, through Meadows' systemic framework, this phenomenon must be re-theorized as a pernicious positive feedback loop. Urban political ecology teaches us that spatial inequality dictates the allocation of environmental quality, which in turn reinforces social stigmatization and disinvestment. When the most vulnerable populations are provided with degraded, unsafe, and poorly maintained green spaces, the therapeutic and socially cohesive functions of those spaces collapse. The research found a significant association between user satisfaction with UGS and self-perceived physical and mental health (Lencastre et al., 2024; Vidal et al., 2021); however, this benefit was unevenly and unjustly distributed, effectively hoarding wellbeing in affluent zip codes. This environmental injustice is, at its core, an existential injustice. It denies marginalized urban populations access to the restorative interludes required to cope with the exhaustive demands of liquid modernity. If urban governance only applies shallow leverage interventions, such as sporadic tree planting without addressing the structural socio-economic divides, the system will persistently revert to its baseline of inequality. Breaking this feedback loop requires intervening at the paradigm level: recognizing that equitable access to high-quality nature is not a luxury amenity, but an unconditional right to the city, echoing Lefebvre (1974) mandate for the spatial reclamation of urban life.

2.2 Urban green space typologies as leverage potentials

To further unearth the systemic potential of these spaces, the thesis proposed a five-cluster typology based on the CICES grid: (1) Environmentally enabled and socially expectant; (2) Socio-environmentally active; (3) Environmentally enabled but socially adynamic; (4) Socio-environmentally inactive; and (5) Socio-environmentally unexplored (Vidal et al., 2022b). Rather than viewing this typology as a static descriptive taxonomy, six years of reflection allow us to interpret these clusters as distinct leverage potentials. For instance, spaces that are "environmentally enabled but socially adynamic" do not need ecological engineering. They require socio-cultural activation. Conversely, "socio-environmentally inactive" spaces in deprived neighborhoods demand comprehensive, paradigm-shifting reinvestment. Crucially, the research demonstrated that UGS perform a vital role in shaping ecological paradigms. By applying the New Ecological Paradigm (NEP) scale, developed by Catton and Dunlap to measure ecocentric versus anthropocentric worldviews, the study found a direct correlation: users who visited UGS on a weekly basis exhibited significantly higher ecocentric worldviews (Vidal et al., 2022a). They were more likely to reject the Human Exceptionalism Paradigm (HEP) and acknowledge the intrinsic right of non-human species to coexist within the urban matrix.

This finding is theoretically explosive. It suggests that ecological consciousness is not solely generated through formal education or abstract climate discourse, it is fundamentally relationally and spatially constructed through somatic, repetitive immersion in the living world. Consequently, UGS must be conceptualized as relational infrastructures. They are the civic laboratories where the modern divide between nature and society is practically and emotionally dismantled. A necessary critical caveat must be acknowledged here. The cross-sectional design of the original study prevents any confident claim about the direction of this association. An equally plausible interpretation is that individuals already holding more ecocentric worldviews are precisely those who seek out and sustain habitual contact with urban green spaces, that is, the relationship may reflect selective exposure rather than attitudinal transformation through experience. The Porto data cannot adjudicate between these readings. What they do permit, however, is the formulation of a theoretically grounded hypothesis: that repeated, embodied presence in high-quality, relationally rich green spaces constitutes at least one pathway through which anthropocentric assumptions are quietly eroded. Whether this operates through mechanisms of cumulative resonance, as Rosa's framework would suggest, or through the cognitive processes associated with attention restoration and awe, as the environmental psychology literature proposes (Kaplan and Kaplan, 1989), remains a productive question for future longitudinal research. The important point, for the argument advanced here, is not to establish monocausal explanation but to identify a structural affinity between ecological contact and paradigmatic

openness, an affinity that the concept of deep structures of urban belonging is designed to theorise and that future research must empirically probe.

3 Affordances, heterotopias and the deep structures of urban belonging

To understand how these relational infrastructures actually operate at the micro-sociological level, we must return to the fine grain of the empirical evidence. Across the four spaces selected for systematic Human Behaviour Mapping (HBM), 979 individual users were observed and coded according to their bodily postures, durations, directionalities, and forms of association (Vidal et al., 2022c). Read against the conceptual horizon offered by Gibson (2014) and Ingold (2021) notion of affordances, which are the possibilities for action that an environment offers a perceiving body, and by Foucault (1986) notion of heterotopia, the "other space" capable of suspending and contesting the dominant ordering of the city, the data ceases to be a behavioral inventory and becomes a sociological cartography of urban inhabitation.

Consider, by way of illustration, a single morning at the Jardim da Corujeira, located in one of Porto's most socio-economically deprived eastern parishes. A group of elderly men gathers around a stone bench at the precise angle where the plane trees cast their densest shade. They do not engage in any of the activities urban planners typically design for: they do not exercise, do not consume, do not transit. They sit, and they talk, sometimes for hours, almost every day. The bench, the shade, the absence of through-traffic, the visual proximity to their neighbourhood. These are not amenities, in any consumer sense. They are affordances, in Gibson's precise meaning, relational properties that emerge only in the encounter between a particular environment and a particular embodied life. A polished marble bench in a flagship waterfront park would not afford the same sociability. Conversely, the modest plane-tree corner of Corujeira affords something no smart bench with a USB charger could ever replicate. The behavioral patterns mapped across the four spaces revealed precisely this differentiated landscape of affordances. At the historic Jardim João Chagas (Cordoaria), the dense canopy and winding paths afforded sleeping, photography, and quiet courtship. In Arca d'Água, the geometry of the lawn and the perimeter circuit afforded physical exercise and contemplative observation of waterfowl. The Mouzinho de Albuquerque roundabout, by contrast, afforded primarily transit, punctuated by solitary acts of eating and reading. Each space functioned not as a generic "green amenity" but as a singular configuration of possibilities, intimately co-produced by its ecological materiality, its design history, and the social composition of its users.

More revealingly still, the mapping exposed emergent, unscripted functions that challenge the sanitizing logics of contemporary spatial production. Both the Cordoaria and the bandstand at Arca d'Água were routinely appropriated as informal shelters by homeless individuals, who arranged their belongings with extraordinary care around the wrought-iron columns. In these moments, the urban garden becomes a Foucauldian heterotopia in the fullest sense: an "other space" that simultaneously mirrors and inverts the dominant socio-economic ordering of the city. It accommodates those whom the housing market has expelled, performing a function of fragile sanctuary that no policy document acknowledges yet every careful observer encounters. Heterotopia, in this register, it is an empirically documented mechanism through which urban nature absorbs the social contradictions that the rest of the city has off-loaded.

Affordances and heterotopias together constitute, I want to argue, the micro-mechanism through which deep paradigm shifts in the city become possible. When an elderly resident finds enduring community under the shade of a centennial plane tree, when an exhausted worker sleeps on the grass during a lunch break, when a homeless person finds in a bandstand a temporary geometry of dignity, these are not residual or peripheral phenomena. They are the elementary acts through which the deep structures of urban belonging are continuously reproduced, built, that is, upon the sensory, temporal, and relational continuities that anchor human life within a specific, breathing, multi-species geography. Figure 1 offers a synthetic mapping of how the five typological clusters identified in the original Porto study can be re-read, six years later, as differentiated leverage potentials along the spectrum between shallow techno-managerial greening and deep ecological inhabitation.

What are the implications of these findings for the governance of complex urban systems? First, we must aggressively critique the dominant frameworks of the "smart city" and purely infrastructural greening. While sensors and automated irrigation optimize metabolic flows, they operate at the shallowest levels of systemic intervention. A smart city that fails to foster ecological belonging remains an alienating city. Second, as cities recognize the value of greening, they inadvertently trigger the paradox of green gentrification. The influx of capital into newly greened areas often displaces the very marginalized communities that desperately require access to relational infrastructures. To intervene at a deep leverage point, urban planning must adopt the "just green enough" (Curran and Hamilton, 2018) strategy championed by critical urban geographers, coupling ecological restoration with aggressive anti-displacement housing policies. Environmental justice cannot be achieved if ecological improvements result in spatial expulsion. Ultimately, the deep structures of urban belonging represent the highest leverage point in the urban system: the paradigm out of which the city arises. Shifting this paradigm means abandoning the anthropocentric view of the city as a machine for capital accumulation and embracing a socio-ecological vision where the city is an autopoietic system of multi-species coexistence. Ecological belonging, the localized, affective, and equitable integration of human and non-human life, is not a byproduct of sustainable cities, it is the fundamental precondition for their existence. A third and final implication concerns the scope and transferability of the argument itself. Porto is not a universal city. It is a medium-sized Southern European urban centre with a particular history of socio-spatial segregation, a dense inherited fabric of neighbourhood-scale green spaces, and a cultural ecology marked by what might loosely be termed a Southern European relationship to public space: sociable, slow, heavily indexed to the rhythms of the street and the square. These conditions almost certainly inflect the specific forms through which deep structures of urban belonging are constituted and expressed in Porto, and they cannot be assumed to operate identically in, say, a rapidly expanding African megacity, a North American suburb designed around the private automobile, or a Northern European city with a different tradition of publicly managed nature. This contextual specificity does not diminish the analytical ambition of the concept but it clarifies its proper scope and, more importantly, opens an invitation to comparative research. Recent international work on urban political ecology (Lawhon et al., 2014), on the social production of nature in cities of

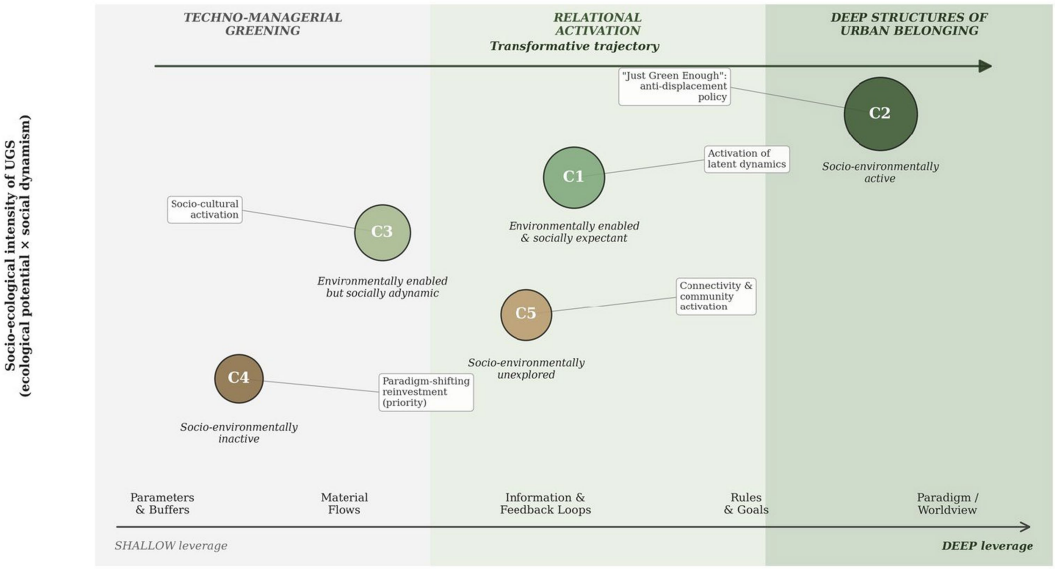

FIGURE 1
Conceptual mapping of the five typological clusters of urban green spaces identified in the Porto study (Vidal, 2022), positioned along the horizontal axis of Meadows (1999) leverage points framework—from shallow parameter adjustments to deep paradigm transformation—and the vertical axis of combined socio-ecological intensity. The figure suggests that each cluster calls for a qualitatively distinct mode of intervention, ranging from infrastructural retrofitting and connectivity strategies to anti-displacement policies and paradigm-shifting reinvestment in socio-environmentally inactive spaces.

the Global South (Lawhon et al., 2014; Anguelovski et al., 2016), and on the relational dimensions of urban belonging in post-colonial contexts (Fincher and Iveson, 2008) offers rich interlocutors for this conversation. Similarly, Amin's (2006) theorisation of urban public space as the site where strangers negotiate a shared, if always precarious, civic life resonates directly with the behavioral patterns documented here.

4 Conclusion

Six years after the original fieldwork ended, what remains most vividly in memory it is the image of people inhabiting the city through its fragments of urban nature. Such scenes may appear superficial from the perspective of conventional urban planning, yet they reveal something fundamental about the relationship between cities, nature, and human flourishing.

Revisiting the Porto study through Meadows' framework of leverage points has led me to a different understanding of what urban green spaces ultimately do. Their significance does not reside solely in the ecosystem services they provide, important though these remain. Nor can it be reduced to questions of design quality, environmental performance, or technological optimisation. Their deepest transformative potential lies in their capacity to sustain what I have termed the deep structures of urban belonging, I mean the relational, affective, and ecological foundations through which people come to experience themselves as part of a shared urban world.

Seen from this perspective, the most consequential leverage points in cities are not necessarily found in infrastructure, regulations, or technological systems, but in the paradigms through which urban life is constantly (re)imagined and organised. The challenge for urban governance to cultivate the conditions under which meaningful forms of socio–ecological coexistence can emerge. This requires confronting environmental injustice, resisting the displacement dynamics associated with green gentrification, and recognising equitable access to high-quality urban nature as a fundamental dimension of the right to the city.

The argument advanced here remains necessarily exploratory. The concept of deep structures of urban belonging requires further theoretical refinement and empirical testing across different urban contexts and cultural settings. Future research may examine how such structures are formed, how they evolve over time, and how they influence ecological consciousness, collective resilience, and urban transformation. Yet if there is one lesson that six years of analytical distance has made clearer, it is that the future of sustainable cities may depend less on how efficiently we manage urban nature than on how deeply we learn to belong within it.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by Ethics Committee of University Fernando Pessoa. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

DV: Validation, Visualization, Conceptualization, Writing – review & editing, Writing – original draft.

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Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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